World Sustainability Series

Walter Leal Filho
Diogo Guedes Vidal
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Ricardo Cunha Dias *Editors*

Sustainable Policies and Practices in Energy, Environment and Health Research

Addressing Cross-cutting Issues

Springer

World Sustainability Series

Series Editor

Walter Leal Filho, European School of Sustainability Science and Research, Research and Transfer Centre "Sustainable Development and Climate Change Management", Hamburg University of Applied Sciences, Hamburg, Germany

Due to its scope and nature, sustainable development is a matter which is very interdisciplinary, and draws from knowledge and inputs from the social sciences and environmental sciences on the one hand, but also from physical sciences and arts on the other. As such, there is a perceived need to foster integrative approaches, whereby the combination of inputs from various fields may contribute to a better understanding of what sustainability is, and means to people. But despite the need for and the relevance of integrative approaches towards sustainable development, there is a paucity of literature which address matters related to sustainability in an integrated way.

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Editors
Walter Leal Filho
Hamburg University of Applied Sciences
Hamburg, Germany

Manchester Metropolitan University
Manchester, UK

Maria Alzira Pimenta Dinis
UFP Energy, Environment and Health
Research Unit
Fernando Pessoa University
Porto, Portugal

Diogo Guedes Vidal
UFP Energy, Environment and Health
Research Unit
Fernando Pessoa University
Porto, Portugal

Ricardo Cunha Dias
Centre for Public Administration
and Public Policies
Institute of Social and Political Sciences
University of Lisboa
Lisbon, Portugal

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Preface

This book aims to provide a contribution to a more comprehensive and interdisciplinary understanding of the cross-cutting issues on energy, environment and health research topics. These subjects are closely connected, and although interdisciplinarity implies a commitment between all fields of science, working together to provide knowledge that could result in the promotion of quality of life, this is not always implemented in practice.

The relationships between sustainable policies and practices on the one hand, and energy, environment and health research on the other, are scarcely exploited in an integrated way. Yet, a broad understanding of all interconnected issues helps towards their integration and this is a positive trend in the sense that it provides outcomes for existing similarities. Such associations also contribute to highlight a cross-cutting problem of contemporary governance and it is up to science to discuss it, aiming to achieve more informed and integrated policies.

A further element which is in favour of integrated approaches is that they may allow different stakeholders to work together. This includes universities, companies, governmental and non-governmental organisations and civil society, which, combined, may articulate together to not only discuss common problems, but also to reach possible solutions.

This book, produced by the European School of Sustainability Science and Research (ESSSR) and the Inter-University Sustainable Development Research Programme (IUSDRP), gives a special emphasis to state-of-the-art descriptions of approaches, methods, initiatives and projects from universities, stakeholders, organizations and civil society across the world, concerning cross-cutting issues in energy, environment and health research.

The book is structured in 3 parts:

Part One—Sustainable Concerns, Beliefs and Values
Part Two—Interdisciplinary Approaches and Methodologies
Part Three—Sustainable Practices and Solutions

These, in turn, address the following aspects:

- Discussions on practical experiences from different stakeholder groups towards sustainable development and cross-cutting issues in energy, environment and health
- Descriptions on the implementation of sustainable development initiatives to solve cross-cutting issues involving energy, environment and health
- Examples of partnerships and networks on sustainable development persuing energy, environment and health cross-cutting issues
- Perspectives of policy and governance towards sustainable development
- Successful experiences involving various sectors of society
- The interconnection between social inequalities and cross-cutting issues in energy, environment and health topics
- Agenda 2030 related issues

A special feature of this book, is that it not only presents a wide range of perspectives, approaches, methods and analyses about sustainability policies and how they relate to energy, environment and health research, but also documents and disseminates specific case studies, which show how this integration may be accomplished in practice.

We would like to thank all authors and reviewers for making available their experience in their chapters, and the willingness to share their ideas. By providing their inputs, the authors have made a positive contribution towards a debate which needs to be continued, and reach a depth far beyond what conferences, workshops or seminars may be able to offer.

Hamburg, Germany/Manchester, UK — Walter Leal Filho
Porto, Portugal — Diogo Guedes Vidal
Porto, Portugal — Maria Alzira Pimenta Dinis
Lisbon, Portugal — Ricardo Cunha Dias
Winter 2021/2022

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Sustainable Concerns, Beliefs and Values

Sustainability Perception of Lotic and Lentic Ecosystems in the Amazon Basin Through the Lens of a Local Community

Ana Sibelonia Saldanha Veras, Diogo Guedes Vidal, Nelson Azevedo Barros, and Maria Alzira Pimenta Dinis

1 Introduction

In the context of hydric resources distribution, Brazil holds the highest hydric availability on the planet, being responsible for almost all the total average change of water bed stream in South America. Brazil has an unequal distribution of its resources, specifically considering the Amazon basin, located in a region with low population density. Therefore, to study the lotic ecosystem is relevant, particularly in the Amazon region, to provide knowledge on lakes comprehension, i.e., naturally formed depression that stores freshwater, and hydrological conditions that play a key role in interactions with terrestrial processes, essential to sustain life through the quality of water in many *igarapés* (streams), i.e., small rivers. This ecosystem is part of the Earth's bloodstream, vital to individuals survival, as well as for nature balance, food and raw material provision, playing a crucial role in remote communities, namely those located in the Amazon Basin.

Water is the second most important component of the Earth, in addition to air, used as irrigation for crops, cooling equipment, industrial chemical processes, city growth, hygiene, as geopolitical divider and means of connectivity, navigation, leisure and recreation (Sabo et al. 2010; Falkenmark 2016; Herrera et al. 2019; Bogardi et al. 2020; Güntzel et al. 2020; Wetser et al. 2020; Plummer and Baird 2021). Individuals cannot survive without water. Accordingly, freshwater man-

A. S. S. Veras (✉)
University Fernando Pessoa, Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: 39347@ufp.edu.pt

D. G. Vidal · N. A. Barros · M. A. Pimenta Dinis
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa, Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: nelson@ufp.edu.pt

M. A. Pimenta Dinis
e-mail: madinis@ufp.edu.pt

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agement has resulted in several concerns and discussions in world forums (e.g., Brundtland Report—Our Common Future), a historical milestone in which sustainable development concept was defined as "… meeting the needs of the present without compromising the survival of future generations". This concept was widely shared in the (United Nations 2000). Thus, the Conference on the Environment—Rio 92, which allowed advances and the adoption of the 21 Agenda, presenting the need to understand the social, cultural, territorial, economic, political (national and international), and environmental dimensions, on the effects of the rapid climate changes and, consequently, on the Earth limits and resilience to support it. Alongside, sustainable tourism practices (i.e., leisure, sport and geotourism) must be committed to a sustainable development vision, depending on proper environmental management, to ensure long-term sustainability (Hummels and Argyrou 2021; Managi et al. 2021; Mihalic et al. 2021).

Considering the background, this work aims to identify the perceptions and attitudes of a local community in the Amazon Basin on lotic and lentic ecosystems in the context of Geotourism activity and its implementation to achieve the Sustainable Development Goals (SDGs). The main sustainability challenges of SDGs 6, 10, 14 and 15 are presented as well as the existing infrastructure to support Geotourism activity.

1.1 Overview of Ecosystem Services of Rivers and Lakes

Ecosystems are open systems comprising environments, both abiotic and biotic, that interact in processes contributing to human well-being, either directly or indirectly. They provide scientific evidence for stakeholders, i.e., public managers and natural water managers, as well as policymakers, to visualise environmental scenarios for future decision-making. In this regard, it is worth noting that these services have been a subject of concern, and their genesis was defined by Walter Westman (1977 *apud* Costanza et al. 2017) in his work "How much are nature's services worth?". This was followed by the development of the concept of "ecosystem services", advocating benefits for human well-being with a focus on the economic and ecological bias (Ehrlich and Ehrlich 1981; MEA 2005; Costanza et al. 2017; Butorac and Buzjak 2020; Aziz 2020; Tengberg et al. 2021). In this complex interaction, there is a heterogeneity of aquatic habitats, including rivers, streams, swamps, and lakes, which points to an enormous potential for research in various areas of the sciences due to its clear, transparent water ecosystems, related to the origins of the Amazon region (Morato 2018; Silva et al. 2020). Although lakes are a small component of the biosphere, they are valuable and necessary, as they cover five million square of the Earth's surface, according to satellite imaging studies (Verpoorter et al. 2014). The Brazilian Amazon, specifically the Northern region of Brazil, is comprised of the Amazon River basin, the most extensive basin on the planet, formed by 25,000 km of navigable rivers in about 6,900,000 km^2, of which approximately 3,800,000 km^2 are in Brazil. The Legal Amazon, as stated in

art. 2 of Law 5.173, of October 1966, includes the states of Acre, Amapá, Amazonas, Mato Grosso, Pará, Rondônia, Roraima, Tocantins and part of Maranhão, and their ecosystems (Brazil 1966; IBGE 2010).

Lotic, e.g., rivers, and lentic, e.g., lakes, ecosystem consist of water bodies that are mostly found in depressed terrain and have no connection with the sea. The fluctuation of a lake's water occurs as a result of the water balance, which emerges from the interaction with the atmosphere, involving precipitation and evaporation, and groundwater, including hydrothermal water (Riccomini et al. 2015, p. 194). Therefore, freshwater ecosystem contributes to climate regulation, assisting nutrient cycling for vegetation, where ecological and biogeographic processes predominate. They are essential and indispensable to individuals living in remote areas, transporting water and materials, maintaining water quality and enabling human development, as these communities not only interact with the place but are also inhabitants of the biosphere and therefore beneficiaries of freshwater services over time (Folke et al. 2016; Janssen et al. 2021; Filocamo et al. 2020; Salinas-Rodríguez et al. 2021).

Amazon, a region with low population density, is a natural environment of floodplain areas, being considered one of the least known environments in the world and one of those that provide more ecosystem services, ensuring the maintenance of life and standing out as an essential ecosystem at a global level (Castello and Macedo 2015; Latrubesse et al. 2020). Despite the worldwide acknowledgement of Amazon contribution to global ecosystem balance, several studies pointed out the dramatic deterioration of these terrestrial and marine freshwater bodies, which implies global vulnerability, originated by overexploitation and with dramatic consequences to biodiversity, livelihoods, and human health (IBGE 2010; Bogardi et al. 2020).

1.1.1 Lotic and Lentic Resources: Rivers and Lakes and Human Use

Lotic and lentic resources in the Amazonian plain are the result of sediment deposition, flooding of floodplains or meander cutoffs. As part of global environmental change, geochemical cycles have received considerable attention from governments since the 1980s. Many lakes had their morphology changed in recent decades as they are affected by climate change and human activity, i.e., the human-induced changes. These lakes may be formed along large rivers when sediments from the main channel are deposited as dykes at the mouth of tributaries, forming a lateral lake, and are permanent in the landscape. Changes are reflected by lake water levels and by the provision of significant habitat for a diverse group of organisms (Hirata 2015; Tan Chao and Kuang 2017; Bucak et al. 2018; Tortajada 2020; Abbasi et al. 2020).

The hydrology of the Amazon basin is significant because it is configured as a enormous complex of rivers, streams, canals, creeks, and lakes with about 20% of all freshwater on Earth. Hydrochemical characteristics are influenced by the Andean mountains, where mineral-rich sediments originate, creating not only the typically

muddy colouration of waters but also originating turbulent waters, as well as watercourses from the Guiana Shield and Central Brazil (De Souza Paes and da Silva 2021).

Of all the regions on the planet, South America is one of the most vulnerable to climate change caused by natural factors, such as the temperature oscillation of the Atlantic and Pacific oceans, a phenomenon which is known as *El Niño*, and anthropic factors originated from the burning of fossil fuel, industrialization and wildfires, leading this region to being severely affected by climate change (Marengo et al. 2011; Lawrence and Vandecar 2015; Andrade et al. 2018; Juelsgaard 2020).

1.2 Sustainable Development Goals (SDGs) 6, 10, 14 and 15

According to the tourism strategy, there are 17 global goals to achieve a true and fair sustainable environment for all within the SDGs, part of the construction of economic, social and environmental indicators necessary for different regions of the planet, along with the 21 Agenda important global commitment. These goals unfold into 169 targets for the period from 2015 to 2030, established by the Assembly of the United Nations Organization-UN, ratified by 193 countries, these being the current sustainability challenges that aim to provide incentives for future generations, leadership, and institutions that carry out the management of environmental dimensions (Lópes-Alcarria et al. 2021).

As a component of the SDGs, geotourism is an activity that correlates geological heritage to tourism in rural areas that emerges in the 1990s. Its benefits are far from being fully known, but current evidence states that this activity can help to reduce rural exodus from remote areas once its development provides new job prospects by using the interpretation of aesthetic resources to address diverse audiences (i.e., highly demanding audiences and scholars). Geotourism activity offers, among other attributes, a better understanding of Earth Sciences, with a focus on conservation and safeguard (Maghsoudi et al. 2019; Veras et al. 2020a, b; Frey 2021). After the recognition of a particular geosite comprising geological, geomorphological, stratigraphic and hydrogeological investigation, the access to fresh surface water is associated with sustainable development (SDGs: 6—essential water; 10—reduced inequalities; 14—life below water, protecting and managing life, and; 15—protecting, promoting and restoring the sustainable use of terrestrial ecosystems). Based on this approach, geotourism can be effective when properly applied in changing the conception of a more committed vision towards geodiversity, biodiversity and the establishment of partnerships with government sectors, stakeholders, and local communities, understood as the main protagonists of change in favour of local progress (Williams et al. 2020; Janssen et al. 2021; Pan et al. 2021).

2 Methodological Procedures

This research is of qualitative-descriptive-exploratory due to the scarcity of work in the area and because it analyses citizens' perceptions of the lotic and lentic ecosystem. The individuals' selection to be interviewed is based on those that are the most experienced in the region as well as those who live close to the water resources. However, due to pandemic scenario was not possible to reach greater number of respondents. Also, being a qualitative approach, the recruitment of respondents should end when theoretical saturation is reached, i.e. when no new properties and dimensions emerge during analysis in terms of observed behaviours and practices (Bloor and Wood 2006). It is expected that this research contributes to the implementation of geotourism within the Brazilian context, aiming to face the challenges of the SDGs 6, 10, 14 and 15.

The research design comprises three stages:

1. A literature review concerning relevant works in the area of lotic environments and sustainable development;
2. The fieldwork which carried out directly with local eight participants. A semi-structured interview script was designed and applied to household, either women or men, using quotes for subsequent content analysis, configuring a descriptive and exploratory methodology (Bardin 1977). The script (Table 1) covers the perception of lotic and lentic ecosystems trough six questions (Minayo 2001; Babbie 2003; Günther 2003; Marconi and Lakatos 2012). The interviews were conducted in homes distributed over a geographical space of 1.7–3 km on so-called vicinal roads or country roads.
3. An audition regarding the available infrastructure at the municipal headquarters, at the Mayor's Hall, as well as on the field. The number of hotels, points of sale of handicrafts, transportation, security, health and sanitation were tracked since these sectors provide indispensable services to the tourism chain. The coordinates through the Global Positioning System (GPS), for the design of a localization map of the research area (Fig. 1), were also recorded.

Table 1 Interview script

Questions
1. The importance of the region's natural water sources
2. Whether you have noticed any change in the water sources since you moved into this place
3. How the maintenance of natural sources is done, and whether you have seen any kind of intervention by the local authorities
4. How the tourist activity in the region is carried out, if they use these natural elements, and whether there is any impact
5. Whether you consider that it should be the local community's responsibility to maintain these natural elements
6. Whether you would do something different if you were responsible for maintaining these water

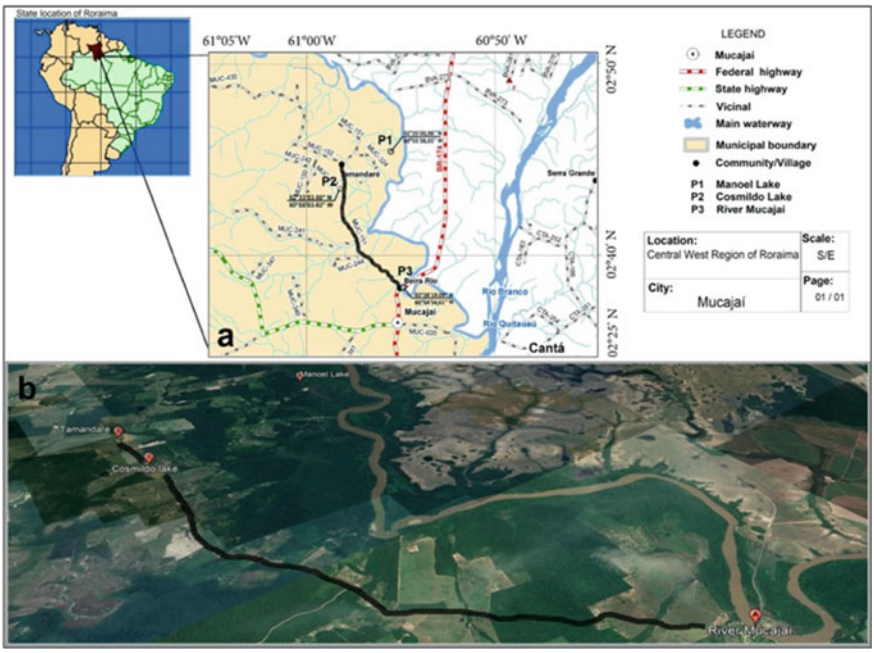

Fig. 1 The geographic location of the Municipality of Mucajaí—Roraima, Brazil. **a** Panoramic aerial landscape view; **b** localisation map and the main water resource the Mucajaí River, Manoel, and Cosmildo Lake

Table 2 Geographical coordinates of the sampling points

Sampling points	Coordinates		Elevation
	Latitude	Longitude	
P 1 Manoel Lake	N 02° 35′ 00.98″	W 60° 55′ 38.01″	79
P 2 Cosmildo Lake	N 02° 33′ 53.80″	W 60° 58′ 03.62″	77
P 3 River Mucajaí	N 02° 28′ 19.09″	W 60° 54′ 54.61″	90

The studied area is located in the Central part of Roraima, the northernmost state in Brazil, well-known for the Amazon Rainforest. The population observed was 18,172 inhabitants, resulting in a demographic density of 1.19 inhabit./km^2. The municipality has a territorial area of 12,351 km^2. According to Köppen climate classification, in its northern area, the altimetric quotas are above 1,000 m of altitude, presenting a tropical wet climate with water deficits around 3–5 months with reduced rainfall (Alvares et al. 2014). The sampling points were chosen because they exhibit expressiveness in the community and more varied uses (Table 2).

3 Results and Discussion

3.1 Analysis of the Interviews with Community Citizens

This section provides the analysis and interpretation of the eight interviews conducted in the field regarding the citizens' perception of lotic and lentic ecosystems based on the SDGs 6, 10, 14, and 15. The respondents are mostly males (n = 6), with middle school level (n = 4), with a mean of 60 years old (Min = 37; Max = 73), living in the region for an average of 41 years (Min = 33; Max = 51) and being agricultural workers (n = 6) (Table 3).

In each household, it was requested that respondents shared their perception about lotic ecosystems. Table 4 presents the interview results and correspondent responses to better illustrate.

Regarding the importance of natural resources, local citizens believe that rivers and lakes are essential to their livelihoods, which highlights their awareness of the importance to safeguard and protect this ecosystem. On the other hand, this resource is ensured by the Federal Constitution of 1988 (Brazil 1988; Hasan et al. 2021). The primary need for safe sanitation is assessed, which would improve resilience and, in turn, lead to a greater and more constant interest in SDG 6.

About the role of the municipal management, a lack of actions and investments are identified regarding basic sanitation to improve the quality of life of its citizens, specifically those located further away, which would partly allow the achievement of sustainability in compliance with the Global Agenda (Maasri et al. 2021). The new legal framework for basic sanitation states within its main focuses: (i) A target of 99% of the population with access to drinking water; (ii) a target of 90% of the population with access to sewage collection and treatment; and (iii) actions to reduce water waste and use rainwater. In the Amazon region it rains a minimum of 471.3 mm/month (Barni et al. 2020; Brazil 2020). The lack of basic sanitation in most remote locations results in many occurrences of diseases due to lack of drinking water. These remote regions are the most vulnerable to the impacts of

Table 3 Respondents' sociodemographic characteristics

Respondent	Sex	Age	Education level	Residence in the region (Years)	Occupation
1	Female	65	Elementary school	33	Agricultural worker
2	Male	41	Middle school	41	Agricultural worker
3	Female	67	Elementary school	40	Housekeeper
4	Male	72	Middle school	51	Agricultural worker
5	Male	67	Elementary school	40	Agricultural worker
6	Male	73	Middle school	51	Agricultural worker
7	Male	51	University	37	Teacher
8	Male	44	Middle school	33	Agricultural worker

Table 4 Questions and correspondent respondents' quotes

Questions	Quotes
The importance of the region's natural water sources	"*It is very rich for us who live here, the land that has a water source adds value to the place, it provides life, sustenance, and entertainment for all. Here we have an association and we all have the concern of not letting the insecticide contaminate the water of the river and the lake. We often fish from these water sources… and our families are all our wealth*" (Respondent 4) "*It is essential for us human beings, for the animals and even for the forests and plants that we have in the region*" (Respondent 5)
Whether you have noticed any change in the water sources since you moved into this place	"*We have observed that these rivers and lakes have decreased in volume year by year. Exactly after the dry season*" (Respondent 5) "*We noticed a change at the top of the water. At that time, few and almost no one frequented Manoel Lake … because they thought that the dark water hid some danger*" (Respondent 6)
How the maintenance of natural sources is done, and whether you have seen any kind of intervention by the local authorities	"*Maintenance should be done on private property to improve the structure that the producer has, but we do not get from the government. The municipality has not done much …*" (Respondent 2) "*The Residents' Association does the maintenance, they get together and on a leisure day they clean up the rubbish (plastics, falling branches and others)*" (Respondent 3)
How the tourist activity in the region is carried out, if they use these natural elements, and whether there is any impact	"*Tourist activity is practically non-existent in these environments… What we see in the region are bicycle rides on trails and there is no participation in the freshwater springs*" (Respondent 5) "*Here in this region, in terms of rural tourism, there is almost zero, but I heard that the municipality is working to bring resources to invest in tourism, especially during this time of pandemic…*" (Respondent 2)
Whether you consider that it should be the local community's responsibility to maintain these natural elements	"*If the community had the support of the authorities, we could do it ourselves, with canoes and boats, to go around and see what they are doing wrong*" (Respondent 1) "*The community knows everything, the best seasons to treat the environment. And there*

(continued)

Table 4 (continued)

Questions	Quotes
	are many young people here who can make a difference in the future" (Respondent 8)
Whether you would do something different if you were responsible for maintaining these water sources	"*These aquifers are the patrimony of all of us citizens. I would raise awareness among everyone, up to the authorities. What mankind needs to do is to be more careful with their attitudes and waste regarding nature*" (Respondent 5) "*I would form a team to assess and look after the river and lake more closely, but those who come from far away have to pay, just a little, but this is for us to organise trips and fishing*" (Respondent 2)

polluted waters and waste disposal, e.g., insecticide chemicals and This represents a significant threat across the planet to the health of humans, biodiversity, and the environment, ultimately ending up in the seas, which is contrary to SDG 14—life in water (Debrah et al. 2021). Awareness of water importance was reported through the interviews, as well as the dependence on water for everything, and the perception of climate change, excessive heat in the summer period, and/or even in the rainy period. Although these citizens are aware of the seriousness of human action, they do not stop setting fire to their lands, which they claim to be an ancestral practice, arguing that the ashes would make the land more fertile. They reiterate the importance of buying land with watercourses because this kind of land is more valued.

While respondents do not take responsibility for the changes identified in the lakes, they perceive changes in the vegetation of the water sheet through the growth and invasion of aquatic plants, found unanimous. As mentioned by Damtew et al. (2021), vegetation is the result of anthropic stressors and climate change, emerging with floating and rooted leaves, part of the ecosystem, and playing a key role in neutralizing pollutants, regulating the production of contaminants, oxygen generation, and the carbon cycle. However, respondents know and describe the vegetation, but are unaware of the reason for the ecosystem's defensive reaction. It is worth to note that experimental projects for the implementation of geotourism activities are welcome in this territory, even if they start with a short duration itinerary.

The perception about the reduction and colour of the water during the dry season shows that citizens, even in remote areas, feel the climate change and are among the most affected. The report of plants on the lamina water signals a probable change in and the colouration is influenced by the vegetables, animals, minerals, tannins and algae in these surface water bodies such as lakes (Ghosal et al. 2020; Abel et al. 2021).

The interviewees were unanimous when they stated that there is no maintenance of natural sources by the local authorities, which do therefore reflect the neglection by the public authorities. In this sense, waters and forests are assets that belong to

the Union and the state, and it is not up to the municipalities to legislate on these resources, according to the Brazilian Forest Code (Brazil 2012). The states regulate their use, through authorizations and concessions. Thus, the initiative of the sensitized community preserves the river and lake, and meets locally, in part, the SDG 15—Ensure and Conserve the Aquatic Ecosystem.

Regarding the tourism activity in the region, one interviewee mentioned that the word tourism is known to all, but not in an alternative way, yet, in this locality. This denotes the citizen's understanding that for every activity an investment must be made, with training and necessary infrastructure to welcome the visitor. It is therefore assumed that the natural will of the community must be in harmony with all relevant stakeholders, which include the leaders, municipal planning and the private sector. However, for other respondents, tourism is limited to walks and physical itineraries, bathing in the river, and taking pictures to send to friends, and this is their understanding of local tourism. The expressive set of scenic landscapes that contemplate the hydric resources and the exploitation of these environments can be worked within what the tripod of the segment advocates, i.e., transportation, lodging, and operationalization of the trip by a travel agent. From this understanding, sustainable tourism should take advantage of environmental resources, respect the authenticity of local culture, ensure long-term local economic sustainability and ensure income opportunities for the host community, and in this aspect also contributes to the mitigation of poverty (UNWTO 2020).

Most of the respondents are fully aware that the river and the lakes need maintenance, which has not been conducted by the public authorities, and that everyone needs to do something for the nature that serves them, e.g., awareness-raising campaigns. In this regard, it is worth highlighting everyone's efforts, within their possibilities, to avoid that waters to be the target of disposable waste, as water is considered a finite and vulnerable resource. If there is a terrible misuse of these resources, it will be translated into a series of complications for humanity, and this is a concern of the, which highlights water security as a global concern (Waseem 2021).

Finally, a consensus among the respondents is identified in relation to the investments in infrastructure and training to attract people to the region. This consensus is based on good planning practices accompanied by a specialist for the development of tourism in the location. Therefore, all this unanimity goes through good planning practices accompanied by a specialist for the development of geotourism in the locality.

3.2 Study Area Assessment Regarding Infrastructures for the Implementation of Geotourism Activity

Visits to natural environments have become increasingly pursued. Geotourism presents itself as a sustainable alternative because it is not seasonal and, to check the specificness of these abiotic resources, the Mucajaí River, the Cosmildo Lake, and

the Manoel Lake are available for geological interpretation, verification of importance and multiple uses, which include leisure and recreation activities, landscaping, diving, fishing and boat trips. Looking at these open-air laboratories from a geomorphological point of view reveals an opportunity to fulfil the Global Agenda goals. The diversity of freshwaters can be found in Fig. 2.

3.2.1 Mucajaí River

The geological and structural framework of the region allows describes Mucajaí River, a lotic system, as a perennial river of particular notoriety, as it not only benefits the people who live in its surroundings but also offers various advantages, especially for agriculture, sustains the unique biodiversity elements in its ecosystem, and is also a cultural and geotouristic element because of its waterfalls. Its location is characterized as feature on the Guiana Shield, of Precambrian origin, formed by a set of lineaments with NE-SW direction extending from a part of the Amazonas State to the proximities of Paramaribo and the Republic of Guyana (Feitoza et al. 2007). With its sinuous geomorphology, the Mucajaí River is about full of natural elements that promote the geotourism scenarios in its middle and upper course, such as the waterfalls known as Prego; da Lata; do Funil; dos Índios; Querosene; and do Arromba. Throughout its course, it is located in a forest region (Ferreira et al. 1988; Veras 2014; Santos et al. 2018). It is representative of the rich natural heritage and can provide a unique, authentic, and unforgettable experience to the Geotourist, in addition to the high diversity of freshwater fish (e.g., Hoplias

Fig. 2 **a** Mucajaí River, belonging to the lotic ecosystem, is the main water resource. **b** Cosmildo Lake and **c** Manoel Lake belong to the lentic ecosystem, surrounded by a terrestrial system of natural vegetation, aquatic macrophytes and small communities (i.e., fish and frogs)

malabaricus; Traira (Wolf fish); Boulengerella ocellata—Bicuda; *Semaprochilodus* spp.—Jaraqui; Hemiodus spp.—Piau; Colossoma macropomum—Tambaqui; Pygocentrus spp.—Piranha).

3.2.2 Manoel Lake

This lake is located at geographical coordinates N 02° 35′ 00.98″ and W 60° 55′ 38.01″ and elevation 77 m above sea level, in the central region of Roraima, in the municipality of Mucajaí. Access is via a side road, known as RR 325 or Tamandaré. With transparent waters, the lake has a depth of 6 m, and 40 cm at its shallowest point. As a true phenomenon of nature, it contributes to agriculture and other economic activities in the region. The landscape around the lake is rich in species, formed by an almost untouched riparian forest with intense green colours. Belonging to the lentic ecosystem, the lake nourishes the biodiversity contained in its waters and terrestrial surroundings, with algae vegetation and endemic insects, and offers specific fish species: Semaprochilodus spp.—Jaraqui; *Hemiodus* spp.—Piau; Colossoma macropomum—Tambaqui. Its enchanting tropical scenery of waters and beauty in a pure state of conservation invites the tourist into taking a boat ride and contemplating nature.

3.2.3 Cosmildo Lake

Geological environment belonging to the Guiana Shield and, finally, to the Central Amazon. It has a direct relationship with the Mucajaí River, the main water resource in the region. Access to the lake is via the Highway RR 325, approximately 30 km away, and can be found according to the geographical coordinates N 60° 57′ 55.89″ and W 60° 57′ 55.89″. Its elevation is 90 m above sea level. The name of the geo-resource is a tribute to the owner of the farm where it is located. The physiographic characteristics are preserved and it is suitable for visits. The landscape scenery in its waters allows boat trips and fishing in favourable seasons, and geotourism activity can be implemented.

3.3 Tourism Infrastructure

The set of implementations of the physical structure and basic services that support the development of tourism enable dynamism for this territory's vocation for tourism. The Urban Equipment available is presented in Tables 5 and 6.

Table 5 Equipment for tourism logistics in Mucajaí-RR

Hotels (beds in HU)	Access infrastructure (roads)	Transportation	Basic sanitation
4 hotels 32 HU's, 40 beds	BR 174 (federal highway) RR 325, 205 and country roads 6, 11	Cooperatives for alternative transportation, Cooperative-Cootam, Macuxi Motorbike Taxi Association Road transportation	Only at houses in urban areas, and it counts with 3 water treatment stations, with 175,000 l

Source Municipal Secretary of Culture, Sports and Tourism of Mucajaí-RR. *UH = Housing units

Table 6 Equipment and services

Theatre	Security	Health	Centre for the commercialization of handcrafted products
1 Centre for conventions 1 Area for the performance of the play 'Passion of Christ' 10,000 m^2	1 Department of the Military Police	2 Health clinics 1 Hospital	3 Basket, wood and bio jewellery stores

Source Municipal Secretary of Culture, Sports and Tourism of Mucajaí-RR

4 Final Remarks

The challenge of universalising the sustainable use of water is a contemporary frontier to be overcome regarding the Global Agenda 2030, based on the premise that humans are the main responsible for the success or failure in the protection of water resources. The plenty of ecosystem services provided by water resources must be stated: store freshwater, provide fishing resources and favour the well-being of citizens with leisure and educational recreation, while considering the interpretation carried out by geotourism. Thus, in the face of so many advantages, it has been a source of prosperity for all living beings, legitimising the objectives of the Global Agenda with the challenge of improving management in remote places (Maasri et al. 2021).

Lastly, it is worth mentioning that geotourism is a process for everyone's participation, in which citizens, water resources management authorities, national and local territories should consider the institutional and legal frameworks, while the numerous sectors that move the economy must be committed to guaranteeing a sustainable water resource. Among the strengths of the SDGs 6, 10, 14 and 15, the goals that stand out are those advocating for harmony and integration not only with environmental dimensions, but also with people, prosperity, the planet, peace, and partnership. This work shows that when asked about the importance of freshwater and its uses including geotourism, citizens reveal that they are committed to

preservation, thus showing the need to receive attention from authorities and investments in infrastructure, and training for managers.

This work shows that when asked about the importance of freshwater and its uses including geotourism, the local community reveals to be committed to preservation, thus showing the need to receive attention from authorities and investments in infrastructure, and training for managers.

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Ana Sibelonia Saldanha Veras Ph.D. student in Ecology and Environmental Health at the European University Fernando Pessoa, Porto Portugal. Graduated and Master in Geography. Currently, she is dedicated to the implementation of geotourism activities at the Secretariat of Tourism, in Mucajaí, Brazil.

Diogo Guedes Vidal is graduated in Sociology (2014) and Msc in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability (2014–2019). He is

currently a Ph.D. research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/ University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Nelson Barros is graduated in Environmental Engineering, MSc n Thermal Engineering an Ph.D. in Environmental Sciences. Member of the Editorial Board of the Journal of Ecological Engineering. Currently, is Associate Professor at University Fernando Pessoa, coordinator of the Ph.D. program in Ecology and Environmental Health and coordinator of the Laboratory of Research in Energy, Environment and Environmental Health (3ERL), a Research Group of the Fernando Pessoa Research Unit in Energy, Environment and Health (FP-ENAS).

Maria Alzira Pimenta Dinis is graduated in Metallurgical Engineering (1992), MSc in Materials Engineering (1995) and Ph.D. in Earth Sciences (2010). She is currently Associate Professor in the University Fernando Pessoa, Porto, Portugal, researching in FP-ENAS, UFP Energy, Environment and Health Research Unit. Her main research domains include Reservoir Modelling and Environmental Engineering, with scientific outputs translated by numerous publications.

Measuring Environmental Concern of Urban Green Spaces' Users (UGSU) Through the Application of the New Ecological Paradigm Scale (NEPS): Evidence from a Southern European City

Diogo Guedes Vidal, Ricardo Cunha Dias, Paulo Castro Seixas, Maria Alzira Pimenta Dinis, Cláudia Oliveira Fernandes, Nelson Barros, and Rui Leandro Maia

1 Introduction—Towards a (Not) New Ecological Paradigm

The relationship between humans and nature has been one of the most enthusiastic topics for many researchers. But this relationship was not always romantic or naive: the nature dominance by humans is a desirable goal with negative impacts on the Earth ecosystems and resources. Much of this goal is based on the need to change

D. G. Vidal (✉) · M. A. P. Dinis · N. Barros · R. L. Maia
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: madinis@ufp.edu.pt

N. Barros
e-mail: nelson@ufp.edu.pt

R. L. Maia
e-mail: rlmaia@ufp.edu.pt

R. C. Dias · P. C. Seixas
Centre for Public Administration and Public Policies (CAPP), Institute of Social and Political Sciences (ISCSP), University of Lisboa (UL), Campus Universitário do Alto da Ajuda, Rua Almerindo Lessa, 1300-663 Lisbon, Portugal
e-mail: rdias@iscsp.ulisboa.pt

P. C. Seixas
e-mail: pseixas@iscsp.ulisboa.pt

C. O. Fernandes
Research Centre in Biodiversity and Genetic Resources (Cibio-inBIO), Faculty of Sciences, University of Porto (FCUP), Rua do Campo Alegre s/n, 4169-007 Porto, Portugal
e-mail: cofernandes@fc.up.pt

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the course of nature to meet humans' desires. Accordingly, the scientific community has proposed the concept of "Anthropocene" as a new era on the Earth's geological time scale characterized by an unprecedented anthropic influence (Crutzen and Stoermer 2000; Steffen et al. 2011).

The demographic transition has been gaining significant expression since the beginning of the twentieth century and had resulted in an expansion of the human population, which is expected to reach 8 billion in a near future (United Nations, Department of Economic and Social Affairs 2019). This expected population growth has posed new challenges to the maintenance of human lives that are undeniably linked with the depletion of wildlife and natural resources (Abegão 2019). The widely recognized consequences of humans' desire to control nature are Climate Change (CC). The human dynamics and trends expressed by the population pressure on natural resources and wildlife, alongside with unsustainable economic development, have been recognized as the mains drivers of CC (UN Environment 2019). IPCC (2018) states that anthropogenic actions are the main causes of CC triggered by the loss of biodiversity and the adverse impact on ecosystem services provision (Food and Agriculture Organization of the United Nations 2019).

Since the second half of the twentieth century, and after two world wars that have destroyed landscape, natural heritage and biodiversity habitats, significant attention has been devoted to the way that humans are dealing with nature (Catton and Dunlap 1978; Carson 2000). But it was in the 1960s that a global environmentalism movement was triggered by an ecological crisis that threatened human existence (Jones and Dunlap 1992). This movement gained expression with some events, such as the "Big Smoke" that covered the city of London in 1952, the Minamata Bahia disaster and the DDT utilization in the USA (Seixas et al. 2020). These events were in the origin of a new worldview that recognized the human interdependence with the ecosystems and that their destruction leads to negative impacts on human health and well-being. Such worldview became known as a "New Ecological Paradigm" (NEP), as opposed to the then dominant "Human Exceptionalism Paradigm" (HEP) (Catton and Dunlap 1978). Much of the debate that evolved since then has been centred in urban areas.

Urban populations are those most affected by the undesirable effects of CC, impacting humans and ecosystem health, since almost 55% of the world population lives currently in urban settlements (Emilsson and Ode Sang 2017; United Nations, Department of Economic and Social Affairs 2019). Some solutions have been pointed out to mitigate the negative impacts on the environment in cities and to provide a balanced combination of humans' growth and nature too. These solutions are known as 'nature-based solutions' (Nbs) (Pauleit et al. 2017) and considered cost-effective by providing environmental, social and economic benefits to the entire ecosystem, both human and non-human (European Commission 2021). Urban Green Spaces (UGS) are one of the most recognized Nbs due to their capability to increase the quality of urban environments, enhancing local resilience, and promoting a sustainable lifestyle, as well as improving both the health and well-being of their users (de Vries 2010; Hartig et al. 2014; Braubach et al. 2017;

Vargas-Hernández et al. 2018; MacKinnon et al. 2019; Jennings and Bamkole 2019; Vidal et al. 2020).

UGS are spaces mainly dedicated to recreational activities, namely to people restore, relax or spending free time with family, friends or alone (Home et al. 2012; Zwierzchowska et al. 2018). Due to cities' specific dynamics and stimulus, causing stress and disorientation, UGS can be assumed as an escape from the urban lifestyle, improving mental health outcomes (Ulrich 1983; Tendais and Ribeiro 2020). For this reason, UGS can act as spaces that boost the desire to know more about nature dynamics, leading to an increase in people's environmental concerns. Some studies have pointed out the influence of nearby school UGS, promoting the development of environmental education activities with students (Wolsink 2016a, b), but the environmental concern of UGS users (UGSU) is still little known or absent. This premise is based on the fact that people care about environmental quality when they believe that poor environmental performance threatens their health. It is a self-interest that underlines environmentally responsible behaviour (Fransson and Garling 1999).

Set against this background, this works aims to apply the New Ecological Paradigm Scale (NEPS) (Dunlap et al. 2000) to a sample of UGSU. As far as it is known, the NEPS has never been previously applied to UGSU. Thus, the assessment and analysis of this group's perception of the environmental concern could be a contribution to promote environmental sustainability in the cities. The first objective consists of studying the psychometric properties and factor structure of the NEPS to assess if its application is reliable when applied to UGSU. The second one aims to identify if UGSU presents a higher ecocentric orientation when compared with other groups. Finally, it will be important to analyse the UGSU NEPS scores and to associate them with sociodemographic variables and usage profiles.

2 A View of the NEPS Origin and Application

Due to events that occurred in the twentieth century and that contributed to shifting the HEP dominant paradigm, characterized by the technological and scientific dominance and the human exemption, a new world division has been proposed, based on the development of a NEP where humans are viewed as dependent upon the physical environment (Catton and Dunlap 1980; Seixas et al. 2020). NEP recognizes the human interdependence with the ecosystems and that its destruction leads to detrimental consequences in public and environmental health. The main principle is that of a finite planet, the limits of humanity will be, despite technological ingenuity, the laws of nature (Battistella et al. 2012).

Within this paradigm, the NEPS was designed to measure the environmental concern of individuals through a single instrument including fifteen statements. The scale firstly consisted of twelve items, with a five-point Likert scale, but in 2000 it was reformulated to fifteen to be able to better understand the key points of the ecological worldview. This improvement resulted in a higher balance between pro and anti-environmental items and, also, avoid sexist terminology (Dunlap et al.

2000). The last version of this scale is divided into five dimensions of an ecological view: (i) the limits of growth reality; (ii) the anti-anthropocentrism; (iii) the Nature balance fragility; (iv) the rejection of exceptionalism; and (v) the possibility of an ecological crisis.

Forty years have passed since the publication of the first version and the NEPS is widely recognized as a simple and useful tool to analyse environmental attitudes reliable and accurate when applied in different contexts and realities. The world-wide application has resulted in a variety of studies contributing to prove the usefulness and timeliness of the scale. A literature review by Talamini et al. (2017) reveals that the NEPS application's main area is the environmental sciences, followed by the social sciences, but it is in the field of environmental psychology that this scale is mostly used.

As stated before, NEPS has been applied in different contexts. A study conducted by Khan et al. (2012) has applied NEPS to a sample of Indian consumers. Zhushi-Etemi et al. (2020) assessed the environmental concern of a sample of employees in the city of Kacanik, Kosovo. Erdoğan (2009) tested the reliability and dimensionality of the revised NEPS to examine if university students in Turkey are endorsing the NEP. The study of Reyna et al. (2018) assessed the psychometric properties of the NEPS in a sample of Argentine population. In the African context, Ogunbode (2013) measured the environmental attitudes among Nigerian university students. Ntanos et al. (2019) measured and analysed citizens' NEPS score in a Greek area. Recently, the principles of the NEPS were at the origin of other scales, such as the Environmentalist Identity Scale (EIA), developed by Seixas et al. (2020).

In Portugal and Brazil, the scale application has resulted in some interesting studies. In Brazil, Battistella et al. (2012) studied the ecological awareness of Brazilian university teachers. In the Portuguese case, Castro and Lima (2001) applied the NEPS to a sample of Lisboa inhabitants to know the predictors of two environmental beliefs. Freitas (2007) applied the scale to analyse the social attitudes about the environment of Madeira island inhabitants. A comparative study between Romania and Portugal (Denis and Pereira 2014) tested NEPS dimensionality and reliability, as well as explored the degree of NEP endorsement. In 2016, the NEPS was used in a study conducted to explore the sustainability perception and practice of a representative sample of the Portuguese population (Schmidt et al. 2016).

Despite the importance of these previous studies, which helped to disseminate the use of NEPS and contributed to its reliability and validity, the application of the scale to a sample of UGSU is still missing.

3 Methodological Procedure

This study aims to measure the environmental concern of a sample of UGSU. Exploratory and descriptive research was conducted in a sample of UGSU in the city of Porto, in the north of Portugal. Twenty-five UGS (Fig. 1) were selected and the survey was applied online through Google Forms. The inclusion criteria for

Fig. 1 UGS location in the city of Porto, Portugal

participating in the study were: being able to read and write, being 18 years old or more and be a user of at least one of the twenty-five selected UGS. The link to the survey was made available through the social networks (*Facebook*, *LinkedIn* and *ResearchGate*) and institutional academics and personal mailing lists.

The survey comprises forty-five questions, 90% of which are closed: (i) the first part comprises a set of questions related to UGS usage profiles and an assessment of a UGS chosen by the respondent (being asked to select the one most often used); (ii) a second part seeks to know the preferences when choosing a green space; (iii) and a third that focuses on attitudes towards the environment and knowledge about ecosystem services of UGS. In the present study, the analysis will focus on the use, profile of users and the NEPS application (Dunlap et al. 2000). Although the application of the research is based on a quota sampling technique, the sample size is not decisive since this is an exploratory study (Daniel 2012).

The data analyses were based on the following stages: sample profile analysis, an exploratory factor analysis (principal components analysis with varimax rotation) of the NEPS and descriptive analyses. To perform these steps, *t*-test for independent samples and analysis of variance were applied to identify the relationships of the NEPS scores and demographic characteristics. The statistical procedures were performed supported by IBM® SPSS® Statistics 25.0.

4 Results

4.1 Sample Profile

One hundred and thirty-two UGSU participated in the survey. The demographic characteristics of the sample are presented in Table 1.

Table 1 Demographic profile of the sample (n = 132)

Sex	**%**
Females	68.9
Males	31.1
Age group	
18–34	32.6
35–64	53.8
65=>	13.6
Marital status	
Married	39.4
Divorced	12.1
Single	36.4
Unmarried union	9.8
Widowed	2.3
Education	
University level	87.9
Non-university level	12.1
Work condition	
Active	81.8
Inactive	6.8
Student	9.8
Retired	1.5
Household income	
Very uncomfortable	0.8
Uncomfortable	7.6
Reasonable	51.5
Comfortable	33.3
Very comfortable	6.8
Housing typology	
With access to a collective garden, belonging to residents of the housing stock	16.7
With access to a private garden	31.8
With access to a public garden	9.1
With no access to a garden	42.4

The majority of the participants are females (68.9%), belonging to the group age 35–64 years old (53.8%) and married (39.4%). The high education level of the sample is notorious (87.9% holds a university degree). Most are active at work (81.8%), revealing a reasonable household income (51.5%). Regarding the housing typology, 42.4% report not having access to a garden, either public or private.

This sociodemographic profile of UGSU matches with the structure of Portuguese society, which is mostly female (52.7%) (Pordata 2018). Furthermore, in the study of Madureira et al. (2018), conducted in the city of Porto, the share of

Table 2 Usage profile of the sample (n = 132)

Do you visit the green space every week?	**%**
Yes	35.6
No	64.4
Do you visit this space regardless of the seasons?	
Yes	87.9
No	12.1
Who do you usually visit this green space with?	
Friends/colleagues	21.2
Family	43.2
Alone	23.5
Boyfriend/Girlfriend	12.1

female participants was very similar to this study (70.7%). The age of the participants is also corroborated by the same study, where 38% have 35–54 years old. Regarding the education level, once again the results of this study are aligned with Madureira et al. (2018) since 75.6% of the UGSU have a university degree. These results reveal that besides being a small sample, the sociodemographic profile of UGSU is quite similar to those find in the previously mentioned study, which may be the result of the data collection technique used (online survey). Concerning the remaining variables, it is quite interesting to see that the majority of the UGSU are those that do not have a house with access to a public or private UGS. This result strengthens the idea that providing universal access to UGS is a key-point in urban spaces.

Regarding the usage profile of UGS (Table 2), the minority of UGSU visit the space every week (35.6%) revealing a moderate frequency and contact with nature, a value below those found in the study of Madureira et al. (2018), 56%.

4.2 Exploratory Factor Analysis

To test the NEPS reliability, the Cronbach Alpha (α) was calculated to measure the internal consistency. As shown in Table 3, for the fifteen items an $\alpha = 0.653$ was found, considered good ($\alpha > 0.6$) (Ursachi et al. 2015). The results also demonstrate that if some item was removed the scale reliability weakens.

Previous studies regarding the psychometric properties of the NEPS have found higher Cronbach Alpha values, as the one carried out by Dunlap et al. (2000) ($\alpha = 0.83$), Battistella et al. (2012) ($\alpha = 0.74$) and the Ntanos et al. (2019) ($\alpha = 0.71$). It is worth remarking that these studies have a larger sample than this one, which could influence the results. It can be stated that the NEPS has satisfactory internal consistency.

After analysing the internal consistency of the scale, the exploratory factor analysis was carried out. A principal component analysis with varimax rotation was

Table 3 Statistics of each item with the NEPS

Statements	Cronbach's alpha if item deleted
We are approaching the limit of the number of people the earth can support	0.544
The Earth has plenty of natural resources if we just learn how to develop them	0.505
The Earth is like a spaceship with very limited room and resources	0.528
Humans have the right to modify the natural environment to suit their needs	0.547
Plants and animals have as much right as humans to exist	0.532
Humans were meant to rule over the rest of nature	0.551
When humans interfere with nature it often produces disastrous consequences	0.533
The balance of nature is strong enough to cope with the impacts of modern industrial nations	0.571
The balance of nature is very delicate and easily upset	0.557
Human ingenuity will ensure that we do not make the earth unliveable	0.524
Despite our special abilities, humans are still subject to the laws of nature	0.519
Humans will eventually learn enough about how nature works to be able to control it	0.523
Humans are severely abusing the environment	0.507
The so-called "ecological crisis" facing humankind has been greatly exaggerated	0.558
If things continue on their present course, we will soon experience a major ecological catastrophe	0.536

chosen to maximize the sum of the load variances of the factor matrix. The latent root technique was selected to extract the factors, in which only those that present eigenvalues greater than 1 were considered significant. Regarding the communalities, all variables present values above 0.5. Therefore, all variables were retained in the model. The NEPs obtained a KMO = 0.76 and a Bartlett test = 423.3 ($p < 0.01$), considered satisfactory. Four factors were extracted (Table 4).

The Cronbach alpha was recalculated regarding the factors' reorganization after the principal component analysis. Factor 1 and 2 presented $\alpha = 0.729$ and 0.658 (good), respectively, which are above the cutoff 0.60 proposed by Ursachi et al. (2015). Factors 3 and 4 are below the cutoff but it was decided to maintain them once the NEPs global $\alpha = 0.653$.

Factor 1 aggregates the statements that relate to the rejection of an anthropocentric view of the world, and it is the one that mostly explains the variance of the model (22.7%). This factor puts in evidence that humans are part of a larger ecosystem and that a balance between species is needed to maintain sustainable growth. Factor 2 combines a set of statements that refers to the humans' control of

Table 4 NEPS exploratory factor analysis

Statements	1	2	3	4
We are approaching the limit of the number of people the earth can support			0.793	
The Earth has plenty of natural resources if we just learn how to develop them				0.592
The Earth is like a spaceship with very limited room and resources			0.662	
Humans have the right to modify the natural environment to suit their needs		0.501		
Plants and animals have as much right as humans to exist	0.690			
Humans were meant to rule over the rest of nature		0.792		
When humans interfere with nature it often produces disastrous consequences	0.733			
The balance of nature is strong enough to cope with the impacts of modern industrial nations				0.726
The balance of nature is very delicate and easily upset	0.885			
Human ingenuity will ensure that we do not make the earth unliveable				0.664
Despite our special abilities, humans are still subject to the laws of nature	0.800			
Humans will eventually learn enough about how nature works to be able to control it		0.713		
Humans are severely abusing the environment	0.552			
The so-called "ecological crisis" facing humankind has been greatly exaggerated		0.533		
If things continue on their present course, we will soon experience a major ecological catastrophe			0.572	
Variance explained	22.7	12.8	12.7	12.2
Cronbach Alpha	0.729	0.658	0.550	0.514

Notes Extraction method—Principal components. Varimax rotation with Keiser normalization. Extraction criterion: Eigenvalues > 1. Total variance explained by extracted components: 60.4%; KMO = 0.76 Bartlett's test: $\chi^2 = 423.3$, $p < 0.001$

nature and explains 12.8% of the model variance. This factor exhibits the negationism of nature to satisfy the humans' needs above all. Factor 3 joins the statements that refer to the Earth limit of growth and explains 12.7% of the variance. This pragmatic view is aware that planet Earth is not infinite and that its limits must be respected. Finally, Factor 4, with 12.2% of variance explained, put together a set of statements that express a utopian view of the world, i.e., that Earth is resilient forever and able to deal with the anthropic actions. These results are not surprising considering that previous research has also identified 4 factors in the NEPS (Battistella et al. 2012; Schinaider and Talamini 2019), namely in the original study

(Dunlap et al. 2000), giving accuracy and robustness to the present research. It is worth to remark that the NEPS application to UGSU explained 60.4% of the model total variance, a value that is higher (56.5%) than the original study by Dunlap et al. (2000).

4.3 Descriptive Analysis

As stated before, the NEPS (Dunlap et al. 2000) was used to measure the environmental concern of UGSU. The average score of each NEPs statement are presented in Table 5, alongside a comparison with previous studies that have applied the scale to different groups.

In general, UGSU present satisfactory environmental concerns, which could be associated with the fact that the majority of the sample holds a university degree. By performing detailed analysis and comparing with the results from previous studies, it can be stated that UGSU are those that mostly recognized that Earth has limited resources (4.20) and that humans do not have the right to modify nature to meet their needs (2.10). In line with this, they also agree that humans do not have the right to rule nature (2.35) and will never be able to control it (2.47). UGSU are those that most strongly refuse the negationism of the ecological crisis and in this sense, they are more aware of the ecological crisis (2.01). Maybe due to its contact with nature at UGS, they strongly disagree that nature is resilient enough to deal with modern industrial nations impact (1.85) and, consequently, nature is assumed as delicate (3.73). It is also quite interesting to see that UGSU and agricultural farmers, which are those that have a more direct connection with nature, are close to agreeing that the natural resources are vast but it is important to learn how to deal with them. This result contrasts with the university teachers and with the general population, that disagrees with this statement. Also, university teachers are those that most agree with the fact that humans are meant to rule over the rest of nature (3.77).

To analyse the association between the NEPS means and sociodemographic and UGSU usage profiles a *t*-test and ANOVA were performed. Regarding the sociodemographic characteristics of UGSU, statistical differences were found in the age group variable only (Table 6).

The results highlight some patterns that deserve further discussion. The first one relates to the fact that the older ones (65 =>) do not believe that Earth has a limit to support the population growth and, consequently, that limit is far from being reached ($p = 0.031$). Furthermore, they are not sure if humans should not rule over the rest of nature ($p = 0.004$). Opposite, adults (35–64) are in more disagreement than youngers (18–34) and elderly (65=>) that humans have the right to modify the natural environment to suit their needs ($p = 0.017$) and also that ecological crisis has been exaggerated ($p = 0.002$). These findings are aligned with those found in Dunlap et al. (2000) study, namely the association with age in the revision of the NEPS. Also, in their contribution to the social basis of environmental concern,

Table 5 UGSU environmental concerns means comparison with previous studies

Statements	Present study	Battistella et al. (2012)[a]	Denis and Pereira (2014)[b]	Schinaider and Talamini (2019)[c]
We are approaching the limit of the number of people the earth can support	3.50	3.58	3.13	3.18
The Earth has plenty of natural resources if we just learn how to develop them	3.80	1.87	1.72	4.15
The Earth is like a spaceship with very limited room and resources	4.20	3.58	2.83	3.50
Humans have the right to modify the natural environment to suit their needs	2.10	3.75	3.41	4.03
Plants and animals have as much right as humans to exist	4.35	4.50	4.40	4.53
Humans were meant to rule over the rest of nature	2.35	3.77	2.97	4.00
When humans interfere with nature it often produces disastrous consequences	4.34	3.60	4.45	4.17
The balance of nature is strong enough to cope with the impacts of modern industrial nations	1.85	4.23	3.58	3.87
The balance of nature is very delicate and easily upset	3.73	3.91	3.97	3.94
Human ingenuity will ensure that we do not make the earth unliveable	2.52	2.83	2.33	3.29
Despite our special abilities, humans are still subject to the laws of nature	4.20	4.21	4.28	3.95
Humans will eventually learn enough about how nature works to be able to control it	2.47	3.15	2.82	3.44
Humans are severely abusing the environment	4.44	4.40	4.42	4.24
The so-called "ecological crisis" facing humankind has been greatly exaggerated	2.01	3.89	2.79	3.54
If things continue on their present course, we will soon experience a major ecological catastrophe	3.89	3.59	3.87	3.88

Notes a University teachers; b Faro, Portugal, inhabitants; c Family agricultural owners

Table 6 NEPs means comparison by UGSU age group

Statements	18–34	35–64	65 =>	*F*	*p*
We are approaching the limit of the number of people the earth can support	3.60[a]	3.59[a]	2.89[b]	3.557	0.031
Humans have the right to modify the natural environment to suit their needs	2.26[a]	1.92[b]	2.44[a]	4.191	0.017
Humans were meant to rule over the rest of nature	2.00[a]	2.39[a]	3.00[b]	5.871	0.004
The so-called "ecological crisis" facing humankind has been greatly exaggerated	2.16[a]	1.77[b]	2.56[a]	6.593	0.002

Notes Only significant differences ($p < 0.05$) are presented. Different letters mean significant statistical differences

Table 7 Association between UGS frequency of use and NEPs means

Statement	Do you visit the UGS every week?		*p*
	Yes	No	
Plants and animals have as much right as humans to exist	4.55	4.20	0.030

Jones and Dunlap (1992) stated that younger adults, well-educated (almost 88% of the sample holds a university degree), raised and living in urban areas (such as the Porto metropolitan area), and working in tertiary sector were found to be present more pro-environmental attitude. Also, in the first Portuguese national report on sustainability perception and practices by Schmidt et al. (2016), similar results were found and the authors advanced with a possible justification that is based on the fact that youngers are closer to environmental concern due to the formal education. On the other hand, when the elderly report more pro-environmental concerns, this is due to their closer connection to nature and agriculture practices. In fact, this can be linked with the results in Table 5, since UGSU and agricultural farmers presented similar means in several NEPS statements, due to their connection to nature.

No significant associations were found with NEPS scores among UGSU usage profiles, with exception to the frequency of use (Table 7).

It is worthwhile to observe that visiting the UGS with more frequency (every week) results in a higher agreement (4.55; $p = 0.030$) with a NEP view that humans are part of a larger ecosystem as other species and that all species have the same right to exist as humans do. Thus, being closer to UGS can lead to a more eco-centric worldview.

5 Final Remarks

The widespread recognition that anthropogenic actions have altered the ecosystem and continue to do it more intensively, resulted in a significant amount of research devoted to understanding how different groups perceive these cross-cutting issues. The importance of studies on this topic is based on a need to identify patterns within different groups to clearly define strategies to improve ecological and environmental awareness and to promote truly sustainable development.

Among different groups in which the NEPS has been applied successfully, UGSU have been put aside from this debate. As far as the authors know, this study is the first exploratory approach that aimed to measure and analyse UGSU NEPS score, choosing a southern European city as a case study. Regarding reliability measures, the NEPS application to UGSU revealed to be consistent, reliable and aligned with the factor structured of the original scale. Additionally, the variance explained by the NEPS in this study is higher than the original, which highlights the capability of this tool to measure the environmental concern of UGSU.

Another important contribution of this study was the comparison of UGSU NEPS results with other populations and previous studies. By comparing with agricultural farmers, university teachers and the general population, UGSU presented higher ecocentric values based on the recognition of the limits of Earth and natural resources. These values are positioned alongside with a view of the world that matches with the NEP: the imbalance of one part of the ecosystem weakens the others. The respect towards nature cycles and the recognition that humans need to adapt to the laws of nature, and not the opposite, is one of the UGSU characteristics.

These results raise two potentialities that can be further explored in the future. Is it the contact with nature (UGS) that enhances a more ecological view of the world? Or are UGSU more naturally interested in environmental issues? In this study, an attentive approach was made to address these questions, namely by associating the UGS usage profiles and the NEPS. Was also found that UGSU visiting the UGS every week believe that plants and animals have the same right to exist such as humans. Also, Nbs can be seen as a public policy of awareness concerning the environment and sustainability. Increasing people's free time by promoting the use of UGS would not only increase awareness but also well-being. This can trigger the development of future studies with larger samples and/or qualitative ones that deeply explore the UGSU contact with nature.

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Diogo Guedes Vidal is graduated in Sociology (2014) and M.Sc. in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability. He is currently a Ph. D. research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Ricardo Cunha Dias is graduated (2015) and has a master's degree (2017) in Sociology and is currently a Ph.D. student in Public Administration, specialization and Public Policy. He is Invited Assistant Professor at the Institute of Social and Political Sciences (ISCSP) at the University of Lisbon and a collaborating researcher at the Center for Administration and Public Policy (CAPP). His main areas of research are transformational governance and sustainable development.

Paulo Castro Seixas is graduated in Anthropology—specialized in Sociology of Tropical Regions—, M.Sc. in Sociology of Education and Ph.D. in Social and Cultural Anthropology—Urban Anthropology. He is Associate Professor with Aggregation at the Higher Institute of Social and Political Sciences of the University of Lisbon and Coordinator of the Public Administration and Territorial Policies Unit. His main research areas are transnational urban studies (with fieldwork in Portugal, Brazil, Romania and Timor-Leste), the socio-anthropology of Timor-Leste and, recently, culture policies in the Portuguese-speaking space.

Maria Alzira Pimenta Dinis is graduated in Metallurgical Engineering (1992), M.Sc. in Materials Engineering (1995) and Ph.D. in Earth Sciences (2010). She is currently Associate Professor in the University Fernando Pessoa, Porto, Portugal, researching in FP-ENAS, UFP Energy, Environment and Health Research Unit. Her main research domains include Reservoir Modelling and Environmental Engineering, with scientific outputs translated by numerous publications.

Cláudia Oliveira Fernandes is graduated in Agricultural Engineering (1997) and in Landscape Architecture (2010), M.Sc. in Natural Resources Management (2001) and Landscape Architecture (2011), and Ph.D. in Environmental Sciences (2009). She is currently Assistant Professor in the School of Sciences, University of Porto, Portugal, and researcher at the Research Centre in Biodiversity and Genetic Resources (CIBIO—InBio Associate Laboratory) leading the Landscape Planning, Design and Management research group (LPDM). Her main research interest includes the assessment, planning, design, and management of a wide-ranging of habitats and ecosystems, especially in urban environments.

Nelson Barros is graduated in Environmental Engineering, M.Sc. in Thermal Engineering an Ph.D. in Environmental Sciences. Member of the Editorial Board of the Journal of Ecological Engineering. Currently, is Associate Professor at University Fernando Pessoa, coordinator of the Ph.D. program in Ecology and Environmental Health and coordinator of the Laboratory of Research in Energy, Environment and Environmental Health (3ERL), a Research Group of the Fernando Pessoa Research Unit in Energy, Environment and Health (FP-ENAS).

Rui Leandro Maia is Ph.D. in Sociology (2002), M.Sc. in History of Populations (1995) and graduated in History (1988). He is currently Invited Associate Professor at Fernando Pessoa University, Porto, Portugal, and researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit. His main research domains include demography, sociology, food safety, environment and treatment, analysis and criticism of sources, with scientific production translated into several publications.

Sustainable Development Goals in Portuguese Speaking Countries: The Perspective of Environmental Education Experts

João Guerra, Luísa Schmidt, and Leonor Prata

1 Introduction

Portuguese speaking countries are at different levels in promoting Environmental Education (EE). A pioneering study of EE in Lusophone nations (Schmidt et al. 2017) showed that, in general, EE was under the responsibility of the Ministries of Environment and Education, with a critical role reserved for municipalities, schools, and environmental NGOs. The results also indicated that EE had definitively entered the public and political agendas of most of the Portuguese-speaking countries, although it was unevenly practised and, in some cases, still at an embryonic stage.

The second edition of the survey (2020) sought to understand better these realities within the implementation process of the 2030 Agenda and a global context marked by the concerns of the COVID-19 pandemic. These two contextual factors have reinforced the need for EE, but the added complexity and demand, have made the action of those promoting it more challenging. Hence, the second edition was divided into three major sections:

(i) Contexts and approaches of Environmental Education in the Community of Portuguese Language Countries (CPLP).

J. Guerra · L. Schmidt · L. Prata (✉)
Institute of Social Sciences (ICS-ULisboa), University of Lisbon, Lisbon, Portugal
e-mail: leonor.prata@ics.ulisboa.pt

J. Guerra
e-mail: joao.guerra@ics.ulisboa.pt

L. Schmidt
e-mail: mlschmidt@ics.ulisboa.pt

J. Guerra · L. Schmidt · L. Prata
Av. Prof. Aníbal de Bettencourt, 9, 1600-189 Lisbon, Portugal

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(ii) Place and role of children and young people in the Environmental Education field of action.
(iii) The 2030 Agenda and the pandemic as conditioning factors of Environmental Education.

Seeking to be as comprehensive as possible and mobilising a "snowball" sampling methodology that allowed broadening the field of inquiry, the questionnaire was initially sent to all respondents of the previous edition and other identified organisations with EE activity, requesting its retransmission to other entities and specialists engaged in the area. Most respondents in the 2020 edition (76.5%) indicated that they had participated in the previous edition, and within the other respondents, there was a slight majority (51.9%) who were aware of the previous study.

The overall purpose was to collect information capable of contributing to a more informed and effective EE and future approaches focused on the complex problems and growing uncertainties that mark different CPLP countries' realities. Hence, in the following chapter, we will address the cross-cutting nature of EE and sustainable development, as well as the perceived impact of the current health crisis, which compounds upon the climate crisis and exacerbates the socio-economic issues within Portuguese-speaking countries, from the perspective of stakeholders that specialise in Environmental Education (EE) and Sustainability.

2 Characterising EE Experts and Their Institutions: EA2CPLP

In terms of nationalities (Fig. 1), response rates vary widely between countries and are far from representative. Despite efforts to contact EE experts from East Timor and Equatorial Guinea, we could not obtain more than one response. On the other hand, despite the differences in geographical and demographic size, it appears that

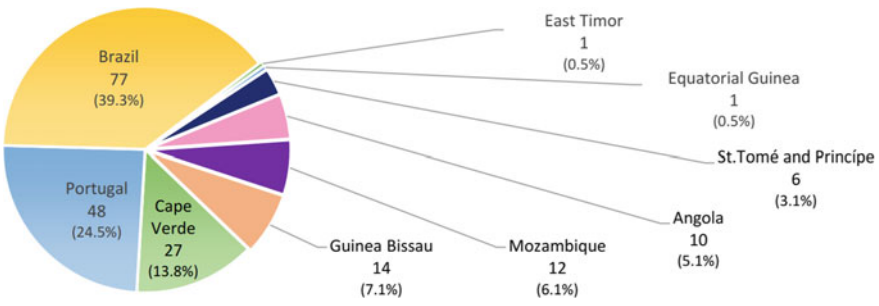

Fig. 1 Nationality of respondents

Angola (10 responses) is under-represented, particularly in comparison to the larger representation of Guinea-Bissau (14) and Cape Verde (27).

In the analysis of this sample, it is crucial to consider the socio-economic and political differences between these nations that may limit not only the action of environmental educators but also other contextual characteristics that mark the development and visibility of EE (e.g., language, isolation, scarcity, or weakness of civil society organisations). Such limitations are accentuated in a pandemic context, which extended throughout the eight-month data collection period. Additionally, given that the research team's in-person contacts were not possible, communication relied upon digital and technological resources, which may be unavailable in vulnerable communities.

The following results must be seen, above all, as testimonies of "environmental educators" and other experts who, in different socio-geographic realities, are committed to or interested in EE and the promotion of sustainability.

If we focus on the scope of action, according to Fig. 2, most respondents develop EE with close proximity to communities (i.e., municipal, local, school levels), although the national level is the category that most stands out, with 83 cases (28% of the total responses). Furthermore, the minority categories are also the most complex: two of the sixteen cases engaged at an international level work within the Lusophone context; whereas around half (33) of Brazilian specialists act at the State level, which only occurs in this nation, given the political (federal) administration of the territory. In turn, the regional scope was also mentioned once in Portugal and Mozambique.

Confirming the centrality of civil society (NGOs, associations, movements) and educational institutions in EE, Fig. 3 also illustrates that Public Sector institutions linked to political power (i.e., local and national governments and public services) correspond to almost one-third of responses. However, previous EE studies in Portugal (Schmidt et al. 2010) suggest that EE experts with the municipal framework are underrepresented (7.8%). After all, municipalities can contribute with diversified resources (e.g., financial, material, technical, structural) but tend to lack human resources that, according to the results, depend primarily on other entities.

On the other hand, despite Environmental Education Centres' theoretical relevance,[1] only nine respondents identified themselves (or their institutions) within this category. Given that qualitative analysis suggests that many entities represented in this sample fulfil this role, we probably testify a lack of dissemination/understanding of this concept in Lusophone nations.

[1] Specialized entities in EE which develop and integrate resources for local communities with an established and stable multidisciplinary team of professionals (Carvalho et al. 2011).

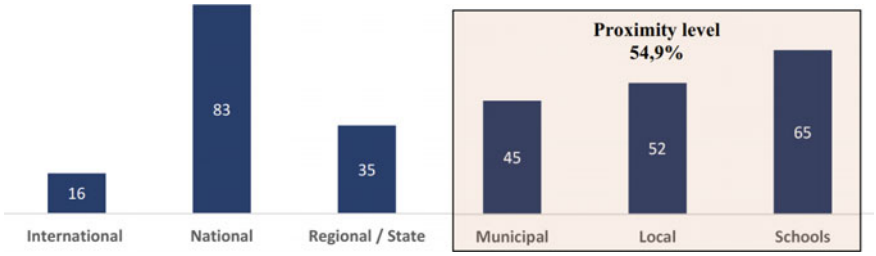

Fig. 2 Geographical scope of EE activities (multiple response)

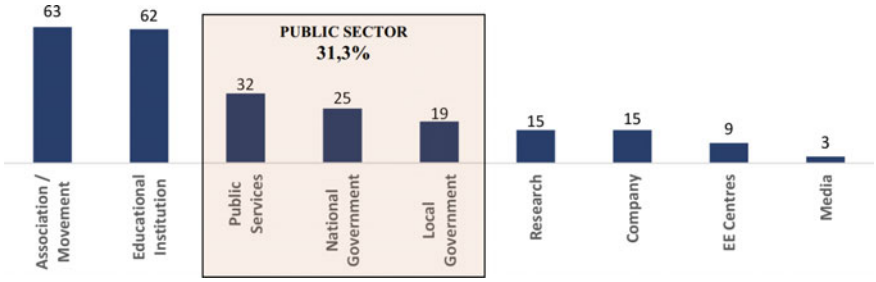

Fig. 3 Type of institution (multiple response)

3 EE Contexts and Approaches in Lusophone Countries

Respondents were quite conservative when asked about the value attributed to EE by different governance levels (Table 1), and smaller administrative divisions were considered better placed to promote EE. Globally, the value attributed at the local level was 3.43 out of 6, while the national level did not exceed 3.02. Moreover, respondents from Portugal and Cape Verde were the most confident regarding EE's attributed value. In contrast, respondents from Brazil, Guinea-Bissau, and St. Tomé and Príncipe considered the attributed value to EE much lower, below 3 out of 6.

However, breaking down government levels in these countries, we find some diversity, which is most visible among the Brdazilian respondents, who were vocal regarding the lack of appreciation of EE given by their federal government (2.14), particularly in comparison with the state (2.87) and the local (2.80) levels of government. In fact, within all the represented nations, only experts from Mozambique, Angola, and the one respondent from Equatorial Guinea, reported that their national governments valued EE more than local governments.

When assessing their performance regarding EE, a similar pattern emerges. The highest average value (3.12) is attributed to the local level, with a negative assessment of regional (2.79) and national (2.63) performance. Likewise, Portugal and Cape Verde stand out as the countries where experts are most optimistic about their governments' action regarding EE, although only Portuguese local

Table 1 Value and performance attributed to EE in different levels of government

Country	Value			Performance		
	National	State/ Regional	Local	National	State/ Regional	Local
Angola	3.70	3.14	3.44	2.88	3.00	3.13
Brazil	2.14	2.87	2.80	1.84	2.51	2.54
Cape Verde	3.73	3.80	4.15	3.68	3.46	3.76
Guinea Bissau	2.36	1.73	2.60	1.83	2.00	1.80
Equatorial Guinea	5.00		3.00	4.00	3.00	3.00
Mozambique	3.67	2.38	3.08	2.91	1.50	3.33
Portugal	3.94	4.09	4.38	3.51	3.48	4.02
St. Tomé and Príncipe	2.40	4.00	2.60	2.00	3.33	2.00
East Timor	5.00			5.00		
Total	3.02	3.15	3.43	2.63	2.79	3.12

government entities are given a particularly positive evaluation (4.02). Experts of Guinea Bissau, Brazil, and St. Tomé and Príncipe were also the most critical of their governments, evaluating them with values below 2 out of 6, in all levels except for the Brazilian local governments (2.54) and states (2.51). Therefore, EE experts in Lusophone countries generally assess their government's interest and performance in this area as moderate or low.

The evaluation of other critical institutions for EE activities like NGOs, Schools or local communities is very different, as shown in Fig. 4. Respondents seem to believe that civil society (i.e., NGOs and local communities' representatives) and their partners from local schools can get better results than governments. According to Fig. 5, only the performance of Angolan schools and the 'local communities' of St. Tomé and Príncipe are assessed negatively. Except for the single respondent of Equatorial Guinea, in all other cases, NGOs are the best-evaluated type of local institution, sometimes with huge differences from the second position (e.g., Angola, Guinea-Bissau, Mozambique).

Such different evaluations stem from an even greater socio-economic diversity, contrasting civic traditions and public services (e.g. public schools) with varying degrees of accessibility. Hence, we sought to understand the kind of environmental education approaches developed at the distinct national and belonging institutional levels. For this analysis, we mobilised the theoretical proposals by Öhman and Östman (2019) to identify different EE approaches and relate them with each national context. The authors identified three types of 'selective EE traditions'[2] that may coexist but differ according to their framing of environmental problems and pedagogical practices, as following:

[2] The concept of Selective Traditions refers to the pedagogical approaches to "knowledge and an educational praxis that is always selected within a specific cultural frame" (Öhman 2004).

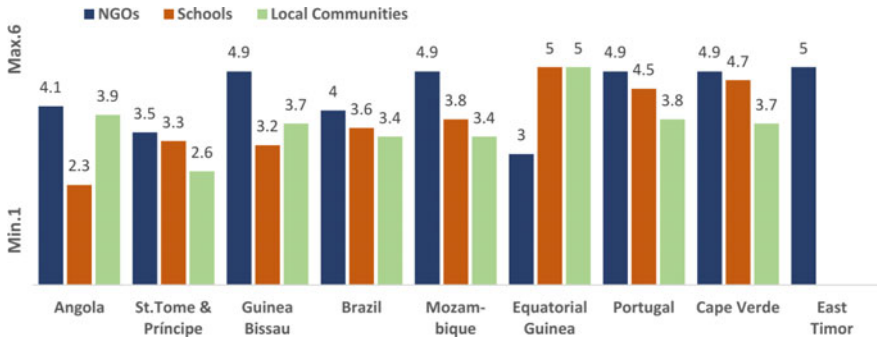

Fig. 4 Assessment of local institution's performance in EE, per country

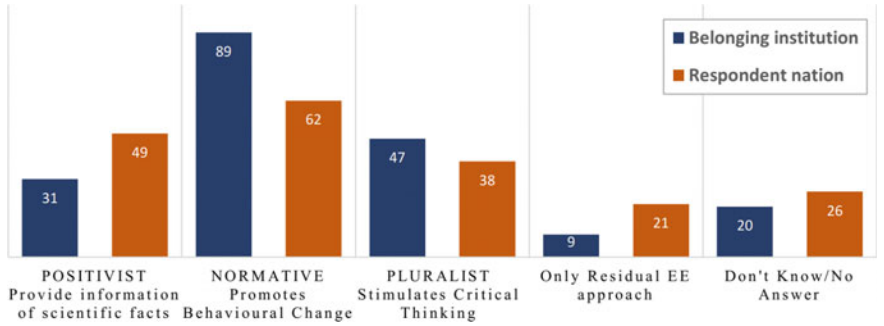

Fig. 5 Approaches to EE, at the institutional and national level

A Positivist Selective Tradition. The EE practices correspond to the transmission of scientific expertise and evidence communication of environmental degradation. In this fact-based approach, environmental problems resulted from a lack (or misuse) of scientific knowledge.
A Normative Selective Tradition. The curricular contents tend to privilege 'environmentally friendly' attitudes and behaviours. This selective tradition tends towards a pedagogical paradigm where students are considered passive recipients of information and objects of transformation.
A Pluralist Selective Tradition. The approach takes a critical and potentially more transformative stance, mobilising participatory processes to deconstruct relevant issues, promoting the development of competencies, and identifying solutions through joint reflection and discussion.

According to surveyed EE experts, the most mobilised approach is the *normative selective tradition* (Fig. 5), which promotes behavioural change at the national and even more so at the institutional level. This cross-cutting choice may result from a

national and global policies momentum that, through targeted policies, seek to match effective behavioural change with the broader emergence of New Ecological Values (Dunlap 2008). Indeed, the prominence of the normative tradition is in line with previously obtained results in Sweden[3] (Öhman 2004) and partly in Portugal (Schmidt et al. 2010).[4]

The *positivist selective tradition* is less common in CPLP countries, although it is most prevalent at the national level. Compared with the other two selective traditions, it is expected to be less susceptible to criticism and thus more resistant to attacks by opponents of Sustainable Development. Indeed, despite the neglect of more systemic and less measurable factors, the knowledge acquired and then transferred to the students remains independent of how it was produced and who adopts it. Such independence can strengthen the message and, in an era when the phenomena of "post-truth" became increasingly evident and disseminated by digital and local communities, turned out even more critical (Gudowskya and Aaron 2019).

Unlike the previous two, pluralistic selective tradition—the most critical approach—is primarily recognised and promoted in non-governmental institutions. It is characterised by engaging different perspectives and by identifying different standpoints through deliberative conversations. In this view, "environmental issues are seen as complex moral and political problems that include conflict-based perspectives stressing public involvement of democratic processes" (Andersson 2016: 3). Based on this systemic approach and calling for a learner-centred teaching approach, pluralistic proposals offer a critical action beyond knowledge and social change, questioning the *status quo* of continuous environmental and social degradation.

However, getting students to actively discuss issues related to the environment without influencing their opinions can be considered a good result of a pluralist viewpoint, but eventually not fast enough for the urgency of today's environmental crisis. Moreover, critical thinking does require reliable information and evidence to make decisions based on scientific principles. This complexity explains why most respondents declared a mixed practice of approaches, not always easy to distinguish. After all, different situations and problems require an equally varied set of responses sustained on scientific evidence, reflection and critical thinking, and social change.

Delving into these approaches, let us look at countries' response rates, comparing their implementation at the national and belonging institution's level (Fig. 6). As previously mentioned, respondents indicated greater use of the positivist approach at the national level (from 6% more in Brazil to 19% more in Cape

[3] *Miljöundervisning och utbildning för hållbar utveckling i svensk skola* [*Environmental education and training for sustainable development in Swedish schools*] Report, developed for the Swedish National Agency for Education (Skolverket), led by Leif Östman (Upsala University) and Johan Öhman (Örebro University) in 2002.

[4] Although this typology was not applied by Schmidt et al. (2010), the results achieved by this city showed a preponderance of EE practices very close to the normative tradition.

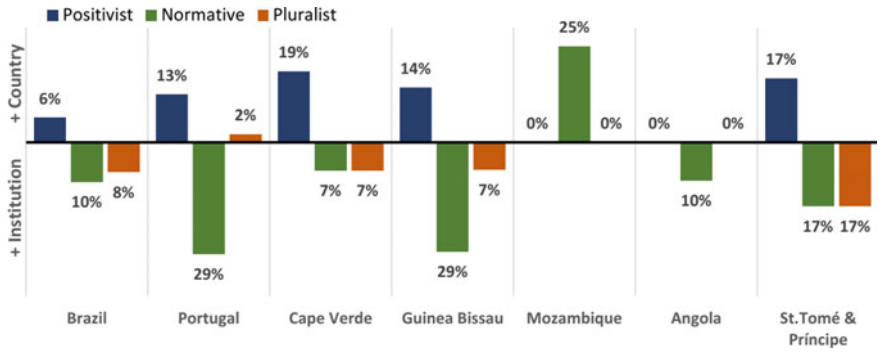

Fig. 6 Difference between national and institutional approaches to EE, per country

Verde). The only exceptions were found in Mozambique and Angola, where respondents gave equal representation to both the positivist and pluralist traditions at the institutional and national levels. As per our respondents, in Mozambique, the normative approach is 25% more developed at the national than at the institutional level, while in Angola, the situation is reversed: 10% more report a normative approach at the institutional than at the national level. The other two EE selective traditions (normative and pluralist) are most commonly developed at respondents' belonging institutions. The normative approach stands out among the Portuguese and the Guinean institutions, while the pluralist approach (less implemented in most geographical contexts) tends to be more present among the respondents' institutions but with less expressive differences.

It is also important to mention a sizeable portion of respondents who took refuge in "non-responses" (e.g., Guiné-Bissau, 35.7%; St. Tomé and Principe, 33.3%; Angola, 30%; Portugal, 25%, Brasil, 24.7%;). Different factors may justify these high rates:

(i) The scarcity of activities and EE's embryonic stage make the requested assessment meaningless or unnecessary in some countries.
(ii) The respondents assume that they do not know how, where, and under what conditions, EE occurs at the national level and, sometimes, in their own institutions.
(iii) An implicit criticism in developing national policies and strategies leads respondents not to classify EE in their country and even at their institution.
(iv) As aforementioned, respondents might have difficulty in selecting only one approach at the institutional or national level when they might identify more than one, in reality.

Although resulting from very different socio-economic contexts, the lack of resources and conditions to implement EE are globally felt. On the other hand, national policies and their inadequacy to needs are often seen more as obstacles than as facilitators of the activity. For example, in the Portuguese case, although this

may be attributed to the post-1996 trend of political stagnation in the field of EE (Schmidt et al. 2010), it appears that the relatively recent ENEA-Portuguese National Strategy for Environmental Education (APA 2017)—has been met with some scepticism from EE experts.

Considering the respondents' experience, it was of interest to identify, in greater depth, which aspects of EE are most developed. To this end, respondents were asked to select a maximum of 6 dimensions of EE that are well-accomplished in their national realities.

According to Table 2, globally, dimensions that combine elements related to the three selective EE traditions are well-positioned. First of all, "Environmental Awareness" stands out with 83% and, still with impressive representation, the stimulus to civic participation (58%), defending the common good (51%), scientific knowledge (48%) and the promotion of action competence (40%). Thus, although the selective pluralist tradition is one of the least represented in both institutional and national approaches, these results reveal a set of practices that hardly leave it out together. Among other categories that may also be associated with this critical approach, we can also find the promotion of "critical thinking" with 37%, particularly in Guinea-Bissau and Brazil. Interestingly, experts from these nations, Mozambique and the one respondent from Equatorial Guinea, highlight EE's role in promoting solidarity and empathy and strengthening community belonging, which suggests integration into a broader vision of sustainable development. When it comes to EE's position in fostering sustainable innovation, entrepreneurship and leadership skills, we find that these categories are most elected amongst Portuguese-speaking African nations, which may pave the way for closer integration between economic and sustainable development.

In sum, even though respondents see environmental issues as complex political problems that may include conflict-based perspectives, they may not outright reject a more fact-based and normative approach, using EE (or Education for Sustainable Development) to influence pupils' norms and attitudes with factual information. After all, a significant part of our respondents, as it happened in other contexts, aim "to form future generations of citizens who either voluntarily change their attitudes and SD behaviour or at least accept policies aimed to steer society in a more sustainable direction" (Andersson 2016: 10). From many of these respondents' perspective, this methodological elasticity will not prevent—rather, will enhance—the "formation" of informed, trained, empowered and critical citizens.

4 Children and Youth: Roles and Agency in EE

Although there is not always a consensus on how to achieve it, according to Mogensen and Schnack (2010), the primary purpose of EA—or more recently of EDS (Education for Sustainable Development) is to encourage within students the ability, motivation, and will, assuming an active role in promoting sustainability and finding democratic solutions to socio-environmental problems.

Table 2 EE dimensions that are best developed nationally, per country

	Brazil (%)	Portugal (%)	Cape Verde (%)	Guinea Bissau (%)	Angola (%)	Mozambique (%)	St. Tomé and Príncipe (%)	Equatorial Guinea* (%)	East Timor* (%)	Total (%)
Environmental awareness	74	92	93	86	80	92	67	100	0	83
Civic participation	26	67	81	93	80	92	83	100	100	58
Common good	39	46	67	79	50	75	50	100	100	51
Scientific knowledge	55	48	48	36	30	42	50	0	100	48
Action competence	34	44	52	43	10	42	50	100	100	40
Critical thinking	52	27	30	43	10	25	17	0	0	37
Solidarity and empathy	43	29	33	43	50	17	17	100	0	36
Sustainable inovation and entrepeneurship	35	31	48	21	50	33	50	0	100	36
Bridging gap between youth and policies	38	35	15	29	10	25	67	0	100	32
Willingness to change	25	42	33	36	20	17	50	0	0	31
Strengthening identity and belonging	42	13	19	29	0	58	0	100	0	28
Leadership skills	17	2	11	29	40	50	0	0	0	16
Total (respondents)	39	24	14	7	5	6	3	1	1	100

*We only received one valid response from these countries

Hence, a consequent EE should be based on the co-creation of solutions, independent thinking, and reflective learning that allow us to deal with our time's growing uncertainties and questions. On the other hand, the practice of EE worldwide has been chiefly targeted to children and youth, in a pattern that stems from the installed idea that specific awareness-raising and mobilisation strategies must be focused on younger age groups (Schmidt et al. 2010). Therefore, it is crucial to understand the profiles of activities in which children and youth engage, their roles, and their perceived impact.

As shown in Fig. 7, about 39% of respondents indicated that children and young people were actively involved in overall EE actions, and only a bit less than a quarter (24.4%) reported leadership roles. "Environmental Clean-up and Conservation" stands out as the most mobilising activity, mentioned by 65.3% of the responses as a *practice* developed by children and young people and 33.7% as a *led* practice by them. At the opposite extreme, perhaps because it supposes greater demands and mostly the mobilisation of older groups, we find "Reporting/ Investigation" activities with substantially lower percentages: 24.5% of the responses for *simple participation* and no more than 14.3% for *leadership*. But perhaps more important is the apparent diversity of children and young people's role, which does not permeate all activities in the same way. When it comes to EE actions developed online (online dissemination), we find that 37.2% of responses refer to leadership, and only a bit more (42.4%) refers to simple participation. It is, after all, a led set of initiatives by young people. On the contrary, on, for example, "Environmental Clean-up and Conservation", "Education and Training", and "Participation in Decision Making" (both at school and community), a large part of the activities remain outside the leadership of the younger groups.

When looking into the perceived impact to these actions (Fig. 8), it should be noted that, overall, respondents attribute a modest, yet positive, evaluation of the impact (3.77 out of 6) regarding the EE actions carried out or led by young people. For instance, although respondents identify a strong adherence and leadership of children and youth in environmental mobilisations (whether within associative contexts or in protests and demonstrations), these forms of intervention are evaluated as some of the environmental activities with the least impact (3.67 and 3.45, respectively). These are unexpected results, given the momentum of youth environmental protests and mobilisations, which have received international political and political recognition (Kühne 2019), due to their poignant focus upon climate policy gaps (Camargo et al. 2020). Likewise, the production of knowledge regarding EE is the activity least reported and among the least impactful. Hence, it is worth noting the apparent absence of a relationship between the degree of child and youth mobilisation achieved by each activity and the perceived impact, as we shall see below.

When breaking down the evaluation of impact at the national level, it is essential to keep the following in mind: according to an expert from Guinea-Bissau, in his country, as in others under analysis, "most of the population is young". The countries in which more respondents indicated leadership of children and youth were, by far, Guinea-Bissau (39%) and Angola (35%). On the other hand, the

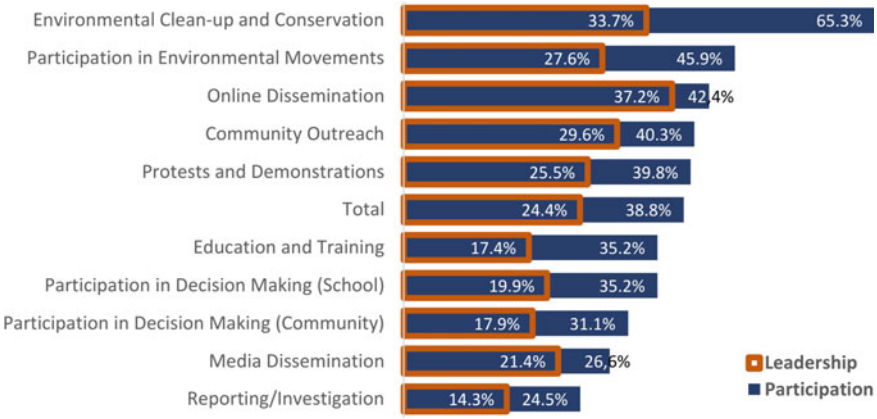

Fig. 7 Participation and leadership of children and youth in EE actions

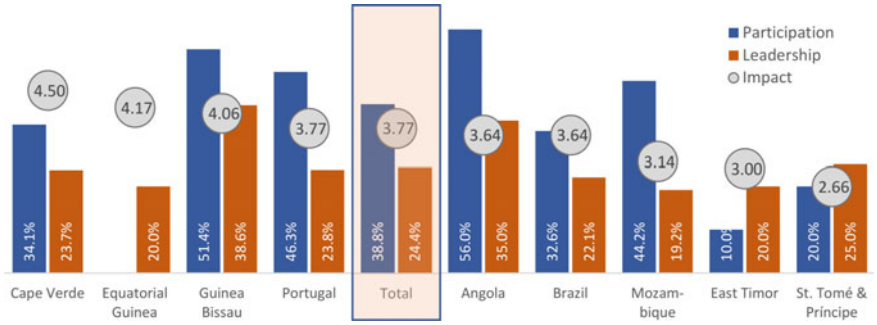

Fig. 8 Participation, leadership and impact of EE done/led by children and youth

recurrent trend of "infantilisation" of EE in Portugal, as noted by Schmidt, Nave and Guerra (2010), is visible by the lack of recognition of youth leadership (23%) and even participation (46%). However, the countries that least report participation are St. Tomé and Príncipe and East Timor, providing lower impact assessments. Perhaps due to current political pressures to EE activities in Brazil, experts from this country were relatively uncertain whether youth action was impactful (3.64), and fewer than one-third of specialists indicated, on average, youth participation, whilst less than a quarter indicated that children and youth were acting as leaders in EE.

Therefore, we tried to inquire about the defence of a specific mobilisation strategy to the children and youth public and the attributed impact of a 'youth parliament' (when existing) in the national public policies definition. However, according to the results expressed in Fig. 9, these instruments do not seem to be popular in Equatorial Guinea and East Timor, where the respondents did not identify any. In contrast, the same respondents strongly advocated a dedicated

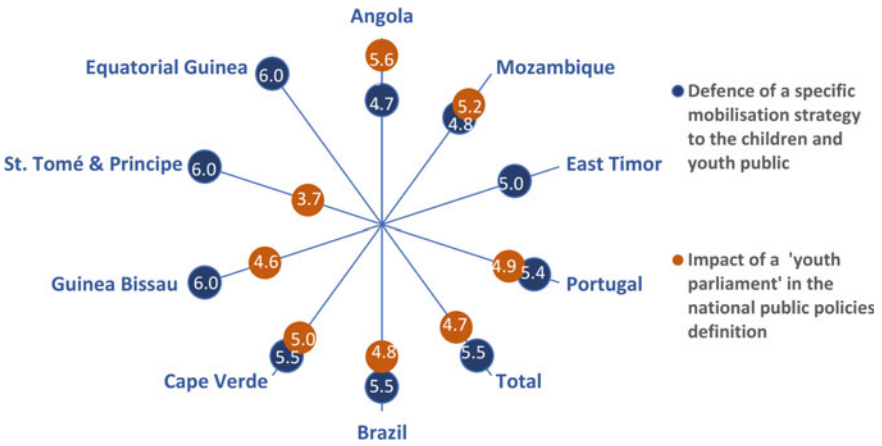

Fig. 9 Defence of a specific youth mobilisation strategy and concretisation with a 'Youth Parliament'

strategy to youth mobilisation (6 and 5 out of 6). Such a dedicated approach is transversally supported by respondents, regardless of their nationality (i.e., from 4.67 in Angola to 6.00 in Guinea-Bissau, Equatorial Guinea, St. Tomé and Principe). However, this does not seem to be related to the confidence in youth democratic engagement methods such as the "Youth Parliament", which, among these respondents, obtains weaker results. If we look globally at the pattern on how children and young people are integrated into EE activities, the diminished dissemination of youth leadership is clear, even in areas where it would make particular sense. Except for countries such as Equatorial Guinea and East Timor—which, as we know, are underrepresented—in the generality of countries, there is some resistance to the pupils' autonomous and prepositive participation that denies the purposes of the pluralistic selective approach: teaching students to independently confront tensions and conflicts and reflexively tackling issues with no single answers.

5 Dual Context: The Pandemic and Agenda 2030

Since this edition of the survey took place in a pandemic context, when the UN 2030 Agenda was meant to be in full implementation, it was deemed advisable to present interconnecting EE and the constraints that arise from both contextual factors, keeping in mind the socio-economic diversity present in the countries set under analysis. Moreover, as Anderson stated, SD perspectives must permeate all education levels, and all learning to early encourage active participation and critical thinking about building a sustainable society (2016).

It was then relevant to ascertain how environmental education has contributed to the 2030 Agenda and the Sustainable Development Goals (SDGs) from the respondents' point of view. Figure 10 illustrates that there are substantial differences between nationalities. Whilst respondents from St. Tomé and Príncipe seem to be less than optimistic about their contribution to the SDGs, the only respondents from Equatorial Guinea and Timor-Leste assume the centrality of this action, assigning the highest value of the scale to the contribution of EE to the 2030 Agenda. At a juncture which is undoubtedly related to the political-economic situation of each country and the openness/ability/willingness of national governments to promote sustainability and "leave no one behind" (UN General Assembly 2015), other factors—more or less specific, but equally relevant—will determine the contribution of EE to the 2030 Agenda. But indeed, one of them is the SARS-COV-2 pandemic, as we will attempt to confirm below.

Considering the current context and the possible short and long-term impacts, we asked respondents to select up to six SDGs that, in their view, could be most affected by the Coronavirus pandemic (Fig. 11). Unsurprisingly, the quartet consisting of poverty, health, economy and hunger, followed very closely by education and social inequalities, comes to the fore, constituting the most threatened areas in any geographic context. Still, respondents from Angola and Guinea-Bissau primarily emphasise SDG 1 (Eradicate poverty) and SDG 2 (Eradicate hunger), to which Mozambicans adds SDG 4 (Quality education). Sharing these same concerns, the remaining respondents also highlight the area of health (SDG 3) as one of the most threatened. According to the respondents' assessment, even areas usually considered to be moderately successful in the scope of the 2030 Agenda—e.g., water and sanitation, quality education—are currently vulnerable to the effects of the pandemic, adding vulnerability to previously vulnerable societies that already present evident shortcomings, given the proposed 2030 targets (UN DESA 2020).

Nonetheless, it may be worth mentioning the modest place attributed by respondents to traditional questions addressed by EE, as are the more directly linked to biodiversity (i.e., Terrestrial Life and, above all, Marine Life). The urgency of socio-economic issues, which the pandemic has aggravated, seems to overshadow environmental imperatives—a concerning trend that is mirrored at the international level (UN DESA 2020).

When analysing the institutional responses (e.g., national/federal government, NGOs and schools), there are notable differences in the assessment of effectiveness,

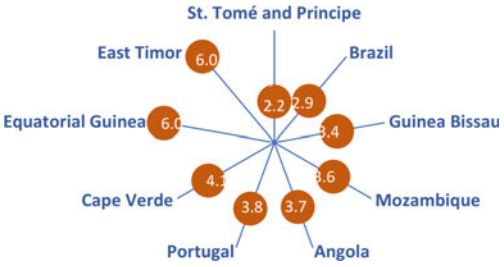

Fig. 10 Assessment of EE's contribution for public policies in Agenda 2030

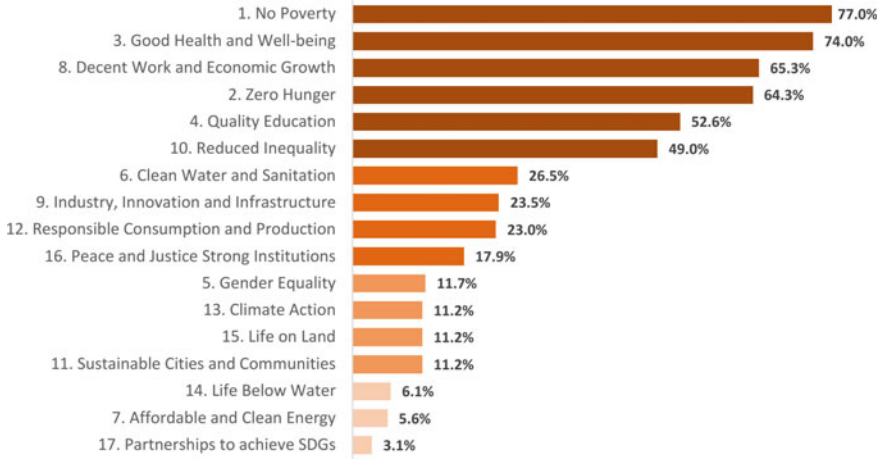

Fig. 11 Most vulnerable SDGs to the effects of the pandemic (Covid-19)

as shown in Fig. 12. Respondents from Portugal, Cape Verde, St. Tomé and Príncipe and, with a lower evaluation, from Mozambique and Angola, do not differentiate the three types of institutions' effectiveness. The respondents from Guinea-Bissau highlight NGOs' role positively, whereas Brazilian respondents underline the Federal Government's role negatively (2.0). On the other hand, the Timor-Leste respondent only assessed the national government action with the maximum value, omitting NGOs and schools' response. Such a situation is partially reflected in Equatorial Guinea's only respondent position, which did not assess NGOs' performance.

Once again, national contexts play an important role, especially in evaluating the answer to one of today's most pressing problems: the COVID-19 pandemic,

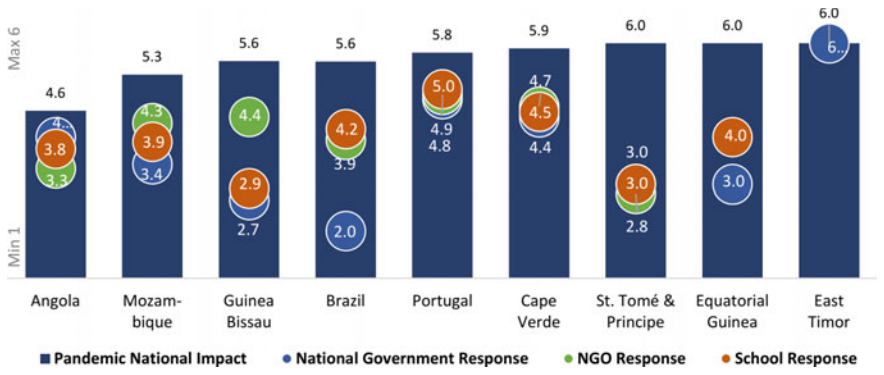

Fig. 12 National impact of the COVID-19 pandemic and evaluation of institutional responses (National government, NGOs and schools)

boosted by a plethora of consequences that lead to complex social processes, which includes: the predatory relationship between man and nature; the fragility of public services, the deepening of social inequalities between countries and within each nation.

It is, after all, the growth of human, social and environmental vulnerabilities and thus constituting a threat to sustainable development. In terms of EE, in particular, experts indicated that they predicted a high impact (average of 5.13 of 6) and evaluated their institutions' responses as quite effective (4.48), although this varied nationally, as can be seen in Fig. 13. Whereas institutional responses in countries such as Portugal (5.2), Cape Verde (4.9), Mozambique (4.5) and Brazil (4.3) were considered adequate, in countries such as St. Tomé and Príncipe (3.0), Angola and Guinea Bissau (both scoring 3.6), experts were more reserved and critical. Angolan respondents assume an intermediate position, predicting COVID to have a lower impact than other nations, although still recognising it as a peril (4.1).

Given the multifaceted impact of this crisis and its links to environmental and health issues intrinsically tied to EE, it becomes crucial to understand whether these institutions have developed actions or projects dealing with the pandemic and lockdown periods. Despite the relatively high assessment of institutional responses' effectiveness, only a minority of respondents reported that such initiatives were taking place (39.8%), with a large proportion indicating they 'didn't know' (17.9%). As we can see in Fig. 14, the most selected response category stated that the circumstances in which belonging institutions find themselves do not allow for such initiatives to occur (19.4%). A considerable portion of these institutions seem not actively act in a pandemic context due to a lack of resources and not due to a lack of will. However, a relatively large proportion (10.7%) indicated that the same institutions were not considering such actions. In general, these are, no doubt, worrying signs regarding the survival of these institutions as well as the future state of EE (institutionally and nationally) and the communities they serve, mainly if we consider the potential contribution of EE in mitigating and adapting to present and future crises related to environmental and human health.

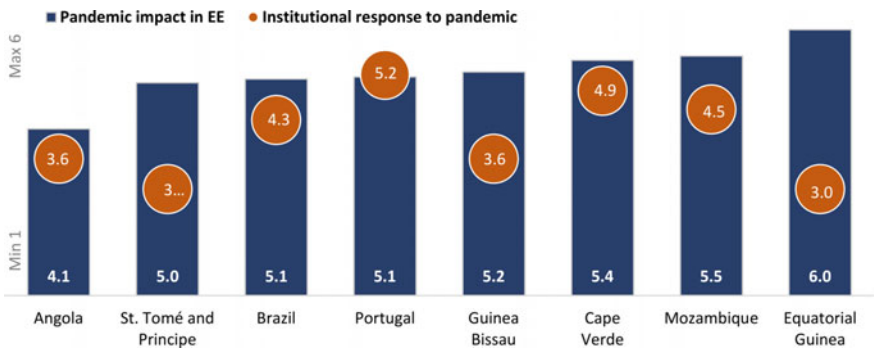

Fig. 13 Impact of the COVID-19 pandemic on EE and institutional responses

Fig. 14 Institutional response to pandemic conjuncture

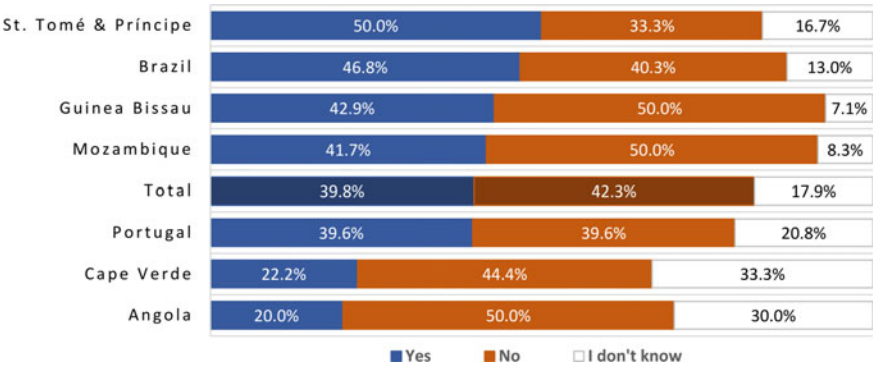

Fig. 15 Development of institutional EE action dealing with the pandemic

As per data shown in Fig. 15, the nationalities whose proportion of positive responses (indicating that such initiatives were taking place) were above average were St. Tomé and Príncipe (50%), Brazil (46.8%), Guinea Bissau (42.9%) and Mozambique (41.7). Portuguese respondents position themselves closer to the sample's average (39.6%) but relatively distant to Cape Verdean (22.2%) and Angolan (20.0%) respondents. Such response pattern is particularly interesting considering Portugal and Cape Verde's positioning in the previous analysis, which indicated these respondents were the most satisfied with EE's effectiveness, both by state and non-governmental actors. Moreover, these are also the two nationalities that most reported a lack of conditions necessary to develop programmes devoted to tackling the pandemic crisis (22.2% and 20.83%, respectively).

Beyond the resources and means that limited their institutions' ability to carry out EE in the current crisis, experts also indicated how their institutions adapted their approach in order to overcome and address obstacles. On the one hand, many reported that their institutions were widening the typical target audiences (i.e., from students to families and their communities), establishing partnerships with other institutions (governmental and non-governmental) and mobilising transdisciplinary knowledge. In particular, some institutions doubled their support of vulnerable and isolated communities (ex. Communities residing in Protected Areas in Brazil) by establishing and maintaining contact and pooling resources, such as masks, food banks, and other essential items. In the procurement of such items, some institutions developed donation campaigns and community service pedagogical activities,

encouraging citizens to develop material and non-material resources for their communities and fostering community belonging, empathy, and action competence.

These dimensions were also developed by engaging in participative and active discussions regarding the impact, mitigation strategies and the experiences of people during this crisis, through the organisation and participation in virtual events, in-person fieldwork in vulnerable communities, as well as mobilising participative pedagogical approaches and creative exercises (i.e., writing short stories, poems). In closing, we share below a Brazilian respondent statement regarding the innovative and responsive EE action undertaken to respond to the current pandemic.

> Jointly with other institutions, w*hat the institute is managing to do is impressive, guaranteeing the survival of fishing communities and others, both in the scope of solidarity within this emergency and through the revision of "what to do" as problems emerge from the social isolation imposed by the pandemic* (Brazilian EE expert).

6 Conclusion

This chapter summarises some of the findings of the 2nd Survey on EE in Portuguese Speaking Countries (EA2CPLP), which aims to contribute to the knowledge about the current state of environmental education in the context of the 2030 Agenda implementation and taking into account the impact of the SARS-COVID-19 pandemic. This second edition of the survey obtained 196 valid answers from environmental education specialists, representing all CPLP countries (although with only one representative from Timor-Leste and Equatorial Guinea). Moreover, with a heterogeneous sample of institutional backgrounds and geographical contexts of action, it was possible to verify the multiplicity of contexts in which EE is developed. Hence, we could identify different working conditions, expectations, and constraints that determine EE's quality and results.

EE approaches depends upon a multitude of conditions that are challenging to untangle. Basing our analysis on Öhman and Östman proposals (2019), it appears that in all institutional and national contexts, the normative selective tradition is prevalent, thus privileging the view of EE as a promoter of attitudinal and behavioural changes of learners. However, our results reveal a complex reality. Perhaps due to environmentalism's roots, in part shared by EE, the positivist selective tradition (fact-based) seems to remain active within our respondents. Moreover, it disputes the second place of the podium with the selective pluralist tradition, which emerges as an approach that promotes engaging with tensions and conflicts by recognising and accepting different standpoints on a deliberative and transformative learner-centred approach. In sum, considering our respondents' responses, the distinction between the three traditions may not always be clear.

Within very permeable socio-political circumstances, fond of the inputs stemming from Agenda 2030 and the pandemic lockdown that marked the investigation period, EE programmes act on facts and evidence, promoting social change (i.e., practices and attitudes) by fostering critical thinking, participatory decision making, value-based learning, and multimethod approaches. On the contrary, even though they see environmental issues as complex political problems that include conflict-based perspectives, pressed by the 2030 Agenda and the pandemic threat, most of our respondents seem to be closer to a normative tradition, not discarding the school and EE to influence students' standards and attitudes.

We could also observe that some of the national disparities identified in the first survey (2017) persist and are particularly visible in EE's categorisation at the national level as "residual or superficial". Such evaluation happens in most Portuguese-speaking African Countries (PALOP) and Brazil, combined with an also impoverished assessment of the current state of the Agenda 2030 and Sustainable Development Goals (particularly the socio-economic ones), which is only relatively positive in Portugal (3.88) and Cape Verde (3.56). Moreover, although there is agreement among experts that the pandemic context will have a substantial impact in all countries, there is only a positive evaluation of Portugal and Cape Verde's response, indicating such inequalities between countries may be exacerbated in the near future.

In sum, avoiding the instrumentalisation of education without forgetting the urgent need for engagement and mobilisation for sustainability (i.e., coping with the consequences of our time's severe socio-ecological problems) does not come across as a concerning issue. In practice, as Andersson (2016) and others have found, a learner-based to EE is complex; (a) on the one hand, a pluralist EE is inextricable from normative and fact-based contributions, and (b) on the other, a purely critical and pluralist approach, isolated from these contributions, may be conducive to discursive relativism and practical gridlocks. Despite the current international support for pluralism (from entities such as UNESCO), educators have struggled to face these issues, particularly given a lack of examples of how it may be carried out and little practical integration of this approach in teacher training programmes (Rudsberg and Öhman 2010). However, as opposed to the other selective traditions of EE—which prioritise academic results and behavioural/attitudinal effects of EE—the pluralist tradition focuses upon the underlying pedagogical *processes*, aiming to enhance action competence through deliberative discussions regarding EE.

According to the authors (Öhman and Östman 2019), overcoming the didactical challenges that EE educators face in the pluralistic approach implies integrating democratic processes within EE, where educators must present scientific facts and normative solutions whilst also promoting deliberation, participation, and meaning-making. These processes allow EE to deal with complex and uncertain issues, addressing "the border between sustainability, and unsustainability [which] is not sharp but rather fuzzy" (Phillis and Andriantiatsaholiniaina 2001: 436). Perhaps, then, EE specialists in this study feel that promoting an engagement with

the real world, backed up with scientific knowledge and normative guidelines, does not inevitably result in the instrumentalisation of education but, on the contrary, may open up a space for action based on newness, creativity, freedom and pluralism.

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João Guerra is a sociologist (Ph.D. in Social Sciences), an Assistant Researcher at the Social Sciences Institute of University of Lisbon (ICS-ULisboa) and co-coordinates the "Sustainability and Climate Change Sciences Seminar" at the Ph.D. Program on "Climate Change and Sustainable Development Policies". He is currently a member of the Research Group on Environment, Territory and Society, and the OBSERVA-Environment, Territory and Society Observatory. Between 2018 and 2019, João was a Foreign Visiting Professor at the Postgraduate Program in Political Sociology at the Federal University of Santa Catarina (UFSC), Brazil. Since 2006, he is member of the ECO XXI and ECO FREGUESIAS National Commissions, two national programs that annually assess the Portuguese municipalities and parishes on Sustainable Development Indicators.

Luísa Schmidt is a sociologist and a Senior Research Fellow at the Institute of Social Sciences—University of Lisbon (ICS-ULisboa). At the ICS-ULisboa she leads the OBSERVA—Observatory of Environment, Territory and Society, a research program founded in 1996. Luísa is also part of the scientific committee of the interdisciplinary Ph.D. on 'Climate Change and Sustainable Development Policies'. She runs several projects in this field of work, e.g., nationwide surveys on environment and society, perceptions and risk assessments regarding climate change, environment, and the media. She is a member of the National Council for the Environment and the Sustainable Development, of the working group on Sustainability of the EEAC (European Environment and Sustainable Development Advisory Councils), a founder of the Energy and Society International Network, among others.

Leonor Prata holds a Masters in Sociology (MSc Sociology Research Track) from the London School of Economics and Political Science (LSE), and is pursuing a Ph.D. degree in Sociology at the Institute of Social Sciences of the University of Lisbon (ICS-ULisboa). Currently, she works as a research assistant in the Observatory of Environment, Territory and Society (OBSERVA). Her doctoral research is in Environmental Education, specifically the International FEE (Foundation for Environmental Education) Eco-Schools Programme in Portugal—an EE programme that is coordinated at the national level by ABAE and is implemented by one fifth of Portuguese schools.

Ocean Literacies: Splashing Around on the Beach or Venturing into the Dark Abyssal Sea

Alison Laurie Neilson and Eunice Castro Seixas

1 Introduction

We are passionate about environmental issues and "sustainability" in the sense that our ancestors might have used this term, specifically, keeping "the sources of water clean for drinking", ensuring the availability of food "that provides energy and does not cause disease" and helping "to create a social network capable of providing long term care and protection" (Padgett 2018, p. 2). We have been students of wildlife biology, environmental studies, education and social sciences and have been teachers as well since the 1980s. Because our praxis has involved multiple, emerging and contested ideas, our discussion of Ocean Literacies draws from our embodied experiences as well as conceptual discourses. The ocean, as the largest surface area of the earth, has been the subject and inspiration for environmental education prior to the sustainability turn in education or the current excitement around Ocean Literacy.

Since the introduction to the global stage via UN official statements, of the term sustainability and its variants of sustainable development, education for sustainable development, sustainability education, etc., much has been written about what these concepts mean (Boström et al. 2015; Connelly 2007; Martinez-Alier et al. 2014) and how they undermine critical approaches to education (Gadotti 2008; Jickling 1992; Selby 2006). A mythology about a potential existence of sustainability that is universally accepted and measurable (Lélé 1991) keeps reappearing with each new generation of scientists and educators, unaware of the contestations about the term and diverse histories of human/nature cultures. It has become the green discursive umbrella in a globalized capitalist economy, which promotes capital accumulation

A. L. Neilson (✉)
Interdisciplinary Centre for Social Sciences, CICS.NOVA FCSH.UNL, Lisbon, Portugal
e-mail: aln@fcsh.unl.pt

E. C. Seixas
SOCIUS/CSG, Lisbon School of Economics and Management (ISEG), Lisbon, Portugal

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through its commitment to a free-market. This hegemonic framing of sustainability linked to a neoliberal model of "development" has deepened social inequities and power differential between North and South and silenced alternative critical perspectives (Castro Seixas 2016). In this chapter, we trace the ways sustainability is taken up from the UN statements of the official Decade of Ocean Science for Sustainable Development, through to policy, research and education, exploring critically what is included and what is not. We then analyze the underlying science and educational efforts related to the campaign for Ocean Literacy, which arises directly out of the decade and the Sustainable Development Goals. We conclude with an examination of alternative concepts for ocean literacies using an example of research that also serves as multidirectional transformative learning and knowledge co-construction, to suggest that other existing practices of teaching about the sea could become more inclusive for building ocean justice literacies.

2 A Little History of "Sustainability" and "Sustainable Development"

In exploring the 2,000+ year history of the concerns over human impacts to the earth, human geographers point out that the word "sustainability" arose in the English language in the mid-twentieth century, but that the idea can be traced in Europe at least back to the early Greeks who "attributed environmental degradation to moral and political decline within a society that failed to live in harmony with its landscape" (Nightingale et al. 2019, p. 13). "Sustainable development" as a global pursuit came from the World Conservation Strategy (International Union for Conservation of Nature and Natural Resources 1980), with the publication of the Bruntland Commission's report: Our Common Future (World Commission on Environment and Development 1987). Five years later, at the 1992 Earth Summit in Rio de Janeiro, Agenda 21, the Programme of Action for Sustainable Development (UNCED 1992) was launched. A global forum of NGOs was held simultaneously offering 16 guiding principles, in particular recognizing environmental education as value-based acts of social transformation, which must recover, reflect and utilize indigenous history and local cultures and develop an ethical awareness of all forms of life (Selby 2006). The 2002 World Summit on Sustainable Development in Johannesburg proposed a Decade of Education for Sustainable Development (2005–2014). This was followed in 2015, when the United Nations launched the 2030 Agenda for Sustainable Development, which outlines 17 Sustainable Development Goals (SDGs) (UN 2015). These goals are embedded in the 2021–2030 United Nations Decade of Ocean Science for Sustainable Development. The Intergovernmental Oceanographic Commission of UNESCO (IOC) is responsible for supporting global ocean science and services, and the Ocean Literacy for All initiative.

The weight of this history in terms of money and words spent manifest in strategies and policies is great (Nightingale et al. 2019). It creates legal obligations as well as social pressures for educators and researchers to use sustainability and

sustainable development in teaching, writing and grant applications. Schools are sent posters and books, and other pedagogical supports, which directly identify and use the SDGs. Research grants, employment contracts, academic publications undertaken by European investigators, including the authors of this chapter, required reference to at least one, often more SDGs. This situation can cause an uncomfortable prerequisite that can undermine critical scholarship in formal academia. Msomphora (2016) showed how commissioning research agendas to meet policy needs entangled researchers within paradigms of questionable economic theories. These entanglements seem inevitable when a narrow selection of disciplinary researchers engage in transdisciplinary realities such as natural ocean scientists studying fisheries or ocean conservation without social scientists nor indigenous or other local knowledges (Bavinck et al. 2018; Chuenpagdee and Jentoft 2019; Hind 2015).

This problem of research being used to make broader meaning beyond its discipline of expertise gets transferred into policy, reinforcing a cycle of further inappropriate use of narrow research. For instance, in a 2016 EU report on marine sustainability, lacking any social scientists, social science or local knowledge, a group of European science academics were engaged in promoting economic growth through Blue Growth policies "with seemingly no concern for the inherent contradiction with biological research on limits of fishing efforts to sustain ecological cycles or other well documented critiques such as 'ocean grabbing'" (Neilson and São Marcos 2019, p. 32). Offering their science as apolitical, they end up as stealth issue advocates instead of honest brokers (Pielke 2007) when advocating for actions, as well as further research funding for their visions of value-free sustainable outcomes. Even critiques by virtue of using the terms, are a reinforcement of the significance. We all operate within this context of sustainability and sustainable development.

In broad terms, sustainability is about the relationships between society and the biophysical environment while sustainable development refers to the realization of sustainability into projects that improve societies and their environments (Nightingale et al. 2019). Research and policy documents often invoke the idea of sustainable development based on pillars: (1) economic, (2) environmental, (3) social, (4) cultural and (5) security and more. These are not just scientific, but have complex ethical, philosophical, and political dimensions (Peters and Wals 2013). There are North–South (mis)communications, as Castro Seixas (2016) outlines when asking "who has the right to speak about development and how?"; "whose voices and alternatives are being suppressed?" (p. 51). There is such a complexity of ideas, values and lived results underpinning each pillar, that one has to ask if it seems possible at all that a sustainable outcome or even a process based on a sustainable approach could be defined or measured. Selby (2006) offered multiple critiques including "Sustainable Development as Oxymoron… [and] as Denial of Intrinsic Value" and education for sustainable development as "Lacking in Thematic and Epistemological Breadth… Falling Short of its Promised Scope… [and] inheriting an Outdated 'Orderliness' Conception of Ecosystem." Nearly two decades later, Nash et al. (2020) described nearly identical concerns.

3 Education as a Solution for Social and Environmental Problems

Since the rise of neoliberalism in the 1970s, the World Bank and the International Monetary Fund, in pressuring nations to pay back loans, have laid claim to education systems (Mundy 2005) promoting individualism, competition, and economic growth. Education is offered as the universal solvent for problems (Campbell 2006), thereby also offering an attractive lure to distract from any critical resistance to the capitalist education, designed to reproduce the labour force and subject people to political state ideology (Althusser 1971). Importantly, "the strength of neoliberalism in all levels of education lies in its invisibility as neutral while it colonizes knowledge to be simple, linear, and pre-determined, rather than embedded in a multitude of social and ecological systems and multiple levels of being, knowing, and doing" (Neilson and São Marcos 2016, p. 1). Resistance to this type of education came from Freire (1970) and his call for educators to dissolve power in pursuit of cultural freedom, to 'unalienate' and 'defetishize', making visible what has been hidden through oppression and giving voice to people who have been silenced (Gadotti 2008). Various levels of environmental philosophers and outdoors educators could be considered as engaged in resistance processes as well, although the inclusion of environmental education into formal school curriculum or even in nonformal settings such as scouts or nature clubs, did not challenge the colonization of knowledge or the hierarchies of power being reinscribed (Giroux 2004).

The official articulation of environmental education began in the 1960s, although some historians mention earlier European and North American philosophers as important pre-environmental movement thinkers; the term "Environmental Education" was first coined at a meeting of the International Union for the Conservation of Nature (IUCN) in 1948. Environmental education has gone from teaching *about, in* and then *for* the environment (Gough 1997).

Palmer (1998) lists various events including the 1972 UN Conference on the Human Environment, Stockholm, the 1975 founding of UNEP and IEEP UNESCO/UNEP international workshop on Environmental Education, "The Belgrade Charter", the 1977 UNESCO First Inter-governmental Conference on Environmental Education, Tbilisi, and the 1997 UNESCO Conference on Environment and Society: Education and Public Awareness for Sustainability, Thessalonika, which has been suggested as the beginning of the end of environmental education, corresponding as well to financial constraints on formal schooling in the 1980s and 1990s. During this period of environmental education initiatives, much activity and contestations arose related to assumptions that these would improve behaviours, to an intense contestation questioning power, knowledge, race (Bullard 1994), gender (Kirk 1997), and impacts on indigenous peoples and the Global South.

Regardless of concerns that it would undermine critical approaches to education (Jickling 1992), "education for sustainable development (ESD), education for sustainability (EfS) or sustainability education… [emerged] as the dominant

international policy discourse and rhetoric" (Stevenson 2007), largely ignoring the principles of the Earth Charter (Gruenewald 2004) and other approaches such as global education (Pike and Selby 2004), ecopedagogy (Gadotti 2008; Kahn 2010) and place-based pedagogies (Ardoin 2006; Gruenewald and Smith 2008), which open spaces for dialogue that allows critical analysis of the discourses surrounding sustainability. An analysis by Huckle and Wals (2015) suggests that the UN Decade of Education for Sustainable Development failed to challenge neoliberalism and move towards genuine sustainability. Many of the same critiques are relevant to the 2030 Agenda for Sustainable Development with their 17 Sustainable Development Goals, SDGs. Additionally, Henderson (2019) points out that none of the SDGs include marine heritage and SDG 14 "life below water" and SDG 15 "life on land" have "the potential to generate environmental in justices if marine protected areas fail to consider the livelihood, food security, and EJ impacts to local or indigenous peoples" and instead reinforce human rights abuses in the name of conservation (Menton et al. 2020, p. 10).

There is a long history and vast literature related to the theoretical concepts and practices that came before the Ocean Literacy of today. Unfortunately, more than a decade after Stevenson (2007) first discussed this, there still continues to be a gap between rhetoric and practice. Being fluent in this literature is not a prerequisite for engaging in ocean literacy. Nevertheless, too many educational efforts are based on the recurring deficit models of information transfer without including broader sources of knowledge, such as indigenous or traditional ecological knowledge (TEK). It is vital to acknowledge and engage with the depth and breadth of histories of people in relationship with the ocean, and the ways that societies have engaged in learning with, in and by the sea. To this end, we discuss some of the histories often hidden by contemporary marine science and education and how the power to hide is manifest in practice.

4 Knowledge, Human/Ocean Relationships and Ocean-Based Human Activities

We are concerned that the Decade of Ocean Science for Sustainable Development lacks input from social sciences (Bavinck and Verrips 2020; Bennett 2019), as powerful myths and images underlie public and scientific opinion about people and their relationships with the sea. These include the belief that all people will selfishly destroy any commons which are not protected by fences and privatization, that fishers are poor, ignorant and it is inevitable that their livelihood will die; therefore, they need to be taught other work (Jentoft et al. 2010). In Portugal, additional gendered narratives have contributed to making the work of women in ocean-based activities invisible (Neilson et al. 2019). Three grand narratives are important, arising from the legacy of the 'Discoveries' by the great sea explorers, from the dictatorship Salazar (1926–1974) who glorified rural and fishing culture and from

Raul Brandão who wrote about the hard life of poor fishermen. The dangerous cod fishing done by the Portuguese in the North Atlantic, inspired their description as the iron men in the wooden ships. The Portuguese dictatorship glorified these fishers as being part of a noble profession whose families should be proud if their fathers and sons lost their lives to help feed the nation. After the revolution in 1974, many of the characteristics promoted as the true Portuguese identity, particularly artisanal fishing, were perceived primarily as legacy of the dictatorship in need of rescue from the primitive state in which they were forced to remain (Garrido 2018).

There is a lack of reciprocity within ocean scientists and holders of local knowledge, that sentences fishers and social scientists to be fluent in marine natural and physical sciences, while natural and physical scientists may remain ignorant of the ways that fishers know the ocean and not know the marine social science, particularly how science and society relations have been discussed in the last 20–30 years (Neilson and São Marcos 2019). Natural sciences cannot answer post-colonial scholars and activists on issues of civilization and the understanding that the current ecological crisis is a result of a One-World-doctrine (Law 2015) and as a product of western evolutionary thinking (Dussel 2000), that sustains itself in a disruptive nature-culture theoretical divide (Escobar 2016).

Current policies and policy makers ignore fishers' socio-cultural identity and relation with the sea, and push these fishing people to become workers in fish farms. The privatization argument "serves to dictate government policy with further detrimental impact on the livelihoods of small-scale fishers, helping to promote the image of fishers as wallowing in poverty in need of rescue from family run fishing boats and free access to the ocean" (Neilson and São Marcos 2020, p. 94). This disrupts an important part of their livelihood as fishers, who decide when to go to sea, being free instead of having "free time" outside of "work time" (Højrup 2003).

Small-scale fishing and human ocean heritage are not seen as having anything helpful for sustaining the ocean. Henderson (2019) points to the limitation of separating people from the sea through the use of the terms "marine" and "maritime", and suggests that ocean archeology should use marine to show that heritage has useful knowledge for current marine stakeholders who might not otherwise think it is relevant. Without heritage, science of the sea also lacks history. An exploration of cross-cultural world histories reveals the sea as the birthplace of humanity and its cultural centre, suggesting that we should consider the oceans as "peopled seascapes" (Shackeroff et al. 2009; Steinberg 2001). Marine animals appear in early rock paintings, even in continental interiors in Africa and Australia. Allison et al. (2020) remind us that current laws arose from the ancient Rhodian sea law, of how maritime societies existed over vast ocean spaces and spans of time, and the existence of traditional institutions for marine resource management in all oceans and other bodies of water. Ironically, among the most vulnerable ocean peoples are those with the longest histories and closest ties to the ocean. These same communities offer important ontologies for transcending human/non-human binaries to think from the perspective of fish who are posited as active agents at the centre of their own worlds (Duggan et al. 2014; Swanson 2017).

5 The Roles of Education

Teaching in universities is done by the same people who do research or those who learned the subject in programs, and generally not by people who have developed a practice of teaching through study of learning and critical education. The resulting teaching is primarily based on transmitting or providing opportunities for acquiring knowledge through focused readings or activities. Reflexive practice including questioning the norms and assumptions, such as the contested assertion of Hardin (1968) that humans will always selfishly create a "Tragedy of the Commons" is not rewarded in metrics of evaluation, precarious work, and managerial control of higher education (Verger 2009). Notwithstanding rhetoric about multi or transdisciplinary studies, higher education is dominated by narrow silos of expertise, and a fisheries biologist who becomes interested in education will read about marine education in the same journals as they read about fisheries research. An article published within these journals very likely is evaluated with a much higher impact score than an article published in a social science or educational journal. Narrow research being used beyond its expertise is reinforced by the power within the hierarchies of knowledge construction in higher education. When well-motivated scientists wanting to make their research serve sustainability get misdirected by seeking advice on how to do outreach from the ostensibly best sources, how is this cycle broken?

Critics of the neoliberal assumptions of Hardin (1968) are common (Lam and Pauly 2010), yet his Tragedy metaphor regularly pops up in academic and public forums without challenge. Similarly, the overfishing story is simpler to teach than wading through the complicated concepts and processes of centralization, capitalization and marketization of neoliberal management systems, all protected by powerful interests (Høst 2010). Opportunities exist to know fishers as mindful stewards of the sea, but unless educators seek and share these stories the cycle of re-affirming harmful myths continue. They are promoted via formal and informal education, especially in the context of conflicting constructions of sea as nature (Braun and Castree 1998), where underlying assumptions differ about whether humans belong in the sea.

We are troubled by how fishers are perceived by educators who do leisure activities on the sea. During interviews about what the sea means to them, some school teachers complained about small-scale fishers not wanting leisure crafts to come close to the fishing boats—not wanting to share the ocean—and that fishers, unlike farmers, did not create food, but were irresponsible with money and fish which are free for the taking (Neilson and São Marcos 2020). This environmental classism reinforces a nature/culture divide and enacts violence against children of coastal fishers since overtly and covertly the message taught is that their families, as fishers, are always bad. Azoreans indicate that school does not work well for their fishing communities as their children either get educated to leave the communities, or drop out before completing secondary education, necessary for obtaining licences to be masters of boats. Research in historical practices suggests that

humans are clearly an integral part of ecosystems (Berkes 2018), having co-evolved with interdependent and affective connections between humans and non-human nature. Barca (2014) points out that "depicting 'humans' as the natural enemies of wilderness is thus irrespective of the millions who have been and continue to be victims of enclosures and 'improvements', a never-ending historical process that four decades of global neo-liberal politics and trade have reinvigorated" (para. 5).

There is a lack of history in marine science, which in turn translates into a deficiency in the current agenda for Ocean Literacy (Henderson 2019). When education neglects the legacies of past exploitations and denial of values and knowledges of ocean peoples (Allison et al. 2020), it allows for traditional uses to be replaced uncritically by modern-day leisure and tourism (Reid and Breidahl 2019), thereby further restricting coastal communities access to ocean dependent human health needs such as "food, shelter, livelihoods, spiritual wellbeing, medicines and other resources" (Nash et al. 2020, p. 3).

Worm et al. (2021) show that the IOC and UNESCO use the term "ocean literacy" to mean "ocean culture" "in their regional settings" implying "that the relationship with the ocean should involve diverse forms of knowledge, values and customs" (p. 2). Thus, to define an ocean literate person as someone who has special expertise, such as a scientist or other ocean professional, or that their knowledge is the source from which to become ocean literate, is to "go against the core intent of ocean literacy: to connect society in all its diversity to the ocean" (p. 2). Furthermore, education related to the sea, ocean literacy, is not a new idea conceptualized by the UN, as Reid and Breidahl (2019) point to the 1989 founding of the Marine Education Society of Australasia, MESA. From the first entering of the sea, ocean peoples have used informal education via cultural narratives told in daily life, during festivals and religious practices as a type of teaching about the sea and the proper way to behave: people developing and passing on an ocean literacy to their offspring (Allison et al. 2020).

6 Solidarity with Fishing Peoples to Co-create Literacies on the Ocean

As critical theorists, it can be a challenge to escape the strong desire to focus on "disproving" myths and provide alternative information which we think will serve environmental justice. It is not a simple task to convince others that something is a myth, nor does it necessarily influence what anyone does or serve to improve anyone's life. Additionally, we are reminded by colleagues to reflect on the important questions "who should be educated, about what, where and with what goals in mind?" (Gough 2017) and conceptualize pedagogy as "as a political and moral practice" (Giroux 2004, p. 500). With these considerations in mind, we describe working in collaboration and solidarity with fishing peoples and argue that this innovative approach allows for a place-conscious co-creation of ocean

literacies, which has the potential to avoid the problems discussed. As such, we try to keep a feminist commitment to do theory as both critique and creativity (Clark/Keefe 2014) and seek to follow Boal (2008) in constructing an aesthetic space to embrace solidarity to serve a just sustainability (Agyeman et al. 2016).

Below, we present a narrative about the first author doing research in Azores. We then critically reflect on these and other similar experiences and how the authors have learned from these in their aim to co-create critical ocean literacies.

I: Meeting one another (2008–2010)*: As an English-speaking woman newly arrived from another country whose home was far from the ocean; a researcher began a journey to find out what the sea means to Portuguese speaking people from fishing communities on small islands in the deep Atlantic Ocean. Aware that her questions would be shaped by her life and education, and which might merely reinforce assumptions moulded as well from movies and environmental campaigns, she chose methods designed to restrain her as a silent listener as well as open the conversations widely to allow in any stories the islanders might tell. She began by seeking advice from local colleagues and various community associations to collect photographs of diverse activities related to the sea. The researcher avoided speaking during the interviews by standing to the side and operating the recording equipment while her younger colleagues sat at the table with the small groups whose conversations were sparked by the offered photographs. The islanders rarely needed any prompting once they started to reminisce and sometimes argue with their friends over details of the stories. They interrupted their conversations with one another to explain their laughter and tears to the foreigner and her assistants, who they spoke with as they would speak to their own grandchildren.*

II: Working together (2010–2016)*: Wanting to privilege the wisdom and experience of the elders in the communities as well as offer an activity for the programs at the community centres, the researcher did most of her initial field work with seniors. The times she and her colleagues went to the fishing ports, they mostly spoke with retired fishers so as not to interrupt the other people working. But this meant that the researcher had by-passed hearing from people who were still active in fishing. The elders who participated in the focus groups mostly spoke about their past with only brief mention of their current life and younger family members. The researcher realized that this work provided an often marginalized but incomplete piece of a static history, when she spoke about her work at a congress organized by the local fishing associations. While welcomed to this stage and appreciated for being an outside researcher interested in hearing about their lives, what she shared with the community was neither new to them nor directly helpful for the current social issues and political struggles they were discussing. Participating in the congress however, was an introduction to the contemporary realities of the fishing communities and a beginning of significant collaborations with associations active in social inclusion and politics of fisheries. Together with these new partners, she organized a gathering for fishers from all nine islands to come together with local and visiting scientists to discuss issues identified by the communities as important.*

They also organized a workshop for children who heard directly from a former fisher and whaler, and a teacher education workshop on biodiversity.

III: Sharing a vision (2016–today)*: It was not until a series of meetings related to social inclusion that identified the importance of a public audience book about the fishing communities, that the research knew that a book was wanted by the local people and that she had partners and sufficient understanding about knowledge co-creation to undertake such a project. The task was a particular challenge as the nine islands of the archipelago differ greatly in geographic size and population, and other inter island differences and rivalries meant that the book would need to have details and photos specific to each island. Finding a balance between the different realities as well as identifying common stories about small-scale and artisanal fishing meant knowing the communities but also being fully aware of the inherent power that she would wield in seeking and sharing the narratives that would make the book. The researcher reached out to the people who daily help fishers with changing regulations and paperwork, asking the secretaries and technicians of the fishing associations for the photos and stories that they thought were needed from their island. The researcher also listened for the limits of what the communities wanted to share and to refrain from asking about death, danger and other loss at sea.*

She reflected on what might be communicated by the arrangements of selected photos and the quotations used. The researcher communicated continually with the communities to ensure that she had labelled all the people, boats, fish and places correctly, as these are important to be highlighted. The researcher sought that the individual voices and photos would share the economic and political realities of small-scale fisheries. In composing the photo narratives, she felt the weight of her responsibility to draw from her own skills and knowledge to care for these stories and facilitate their sharing without imposing her meanings. She knew that deciding on what was included and all the various details was enacting a power entrusted to her. Over the course of many years, with the spray of the ocean hanging on their skin, a community of people, including fishers, educators and researchers have been co-creating ocean literacies together. The book, "A sea full of life: Visions from the Azores / Um mar cheio de vida: Visões dos Açores" (Neilson 2021) *is part of those literacies.*

The work in the Azores began with respect for the fishing communities: that they care and know a great deal about the ocean. This approach is contrary to how many marine science communicators operate in Portugal (Pinto et al. 2018). Unlike the convention in positivist research, they sought "the diverse range in which people engaged the storied landscape and drew meaning from it" (Oliver 2010 in Marker 2018, p. 455). The researchers shifted how they positioned themselves in relation to the people from whom they were learning, which could shift what was being learnt and cared about (Jickling 2016). The trust in small fishing communities was based on knowing about the vast often untapped indigenous and traditional ecological knowledges TEK, that exist (Berkes 2018; Cajete 1994; Reid et al. 2002). This belief was shown to be justified as the islanders spoke about details of being on the

water, catching fish, as well as exploring political, philosophical and ethical issues, including asserting that fish are worthy of care and of kinship (Neilson et al. 2016). Sheridan and Longboat (2006) remind us that people and places have spiritual identities; they disrupt the person-place dualism and put mind, landscape and depth of time back together with an ecological sense of imagination as 'the cognitive and spiritual condition of entwining with local and cosmological intelligences' (p. 370). Drury et al. (2003) suggest that we can disrupt colonialism by engaging different perspectives to develop a sense of "we-ness" within the personal and collective, discursive and material, social and ecological process of place making (Haluza-Delay 2013).

The second author has also participated in research on small-scale fisheries in Portugal and shares the same principles on the value of collaborative and experiential research, and a humility to be willing to learn from (non-expert) others, in this case, fishermen and their families. Reflecting on these experiences though, she has a mixed feeling because of the many constraints to working more collaboratively that have emerged at that time. Part of these were related to the nature of the project and its objectives which valued the local knowledge of the fishers, but were not specifically focused on co-creation. Time and budget constraints to the fieldwork meant there was very little time to get to know the local community and gain their confidence. But this also derived from the main approach of the project in question, which was framed by social and environmental psychology, a field that envisions the methods and the strategies to deal with power differentials in a different way than for example sociology or anthropology do. Not all social sciences understand critical thinking, collaborative research and co-creation the same way, and although sometimes the same authors and concepts are used, these are then translated into practice in a very different manner. Still, for the researcher, the memories of the time spent with the fishermen and their availability, respect and hospitality (in spite of their previous negative experiences with researchers) will forever remain as personal gains and important learning experiences. These are actually being revived in the present as the researcher now lives in a small fishing community in Portugal, where again she has felt very welcomed. This has led her to question if during the aforementioned research she did not get more than she gave to this community. The question of who benefits ultimately from the research is key to critical pedagogy, participatory and place-conscious approaches.

7 Conclusion

You do not go alone to the deep ocean, to the "meaning-soaked sites" (Marker 2018); you need people who are skilled with boats and reading the weather. But asking for their help could mean putting them at risk if you do not follow them, nor take the proper preparations and precautions.

As Donna Haraway (1988) stated: "situated knowledges are about communities, not about isolated individuals" (p. 590). As feminists, critical pedagogy and

place-conscious education scholars have shown us, learning is a collective, sociopolitical and also a deeply personal and experiential process and if we, as researchers and educators want to contribute to critical literacies on ocean's sustainability, we cannot continue to ignore the importance of the social context, of our embodied experiences and the values that are brought to these activities, or we risk reproducing mainstream notions of sustainability that are producing inequality and oppression. This problem calls for a greater acknowledgement of the importance of social sciences' contribution to this field, but also for an engagement with alternative perspectives and epistemologies as well as non-expert actors and local and marginalized communities.

In this text, we have tried to show the urgency of a critical work on sustainability and the oceans, and the need to engage in solidarity with fishing communities to co-create ocean literacies. There are many constraints to pursuing these aims and we have attempted to discuss briefly some of these, such as: the neoliberal framing and instrumentalization of sustainability that have marginalized alternative perspectives; the predominance of natural sciences scholars and approaches in this field and the dominance of a 'corporate culture' on research and higher education. Keeping research and educational professionals in precarious employment relationships, pressures them to become fundraisers, pursue 'applied' and uncritical research, or deliver certain measurable outputs in a minimal (and sometimes unrealistic) time period (Giroux 2009). Research is often also grounded in positivist conventions that rely on approaches that are contrary to real collaborative and co-creation work, with a posture of humility, openness, and constant reflexivity.

But we have also tried to show that co-creating ocean literacies is not only desirable, it is also possible. Reporting on our own research experiences and challenges, we have highlighted the value of making space to listening to others, opening not only our minds but also our hearts (Neilson et al. 2012), and following a political ethics of care which implies "seeing the educator as expert but engaging with many and different sources of authority in epistemic communities that are defined by shared meanings of the world—meanings that challenge hegemonic views on care" (Zembylas et al. 2014, p. 203). In this process, we can allow ourselves to change and to "becoming reconnected to complex, multiple perceptions, and lived realities of the environment [and] reviving a state of being within one's own body, being fully within relationships, ecosystems and systems of spirituality" (Neilson 2008).

Co-creation with coastal and fishing communities may help to transcend the human/non-human binaries (Duggan et al. 2014) and work together towards more just, inclusive and sustainable societies. As Russell and Bell (1996) have suggested: "working from the standpoint of a politicized ethic of care which includes both the human and nonhuman is a good place from which to start acknowledging and nurturing connections to community" (p. 178). Educators and researchers can play an important role in this aim, as long as they recognize that oppressions exist in the ways that places are represented by official bodies including schools (Willems-Braun 1997), and strive for working collaboratively with marginalized coastal communities. We need to recognize that formal education could benefit

from learning how can we act collectively to face the adversities that fall upon us all (Gruenewald 2003). However, this way of working also requires courage from the part of the researchers and educators as they will have to break with the dominant way of doing research in the neoliberal corporate culture of higher education (Giroux 2009). Courage and care are perhaps two among the most important principles guiding collaborative research and education.

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Alison Laurie Neilson is an integrated researcher at the Interdisciplinary Centre for Social Sciences interdisciplinary, CICS.NOVA at the Universidade NOVA de Lisboa, Portugal. With a Ph.D. in education (2006), a Masters in ecology (1991) and a bachelor in environmental studies (1989), she is researcher who transcends boundaries between arts/sciences, academic/non-academic and researcher/researched in knowledge creation and fisheries governance. She works on environmental justice issues in small-scale fishing communities of the Azores Islands Portugal. She conducts narrative and arts-informed research on the way sustainability is understood and used in education and fishing policy. She looks at the way knowledge, wisdom and politics are mixed together. Alison is also associated with the Centre for Social Studies, CES, University of Coimbra and a member of multiple networks related to people and the sea (e.g., OceanGov COST, SIHD-ICES). She is also a trained facilitator and accredited teacher trainer.

Eunice Castro Seixas graduated in Health Psychology (1996), completed a Master in Social Psychology (2004), and a Ph.D. in Sociology, specialization in "Post-Colonialisms and Global Citizenship" (2013). She is affiliated with the Research Center in Economic and Organizational Sociology (SOCIUS), Research in Social Sciences and Management (CSG), Lisbon School of Economics and Management (ISEG), Universidade de Lisboa, Portugal. She is currently the PI of the CRiCity Project—"Children and their right to the city: Tackling urban inequity through the participatory design of child-friendly cities" (PTDC/SOC-SOC/30415/2017). She is the author of several peer-reviewed publications in indexed journals in both Portuguese and English. Some of her publications related to sustainability are published in Scopus/WoS journals like: Comunicação E Sociedade, Journalism, Political Psychology, and Journal of Environmental Policy and Planning, as well as in the book "Social Inequalities, Media and Communication: Theory and Roots", edited by Jan Servaes and Toks Oyedemi, and published in 2016 by Lexington Books.

Beliefs and Values Towards Sustainable Development in the Age of Covid-19

João Casqueira Cardoso, Nora Pelamo, Oliver Harding, and Tamara Marigoh Ndibo

And while this is a training,
In sustaining the future of our planet,
There is no rehearsal. The time is
Now
Now
Now,
Because the reversal of harm,
And protection of a future so universal
Should be anything but controversial.
Earthrise poem by
Amanda Gorman about the photo
taken on Christmas Eve, 1968, by astronaut Bill Anders

1 Introduction

Sustainable development is a relatively recent concept. It is more widely known now thanks to the Sustainable Development Goals (SDG) promoted by the United Nations. Despite attempts to turn the concept into a societal cause, we may ask

J. C. Cardoso (✉)
CEPESE (Research Centre for the Study of Population, Economy and Society), University Fernando Pessoa, Porto, Portugal
e-mail: jcasq@ufp.edu.pt

N. Pelamo · O. Harding · T. M. Ndibo
Master in Humanitarian Action, Cooperation and Development, University Fernando Pessoa, Porto, Portugal

J. C. Cardoso · N. Pelamo · O. Harding · T. M. Ndibo
CENMIN, University Fernando Pessoa, Praça 9 de abril 349, 4249-004 Porto, Portugal

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whether it is not mainly an issue for the broad political agenda at the state or multi-state level, rather than at local levels, shared by smaller communities, citizens or households. We may also question whether governments or companies are genuinely involved in sustainable development, as the progress towards better practices have been slow, or even shown a retrograde steps, an aspect visible in the air and water pollution indicators (Khomenko et al. 2021).

This set of uncertainties leads us to put into question the conceptions and beliefs, associated to values, as regards sustainable development. What are the main conceptions on sustainable development, today? Do governments, local communities, companies, NGOs, and individuals share them? Has the pandemic of Covid-19, that impacted all countries since early 2020, and that demanded changes in social lifestyle, been related to a common attitude in relation to the importance of sustainable development?

As a result of lockdowns, and of self-restrictions, a drastic reduction in consumption has been visible, as has a reduction in the use of polluting transports. The signs of this impact in the field are visible, but we may ask whether a change has evolved in the beliefs and values on sustainable development.

To open the debate on this contemporary issue, this contribution will firstly do an analysis of texts evidencing the beliefs and values in sustainable development, from international organizations and states, exploring their main conceptions, values and priorities. Secondly, it explores the way citizens assess the implementation of the SDG in their states in the five countries (China, Finland, Belgium, Cape Verde and Argentina). This, in order to assess their view on if the SDG have been effectively implemented, at all levels (national/local). It is also relevant to ask whether the pandemic of Covid-19 have changed practices and beliefs on sustainable development. For this part of the research, the methodology used an online survey, quick and simple to answer (yes/no answers). The survey was first submitted to a preliminary process of assessment before the Ethics Committee of the University Fernando Pessoa. Following this stage, the link of the survey was sent to the contacts of the network Together-Spiral, a network gathering citizens with civic responsibilities, and dedicated to the issue of issue of co-responsibility for well-being. This task was done in March 2021. The survey included seven questions, intending to assess the level of comprehension of the concept of SDG. The participants were asked if they have the perception that their country and region have implemented the SDG, and if the respective country and region have introduced changes in the environment sustainability policies during the pandemic. In addition, the survey aimed at assessing whether the pandemic has introduced changes in the weekly habits towards more environmental sustainability, and if changes towards sustainable development values have occurred in the workplace. Finally, the survey wanted to know if the participants would take new actions in favour of sustainable development—as a consequence of the pandemic.

2 The Vision of International Organizations

Within the international sphere, sustainable development gained a visibility after the Brundtland Report (United Nations 1987), which defined sustainable development as a development model that "meets the needs of the present without compromising the ability of future generations to meet their own needs". The Brundtland Report innovated in the sense that it refused to deal exclusively with environmental problems, opting for a relational perspective focused on the interrelationships between development styles and their impacts on nature. The discourse is oriented towards a *multidimensional perspective* that articulates the economic, political, ethical, social, cultural and ecological aspects. It introduced a development philosophy that combined economic efficiency with ecological prudence and social justice. It also emphasized that the problems of the environment and sustainable development are directly related to the satisfaction of basic needs, food, health and housing, and an energy matrix that privileges renewable sources in the process of technological innovation (Lima 1997).

With the Covid-19 pandemic crisis, many international organizations had to react and propose alternative ways to keep the objectives of achieving the SDG alive. The International Monetary Fund (IMF) was one of them. It acknowledged that "vaccine nationalism" was predicted and has revealed the gap between wealthy countries and the poorest countries. The IMF call was clear: **'**We must act now to end the pandemic everywhere, reverse the divergence in prospects across and within countries, and to build forward to a more prosperous, green, and inclusive future' (Gopinath 2021).

Some recent international organizations have had a transformation impact on the way sustainable development is understood. An example of this is the emerging use of blockchain and crypto coins. The Word Food Programme is currently assisting Syrian populations requesting cash back at WFP-contracted supermarkets using blockchain accounts (World Food Program 2018). Use of digital currency may control the spenders' purchases, limiting their purchases to essential food items, and controlling volume. This could easily stop panic buying and distribute food more fairly.

But for part of the doctrine, sustainable development should be seen as having a broader social function, and requiring stronger initiatives not only from international organizations, but also from states and state policies (Trindade 1993). This, because sustainable development is linked to an extensive legal framework of rights, duties, principles and instruments formulated at national level, and which the conceptions depend on each local ecological environment, and on the specific needs —such as the reduction of social inequalities, the redistribution of wealth, the protection of cultural rights, the democratization of control over ways of using natural resources, and respect for human rights. It remains to be seen whether the current legal definitions of sustainable development shared by states encompass this range of requirements.

3 The Vision of States

The SDG have, in the majority of the states of the world, been integrated in political agenda, as well as in many laws. However, a quick constitutional analysis shows that only a relatively small proportion of states of the world make an explicit reference, in their constitutions. We have concentrated our attention on states that, first, mention sustainable or ecological development in their constitution, and, second, are representative of a world region. We have retained China, the first state to face the new coronavirus Covid-19 pandemic, as well as two European states (Finland and Belgium), the former being among the best to rate in the sustainable development indicators, and the latter harbouring the key European Union institutions. For balance we have also included two other states outside Asia and Europe: Cape Verde and Argentina.

China

From all the Asian countries, in recent years China has taken the lead in sustainability topics (Zhang et al. 2020). The West's perception of China has always been divided between pollution covered multitiered cities and picturesque scenes from the Province of Yunnan's mountains with clear skies. This reality is due to the rapid economic growth and Chinese policy system that regulated its inner migration (Peilei and Jiaguo 2009). However, within the last two years China has proved its capability to lead environmental sustainability and surpass the west. Not only the notion of ecological development is mentioned in the Chinese Constitution Preamble "Promote the coordinated development of the material, political, spiritual, social, and ecological civilizations" and, indirectly, in Article 14 of the Constitution, indicating that "The State practices strict economy and combats waste". Constitute 2018). But Chinese policies have also quickly advanced while Europe still debates tariffs and trade pricing for electronic vehicles, furthermore, China has multiplied its alternative vehicles and has become a leading manufacturer of EV's (Marquis et al. 2013).

In addition, cities such as Shanghai and Beijing have implemented a new recycling system and takeaway-food packaging regulation that can only be fully biodegradable (Zhou et al. 2019; Wong 2019). Whilst in Europe banning straws is being discussed, in China the whole menu in terms of packaging material has been questioned. To clarify, waste sorting to Chinese urban cities is not anything new but utilizing it to reproduce energy is (Huang et al. 2020; The World Economic Forum 2019).

Furthermore, services function on a higher speed and the usage of physical money has almost disappeared. Digital billing via smartphones application (such as Alipay or WeChat) is now the only way to pay utility bills (Lewis 2019). Therefore, when Covid-19 hit China, the country was undoubtedly better prepared than many western countries to handle the crisis. Daily finances and groceries are handled via their WeChat or Alipay services. Home quarantine was not a challenge in terms of daily necessities. Moreover, businesses were able to maintain their delivery schedule.

As the world experienced the largest lockdown, analytics from Chinese study made regarding pollution rates during the lockdown of spring 2020 prove to be useful for all countries. However, it was discovered (He et al. 2020) that even though pollution rates and CO_2 emissions drastically decreased due to a shutdown procedure, it is hardly a sustainable solution due to the society financial constraints.

Finland

As other Nordic countries, Finland has a tradition of citizen's access to nature, and environmental decision-making. The Constitution of Finland refers explicitly to the "Responsibility for the environment" (Article 20), which states: "Nature and its biodiversity, the environment and the national heritage are the responsibility of everyone. The public authorities shall endeavour to guarantee for everyone the right to a healthy environment and for everyone the possibility to influence the decisions that concern their own living environment" (Constitute 2021a).

In comparison to the rest of Europe, small countries like Finland have struggled with Covid-19 in terms of sustainability and businesses. While CO_2 emission have reduced, local businesses suffered due to lacking resources and materials, which has led to a challenged local manufacturing. Restaurants were not able to keep environmentally friendly packaging and deliveries depended on petrol vehicles. Although many initiatives and committee platforms aim to tackle climate change inside Finnish borders, many sustainability policies were pushed aside by nothing else but the pandemic and the complications caused by it (Kanda and Kivimaa 2020).

This also seems peculiar considering that the Finns are people who value nature and outdoor life. It could then be argued that the economic uncertainties play a huge role when it comes to sustainability, as China's economy has not suffered major downfall while Europe Union members discuss how to avoid a financial crisis.

The clear lines of European Union Law versus National law have been hindered by the pandemic of Covid-19, leaving many European countries to improvise and lean on their constitutional structure. This has left very little room to continue the clear sustainable vision the EU is trying to achieve and hindered the goals the west is trying to aim at (Van Kolfschooten and de Ruijter 2020; Jeronimo 2020).

Belgium

The Belgian Constitution integrated, in 2006, a new section on sustainable development—Article 7bis. This article states that: "In the exercise of their respective competences, the Federal State, the Communities and the Regions pursue the objectives of sustainable development in its social, economic and environmental aspects, taking into account the solidarity between the generations" (Constitute 2021b). Sustainable development turns into a central element of policies, and has to be achieved in a realistic way: "with concrete budgetary means, by political decisions and by the exemplary role to be played by public authorities" (Minatchy 2007). Belgium has a complex structure since it is a Federal State whose competences are shared between the Communities, the Regions and the Federal State. This means that in Belgium, the SDG policy is implemented at the national level, at the

federal level and by the regions and communities (Sustainable Development Goals Belgium 2016). That is the main reason why making sure there is cooperation and a close collaboration between these three entities is a crucial stake. But what is the reality and how have the SDGs been applied? Zakia Khattabi, Minister of the Climate, of the Environment, of the Sustainable Development, and of the Green Deal explained: "Only five years ago, SDG were still, for many, a topic of discussion rather than a strategic element in the management of a company/organization. The present barometer [the 2020 Belgian Barometer of SDG], which was able to benefit from a massive participation of Belgian companies and organizations, clearly shows that sustainable development objectives are widely taken into account in the business world. Better still, they are literally anchored in their activities. Regardless of their size, shape or status, in five years SDGs have become the business of all organizations" (Sustainable Development Goals Belgium 2016). Nevertheless, it is necessary to specify that Belgian companies tend to establish a hierarchy of priority within the SDG, which led them to select which SDG they will try to achieve.

The year 2020 was supposed to be a pivotal year for sustainable development in Belgium. Indeed, Belgium's new Autumn 2020 government affirmed it would put the 2030 SDG Agenda's as a central element of its policies. However, the Covid-19 pandemic stopped this process, and new priorities were on the agenda. It now appears clear that Belgium has accumulated a significant backlog in the implementation of a federal sustainable development plan, despite the existence of the Federal Council for Sustainable Development. Also, a sort of "Belgian SDG Charter" for companies and organizations should have been drawn up to help them to implement SDG in practice. The Covid-19 pandemic could be seen as the main "brake" in making sustainable development a reality. The past few years have shown that Belgium wasn't ready to fully realize the SDG by 2030. In fact, Covid-19 crisis represented a huge opportunity to use the various economic recovery plans as a springboard to make SDG a real guideline for sustainable development. But the focus that the Belgium State is putting on such objectives is now postponed to long-term, meaning not immediate, policies.

Cape Verde

The notion of sustainable development is associated, in the wording of the Constitution of Cape Verde to the notion of education, and more specifically to research.[1] This is an ambitious objective, in a country still fighting the guarantee access to basic education in a sustainable way to all children. Another section of the Constitution on the economic organization, and more specifically the notion of "economic democracy", refers to an interesting vision on sustainable development. Article 90 § 3 states that: "Economic activities must be realized taking into

[1] Article 77 of the Constitution of Cape Verde (on the Right to Education), referring that: "3. In order to guarantee the right to education, the State shall have the responsibility, namely: (…) l) To foment fundamental scientific research as well as applied research, preferably in domains with interest in *sustained and sustainable human development of the country*" (our underlining).

consideration the conservation of the ecosystem, the durability of the development and the balance of the relations between man and the environment". So, sustainable development seems to be associated to a political and economic philosophy, and more specifically with a notion of "economic democracy" (Governo de Cabo Verde s/d).[2] The state is seen as the major provider and arbitrator of this notion of development, and there is no reference to a participatory process, involving the citizen as an autonomous and responsible actor of development.

The Covid-19 pandemic may have broken the wings of the SDG strategy, in Cape Verde. A still fragile country, due to its geographic ultra-peripheral position, the country had been among the best examples in terms of United Nations programs in favour of sustainable development in the last years. An archipelagic set of ten islands, Cape Verde has a small population of half a million inhabitants, and one million nationals living abroad, and depend heavily of importations and on emigration remittances. Cape Verde managed to achieve, in the last few years, the integration of various UN programs focusing on the SDG into the national policies (UN News s/d), and has been part of a pilot project, UN INFO, monitoring the implementation of the SDG, in 2008.[3] The Covid-19 crisis has obliged the country to shift to "emergency development mode", and reprogrammed its budget and UN aid in order to respond in parallel to the public health needs and to the high risks supported by a depend economy (UN News s/d). The pandemic of Covid-19 is likely to have increased even more the weight of the state and state associated bodies (such as the UN agencies) in the society, and increased a "state-centred" vision of sustainable development, when it is already very much the case, when we look at the constitutional text.

Argentina

Already weakened by successive waves of financial crisis, Argentina was in the process of recovering and returning to normality when the Covid-19 crisis started. The UN office in Argentina indicates, within the bulk of the United Nations Strategic Cooperation Framework, 2021–2025, and the 2030 Agenda and the 17 Sustainable Development Goals (SDGs), that the six top priorities ("Transversal strategic priorities and cross-cutting areas") integrate: Environmental sustainability (priority 4); and Covid-19 pandemic and its implications (priority 6) (United Nations Sustainable Development Group 2021). The Constitution of Argentina (Congreso de la Nación Argentina s/d) is among the most interesting norm as regards sustainable development. It contains a specific provision (Section 41), which includes not only a reference to environment, but also to a philosophy of human development. However, the article does not refer to sustainable development at all. It reads: "All inhabitants are entitled to the right to a healthy and balanced environment fit for human development in order that productive activities shall

[2] Translated into English by the authors, on the basis of: https://constitutions.unwomen.org/en/countries/africa/~/media/983cd3b8346a4d53b9e116676bff7363.ashx.

[3] https://uninfo.org.

meet present needs without endangering those of future generations; and shall have the duty to preserve it".[4] In addition, several paragraphs of the section on the power of the Parliament (Section 75) deal with the recognition of the rights to the ancestral lands of indigenous populations.[5]

Argentina has been one of Latin American countries most affected by the Covid-19 pandemic, registering high level of infection much before other countries (with the exception of Brazil). In particular, recent literature shows that the already marginalized groups of indigenous populations have suffered the disproportionately from Covid-19 (Haas et al. 2021). The government of Argentina showed to be aware of the challenges caused by the pandemic, in social terms. In its Voluntary National Review of the SDG, in 2020 (United Nations 2020), it affirmed the link between the economic consolidation and fight against social inequalities, and reminds that "(…) achieving the objectives set by the 2030 Agenda remains a challenge and a horizon for our country". But no mention at all of sustainable development is done. So, it remains to be seen whether the civil societies, in Argentina and in the remaining countries studied, have integrated the SDG, and if their implementation is as important as the various states affirm.

4 The Vision of the Civil Society

The pandemic of Covid-19 has, in some cases, been looked by the public opinion at as an opportunity to reconsider sustainable development, in particular as a consequence of the use of digital technologies, and also a reduction of consumption. Yet, it is necessary to explore how exactly the common citizen sees sustainable development in practice. Is this vision compatible with the one of the respective states? Has the pandemic impacted the involvement of citizens in concrete actions?

[4] The remaining paragraph reads: "As a first priority, environmental damage shall bring about the obligation to repair it according to law. The authorities shall provide for the protection of this right, the rational use of natural resources, the preservation of the natural and cultural heritage and of the biological diversity, and shall also provide for environmental information and education". The last paragraphs of this section also contain a reference to the way this regulation of the use of resources shall be done between the central and the local powers ("The Nation shall regulate the minimum protection standards, and the provinces those necessary to reinforce them, without altering their local jurisdictions"). A last paragraph of the article also contains a reference to the prohibition of the "entry into the national territory of present or potential dangerous wastes, and of radioactive ones".

[5] Section 75 § 17: "To recognize the ethnic and cultural pre-existence of indigenous peoples of Argentina. To guarantee respect for the identity and the right to bilingual and intercultural education; to recognize the legal capacity of their communities, and the community possession and ownership of the lands they traditionally occupy; and to regulate the granting of other lands adequate and sufficient for human development; none of them shall be sold, transmitted or subject to liens or attachments. To guarantee their participation in issues related to their natural resources and in other interests affecting them. The provinces may jointly exercise these powers".

To assess this aspect, we have built a survey[6] of seven questions, distributed to the population in general of the states studied, targeting persons that have responsibilities at local level (municipalities, associations, NGOs) thanks to the network Together-Spiral.[7] The questions asked were as follows: Are you familiar with the concept of Sustainable Development Goals (SDG)? Do you consider that your country has implemented the SDG? In your view, has your country changed environment sustainability policies during the pandemic? In your view, has your municipality or region changed environment sustainability policies during the pandemic? With the pandemic, have you noticed any change in your weekly habits (purchases, etc.) towards more environmental sustainability? If you are currently working: Has the pandemic changed the sustainable development values at your workplace? Would you take new actions in favour of sustainable development (like, for example, participating in groups or associations)? As a result of this process, we collected 91 replies. In some cases, the number of replies was not significant enough to be analysed (<10) (China and Argentina).

As concerns the result in Finland, the majority of respondents stated to have heard about the SDG, and also that the SDG have been implemented by the Finnish authorities. This isn't a rarity per se, as in previous Governmental elections, namely in 2019, the Paris Climate agreement and EU's climate goals together with the Finnish efforts on sustainability were a key theme and an element to multiple debates. The Social Democrats winning the elections have crucially defended together with the Green Party that the current climate goals are mandatory and not opened to adjustments (Duxbury 2019; The Finnish Government 2020). Interestingly, the respondents were divided when it came to answering the question whether there have been changes with proceeding with sustainable goals in general regarding the SDG due to the Covid-19 pandemic. In this field, the data demonstrated a fifty-fifty separation. Such a result could be explained by the different regulations existing between rural areas and big cities. Moreover, the majority of respondents answered stating 'no' to the question whether or not their local city or village have altered the sustainability measures during Covid-19, which entails that the leadership during the pandemic has been thriving strictly from the government sector, instead of local municipalities. In addition, the majority of respondents (more than 80%), stated to have changed their own habits of living to a much more sustainable direction by affirming that they have become more sustainable during the pandemic on a personal level. Since most Finns alongside the rest of Europe have faced lockdowns and working from home, perhaps this demonstrated the positive outcome of Covid-19, as people have had more time to make more sustainable choices. Only around 18% of the respondents thought to have their workplace sustainability measures changed during the pandemic, which coincides

[6] The survey used the instrument SurveyMonkey, and was applied in March 2021, following a process of submission to the Ethics Committee of the University Fernando Pessoa. Only adults could reply to the survey.

[7] https://wikispiral.org.

with the previous results and explanation of working from home. Lastly, more than 90% thought of being able to change their habits for future generations in order to become more sustainable.

In the case of Belgium, one survey was made in French and another one in Dutch, in order to target both language communities. The results showed that, in both case, the majority of respondents are aware of the existence of the SDG. Where the results seem more surprising is when the majority of respondents stated that Belgium didn't already implement the SDG in its policies. The results show that the majority of French speakers don't think the SDG are already on the agenda. The Dutch speakers were more polarized in their answer since we find that half of them considered that the implementation of the SDG was a fail in Belgium. The vast majority considered that the Belgian government didn't change their policies in terms of sustainable development during the pandemic (87% of French speakers and 70% of Dutch speakers). We also observe a preponderance of negative answers from the respondents when asked if they were thinking that their municipality or their region changed their policies in term of sustainable development. Belgian respondents clearly think that there is not enough done in this area, but they also seems to be disappointed: indeed, as regards the impact at work, more than 60% of the respondents of the French speaking community reply that the pandemic has not changed the sustainable development values at the workplace (same proportion for the Dutch speaking community). This assumption is confirmed by the fact that the vast majority answered that they would take new measures in favour of the sustainable development for the next generations.

Finally, as concerns Cape Verde, almost the totality of the respondents affirms that they are familiar with the SDG. Still, only 75% consider that the country has implemented them. What is interesting is that an even lower number—more than 40% of respondents—consider that the country has changed environment sustainability policies during the pandemic, but this number falls to a bit more than 35% when asked whether the municipality or region changed environment sustainability policies. This may confirm that the strategy of implementation of the SDG is essentially a national (or even international) one, not a local one. As regards the impact at work, half of the respondents reply that the pandemic changed the sustainable development values at their workplace. The Cape Verde respondents are all, without exception, willing to take new measures in favour of the sustainable development for the next generations.

Apart from looking at the population in general, we may ask whether the business sector has changed its view on sustainable development, as a result of the pandemic. Has it been a new opportunity to make profits, or a window opened to more sharing, more free-available resources for example? For the Business Council for Sustainable Development Argentina, a group of businesses in this country, the Covid-19 crisis should be seen as a new opportunity to adapt to a "transition", not to a "new normal". More innovation, more and new forms of education, more digital economy is seen, for them, as a positive factor and one compatible with the

SDG. Digital society, Artificial Intelligence, is genuinely good for all, and the pandemic made this more obvious (The World Business Council for Sustainable Development 2021).

Teh et al. (2020) observe that in a recent survey of more than 1000 CEOs of the United Nations Global Compact (UNGC), 97% of CEOs believe that a sustainable future is essential to the success of their business. Other authors also suggest that consumers and stakeholders have power and can define which companies succeed (Morioka et al. 2017). Consumers and activists seem to have gained more power, with the pandemic, to demand that companies act in the best interests of saving the world and ensuring SDG targets are met. Apsen Technology embeds artificial intelligence (AI) throughout industrial manufacturing environments. They claim that sustainability takes centre stage and assert: 'Sustainability is no longer an option—it's an imperative'.[8] They too acknowledge that, 'awareness and alarm about the impact of human activity on the environment has begun to shift buying and investment behaviour around the world.' Consumers and businesses have to change to address sustainability.

On the side of NGOs, Greenpeace has been and remain champions of environmentalism. In the same trend, the international NGO Extinction Rebellion more radical and during the Covid-19 pandemic, has encouraged civil disobedience and mass protests. Elkington (2018), dubbed the grandfather of sustainability in a Reuters article notes that 'Extinction Rebellion is just the start: civil society is becoming become far less civil' and that 'capitalism faces an existential challenge'. He asks whether artificial intelligence can help to save the world. He concludes by saying that: "It's time we came together to co-evolve not just a wish-list, as we now have in the UN Sustainable Development Goals, but an action plan and investment programme to turn goals into on-the-ground realities".

5 Conclusions

Sustainability as a concept on a global level, was formed for what it is today, by becoming a by-product of failed negotiations during the 1970s, as due to the pressure of the Cold War—a consensus was not globally reachable on 'global common grounds' in terms of international agreements nor perception of what it meant to care for the environment as a whole (Leiserowitz et al. 2006). But we may ask whether we have now a clearer notion of sustainable development, as the concept can be described as a mixture of communal interaction: environmental surroundings and the use of the latter as resources, furthermore subcategories emerge from the three as educational issues—economic development or consumerism, and equity.

[8] https://www.aspentech.com/en/resources/executive-brief/sustainability-takes-center-stage.

In this study, we observe a plurality of definitions of sustainable development among states, and also a diversity of legal scope and perspectives. This is a challenge, especially if the approach is not adapted to the needs of the populations. In some cases, and despite the good intentions of states and populations, the organizational structure of the state is an impairment. In the case of Belgium, we have noticed that competences are divided between different entities and overlapping environmental responsibilities are in practice a barrier to progress, as it is difficult to avoid interference between the policies of different governments levels.

In *The Third Wave,* the futurist Alvin Toffler (Toffler 1980) argues that there are three types of societies: agricultural, industrial and post-industrial. These societies can be imagined as waves travelling around the world, each successive wave changing society and culture. The industrial revolutions fuelled by coal in 1765, gas in 1870, and nuclear power in 1969 all damaged the environment. In what has been coined the fourth revolution with the adoption of the Internet and renewable energy there may be opportunities to reduce our environmental impact and align with the UN SDGs.

Each decade has brought its own influence as technology has gone forward. From these key themes several UN initiatives have risen such as the Earth Charter for example that was formed to create common norms to reduce poverty and aim towards sustainable resolutions (Leiserowitz et al. 2006). Thus, it can be stated that in terms of scientific research and technology or even international agreements we have tools in place to set us to become sustainable. But have we? Time will tell if we succeed. It does not seem that our core values or science have reached us to see eye to eye as many gaps exist between the individual, national and international treaties couldn't be bigger, thus sustainability is a problem of ethics (Lyon Dahl 2012), where behaviour patterns should be pointed as indicators of unsustainable actions. Indeed, according to Lyon Dahl, our consumerism needs to change in an individual level in order to become more sustainable, but there ought to be governmental methods on a national level in place to make these choices much more appealing. Furthermore, have governments failed to do so? We can all remember the young activist Greta Thundberg publicly begging decision makers and people in general to become aware of the damaging environmental habits we as habitants within societies force our planet to endure even if most nations have signed into international treaties to become more ecological. The pandemic of Covid-19 has revealed how fragile is the implementation of the SDG, and how the attitude of governments towards sustainable development has been minimal so far.

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João Casqueira Cardoso is Associate Professor and coordinator of the Master course in Humanitarian Action, Cooperation and Development, University Fernando Pessoa. He holds a Master in International Studies (Reading University) and a Ph.D. in Law (European University Institute), and has a long experience in international relations, including in the field of health. He has worked for the Directorate General for Studies of the European Parliament, for the Council of Europe, and for the International Labour Organization. He is a full member of the CEPESE—Research Centre for the study of Population, Economy and Society (Porto).

Nora Pelamo is an international relations professional who has lived for the last seven years in Shanghai (China), where her career focused on finance via private portfolio management and Global advocacy for Center Counter Parties. She gained experience in risk management and within preparement of regulatory initiatives. Nora holds a Bachelor degree in Political Science and International Relations from the University Fernando Pessoa, and started her professional career in the Brazilian Embassy in Finland before relocating to Shanghai. She is currently a researcher-student in the Master course in Humanitarian Action, Cooperation and Development, University Fernando Pessoa.

Oliver Harding has worked in outdoor education for several decades. He studied Outdoor Education at Charlotte Mason College in the English Lake District and then worked with young people, as a tutor at Outward Bound. He studied Psychology at Lancaster University, and then a postgraduate diploma in Typography at Reading University before starting his own business in pre-press serving the publishing industry. He then returned to Outdoor Education and developed one of the most successful racing clubs for young people in the United Kingdom. He is currently a researcher-student in the Master course in Humanitarian Action, Cooperation and Development, University Fernando Pessoa.

Tamara Marigoh Ndibo originates from Belgium, France and Cameroun. She grew up in a mixed environment, which helped her to be interested from the youngest age to issues related to racism, migration or international relations in general, and to become a young activist. She has a Bachelor degree in Political Sciences between Brussels (at the Free University of Brussels) and Rome, in Erasmus (at the LUISS). She is currently a researcher-student in the Master course in Humanitarian Action, Cooperation and Development, University Fernando Pessoa.

Environmental Agenda, Legislative Power and Social Participation: An In-Depth Analysis of the Commission on the Environment and Sustainable Development in Brazil

Carolina Pimentel Corrêa

1 Introduction

A large portion of environmental policies come from decisions taken within the legislative branch. The role of political actors within representative institutions has a fundamental role in the development of legislation that will guide environmental tools and projects in a given context. In the Brazilian case, the *Congresso Nacional* [National Congress] has permanent commissions designed to address specific topics, including the environmental question. In Brazil, the national legislative branch is bicameral, thus in the lower house, the *Câmara dos Deputados*, there is the *Comissão de Meio Ambiente e Desenvolvimento Sustentável* (CMADS) [Commission on the Environment and Sustainable Development], while in the upper house, the *Senado Federal* [Senate], there is the *Comissão de Meio Ambiente* (CMA) [Commission on the Environment]. In both commissions, the environmental theme is the focus, and it is the responsibility of members of congress to discuss and vote on proposals that can directly influence the type of environmental policy implemented in the country. In this chapter, I analyze in detail the work developed by the CMADS, since it has a more active operating agenda than the Senate Commission on the Environment.

The CMADS hosts important votes and debates on the environmental agenda, which often involve contrasting ideas concerning economic development and environmental sustainability. In fact, Brazil suffers from a paradox, as it has a prominent position in the global environmental sphere, due to its biodiversity and because it harbors 60.1% of the Amazon rainforest and approximately 12% of the

C. P. Corrêa (✉)
Graduate Program in Political Science (PNPD—CAPES), Federal University of Rio Grande do Sul, Porto Alegre, Brazil

C. P. Corrêa
9500 Bento Gonçalves Ave. Office building 43321 (IFCH), Room 224, Porto Alegre, Rio Grande do Sul 91509-900, Brazil

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planet's fresh waters, but at the same time, still speculates on the traditional, highly polluting economic development matrix. In addition, the Brazilian population endures profound economic inequality, in some cases marked by environmental conflicts. Therefore, the environmental agenda in Brazil faces political and social obstacles that hinder the promotion of truly efficient environmental policies (Bursztyn and Bursztyn 2013).

The CMADS is a specialized technical body located within the legislative branch, which deals with the complexity of this agenda and works on formulating possible solutions. Through the promotion of public hearings, representatives who are members of the CMADS can engage with government officials, technical and scientific specialists, and civil society organizations. Representatives use this instrument to instruct matters that are under their inquiry, and to discuss matters of public interest. Indeed, public hearings led by the permanent commissions represent the main interface between the legislative branch and society.

Consequently, the questions that guide this chapter are: how is the CMADS structured, how does it work, and who are the political and social actors that participate in this discussion space? The analysis focuses on understanding the extent to which the CMADS is permeable to the participation of different sectors of society and how these characters act in this political field. To answer these questions, I analyzed the work of the CMADS from its creation, in 2004, up to 2019.[1] Thus, I elaborated a radiography concerning its functioning, addressing the themes debated, the number of proposals voted, and principally, the logic of social participation in public hearings. I used a secondary database, namely the annual reports, as well as videos, transcripts and the minutes of the public hearings held. Part of this material had already been analyzed in previous works (Corrêa 2017, 2018; Corrêa and Pereira 2019).

There is a very well-developed agenda of studies on the legislative branch in Brazil, which has provided important contributions to political science (e.g. Abranches 1988; Figueiredo and Limongi 1999; Freitas 2016). Several authors have invested in empirical studies to understand the Brazilian legislative process, which can even be divided into different generations (Corrêa and Peres 2018). These authors were strongly influenced by international studies based on the new institutionalist paradigm of rational choice theory (Shepsle 1986; Krehbiel 1991; Cox and McCubbins 1993). Regarding research on legislative commissions in Brazil, in the first generation of authors, works on the preponderance of the executive branch and the importance of parties in the decision making process stand out (e.g. Figueiredo and Limongi 1999, 2005; Santos 2002a, 2003; Pereira and Mueller 2000; Reich 2002; Amorim Neto et al. 2003), while in the second generation, a perception emerges of a change in the pattern of legislative production in favor of the role of legislators and the commissions themselves (e.g. Santos 2002b, 2008; Pacheco 2014; Almeida 2019; Resende 2019).

[1] The cutoff date used in the analysis does not include the year 2020 because the global context of the COVID-19 pandemic altered the functioning of the National Congress, which meant the permanent commissions interrupted much of their work.

With regard to studies that consider the participation of civil society and different interest groups in public hearings within legislative commissions or similar bodies, research remains quite limited, though a few works are encountered on the United States (Kathelene 1994; Ebdon 2002; Brasher 2006), Germany (Eising and Spohr 2017), Nigeria (Ikedinma 2018), United Kingdom (Geddes 2018), Spain (Durán 2014) and Brazil (Resende 2014; Santos et al. 2016; Zorzal and Carlos 2017; Andrade 2018; Pina 2020). In the Brazilian case, studies by Fonseca et al. (2013) and César (2011), who analyzed the participation in public hearings held by other governmental bodies not connected with the legislative branch, are also worth mentioning.

Indeed, the promulgation of the Brazilian Constitution of 1988 expanded and diversified the institutional spaces of popular participation and these instances of participatory democracy have been extensively studied (e.g. Avritzer 2002, 2010; Lüchmann 2007; Pires and Vaz 2012; Souza 2012).[2] In this sense, the participation of society in the resolution of environmental issues and the formulation of sustainable development policies occupies a prominent place on the agenda (e.g. Jacobi 2003; Losekann 2012; Fleury and Almeida 2013). However, the Brazilian legislative sphere has been neglected in these studies on the environment, that is, it remains unknown who participates in this space, which deals with and votes on important environmental issues in the country. This chapter seeks to fill part of this lacuna, since public hearings, legislative commissions and consultative processes are also considered to be bodies for discussion and decision making in which inclusive representation can be exercised (Young 2000).

In terms of the theoretical approach, the traditional sociological reflection on structure and action can help us understand what happens within a legislative commission. On the one hand, we have an institutionalized structure responsible for creating laws and standards—a permanent commission that works within the National Congress, while on the other, within this institution, we have the performance of different political and social actors, who often understand socio-environmental issues in diverse manners based on different experiences and perceptions of reality.

If the approach of structure versus action differentiated classic authors like Max Weber and Émile Durkheim, attempts at synthesis brought together authors like Norbert Elias, Anthony Giddens, and Pierre Bourdieu. These three tried to comprehend society based on an understanding that considered its structural aspects and

[2] There are numerous examples of Brazilian political-institutional spaces that allow popular participation. Participatory budgeting, for example, was a successful initiative implemented in Porto Alegre, RS, which allowed the population to express their opinion on how public money should be spent. This initiative has been replicated elsewhere and has been the subject of much research. In the environmental field, Brazil has the National Environment Council (*Conselho Nacional de Meio Ambiente*, CONAMA), which brings together representatives from different sectors of society and works with its state (CONSEMAS) and municipal (COMUMAS) counterparts at the local level. They are consultative and deliberative bodies of the National Environment System (*Sistema Nacional de Meio Ambiente*, SISNAMA) and were established in 1981, by the National Environmental Policy.

the aspects of individual action. In an attempt to overcome the old sociological dilemma, Bourdieu (1984, 1994) brought structuralism-constructivism to life using the concept of practice, understood as the product of the dialectical relationship between action and structure. For Bourdieu, every individual acts within a *field* that is socially predetermined. The agent's actions need to be considered from the position they occupy in this field, the way they constitute their specific dispositions (*habitus*) and the distribution of the different types of capital. The political field described by Bourdieu (2000) as a field of forces and struggles that aims to transform relationships and structures based on a very specific game of interests can theoretically define the CMADS. In fact, every member of congress and every social actor who interacts in the CMADS is an important part of this power game. Each political and social actor has a specific *habitus*, which influences the dynamics of participation and the very functioning of the commission.

This perspective of analysis that considers the relationship between structure and agent based on social practices (Bourdieu 1984) enables me to understand the presence and action of different individuals within the CMADS, which is itself understood as a political institutional structure of a legislative nature, a political field of power. It is this theoretical framework that guides the analysis undertaken here and the organization of this chapter.

2 Structure. The System of Legislative Commissions in Brazil and the CMADS

The system of legislative commissions within parliaments emerged as a tool for organizing the legislative process that was capable of relieving the plenary agenda and reducing the amount of time spent debating and analyzing each law proposal. When adopting thematic commissions, the procedure for analyzing the propositions can be simplified, since the first discussion or analysis of law proposals is under the responsibility of these bodies. This type of organization of the legislative branch has become quite common and has been adopted in numerous countries. In the case of Brazil, as mentioned above, the National Congress has legislative commissions (permanent and temporary) in the two legislative houses. In addition, Brazilian state and municipal legislatures also adopt this type of configuration.

Therefore, commissions are specialized bodies, in which representatives debate and vote on legislative proposals related to a certain topic. Among their duties is also the supervision of the actions of the executive branch on the matter. To vote on law proposals, committees hold deliberative meetings, at which representatives appointed as rapporteurs present opinions on the proposals being voted on. These commissions also hold public hearings. When their members need to vote on a controversial or complex proposal, they petition for a public hearing and then invite authorities and representatives of different social groups to debate a certain topic

(Art. 255, RICD).[3] Both deliberative meetings and public hearings are held in person, within the lower house.

The first legislative commissions appeared in Brazil after the Constituent Assembly of 1823. Over the years, the Brazilian legislative branch has undergone changes. The internal organization of the *Câmara dos Deputados* has been gradually updated and its internal rules modified. The need to debate different topics and expand the scope of Brazilian policies has caused the number of commissions to increase progressively. In addition, in some cases, the 1988 Constitution endowed permanent commissions with conclusive power, that is, they have complete authority to pass certain bills. This division of labor allows commissions to pass legislation without the need for an explicit statement from a plenary session of the lower house,[4] and thus frees up the house agenda (Figueiredo and Limongi 1999).

At present, the lower house has 25 permanent commissions[5] dedicated to subjects that include education, culture, sports, the environment, human rights, and science and technology. Some commissions are more relevant due to the degree of importance of the matters discussed there. The Commission on the Constitution, Justice and Citizenship and the Commission on Finance and Taxation, understandably, have a certain prominence. However, depending on the repercussion of a given debate, the commissions may gain greater visibility. The CMADS, for example, stood out in the media when it discussed changes to the Brazilian Forest Code (Corrêa 2017).

The CMADS was created in 2004. Before that, the environmental theme was part of a permanent commission that also dealt with consumer and minority rights —the Commission on Consumer Protection, the Environment and Minorities. The creation of an exclusive commission to debate proposals of an environmental nature was the result of a process of dismemberment and reorganization of several permanent commissions of the lower house. This process encompassed the issue of the environment and sustainable development due to the increased demand for questions and proposals related to the theme.

From 2004 to 2019, the CMADS approved 567 law proposals, with 63% subject to the commissions' conclusive assessment. Figure 1 shows the annual data on the number of proposals approved and rejected by the commission. In general, the CMADS votes on a wide range of environmental issues and the position of representatives on the most controversial issues can be quite contrasting. The most common clash is between the environmentalists and *ruralistas* (a multiparty agribusiness caucus), who represent two congressional caucuses.

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[3] RICD: This formal document contains the operating rules for the lower house. Theoretically, it should guide the way in which representatives develop their actions within this legislative space.

[4] This is set out in Art. 24 of the RICD.

[5] For more details, access https://www.camara.leg.br/comissoes/comissoes-permanentes (in Portuguese, English and Spanish).

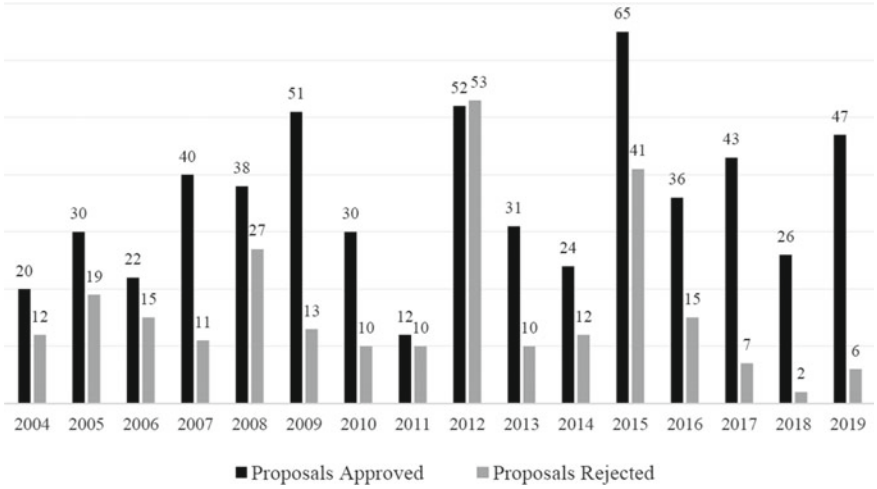

Fig. 1 Number of law proposals approved and rejected by the Commission on the Environment and Sustainable Development (CMADS) (2004–2019). *Source* Elaborated by the author

Public hearings are the main space in which the representatives can speak freely and debate certain agendas, which allows them to take a position on them before voting. In the case of the CMADS, the position of the representatives is much more closely related to the defense of certain sectors of society than partisan or personal (Corrêa 2017; Corrêa and Pereira 2019). Over the period analyzed here, the CMADS held 382 public hearings on numerous topics (Table 1). The three most discussed topics were "forest preservation," "energy," and "water," which represent more than 40% of the public hearings.

The CMADS held more public hearings in certain years. Some explanation could help understand why there is such a difference. The first explanation is related to the behavior and action dynamics of the representatives who made up the commission that year, since they are the ones who propose the holding of hearings and, therefore, indicate what topics could be discussed in a public hearing and what the profile of the guest speakers should be. The second explanation refers to electoral years. Every second year, there are elections in Brazil, and this influences the behavior of representatives who may be running for reelection or canvassing for a party candidate. Regardless of the number of public hearings held, social participation exists and, therefore, a more accurate analysis is required.

Table 1 Number of public hearings in the CMADS according to the issues covered (2004–2019)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019	Total
Forest preservation	4	5	2	7	9	7	2	7	4	12	5	7	1	5	0	13	90
Energy	2	4	0	6	1	2	3	6	5	4	0	4	2	4	0	1	44
Water	1	1	0	4	1	1	2	5	5	2	3	4	0	2	1	4	36
Agriculture/Livestock/ Farming/Fishing/ Extractivism	1	3	0	2	0	2	1	0	1	5	2	5	1	4	1	6	34
Pollution	3	2	0	1	1	4	1	3	0	4	2	3	1	3	2	4	34
Fauna	2	2	1	3	0	1	0	0	0	5	0	3	2	5	1	5	30
Supervision of government bodies, projects, and policies	4	0	0	4	3	0	2	3	1	0	0	3	1	1	0	6	28
Recycling	1	1	0	2	1	2	0	2	1	1	0	2	1	3	1	2	20
Others	0	0	0	1	0	1	1	2	3	2	1	3	1	1	0	3	19
Environmental accidents and crimes/ Health issues	0	4	1	2	2	0	0	1	2	1	0	2	1	2	0	0	18
Urban issues/ Sustainable cities	1	1	0	0	2	3	1	2	0	0	1	3	1	0	0	1	16
Climate change	1	1	0	3	0	1	0	0	0	1	1	3	0	1	0	1	13
Total	20	24	4	35	20	24	13	31	22	37	15	42	12	31	6	46	382

Source Elaborated by the author. Based on CMADS annual reports

3 Actors. Participants at the CMADS Public Hearings

Public hearings are an instrument that provides the opportunity for dialogue between different actors in society and allows different experiences, capitals, *habitus*, and social practices to come together in a public space. The construction of this dialogue takes place in different ways and depends a great deal on the role developed by the actors present. In this sense, it is important to understand who the political and social actors are who occupied this space of power and gave voice to their demands, providing their opinions on socio-environmental issues.

To construct a detailed picture of this participation, I analyzed all public hearings held by the CMADS from February 2004 to December 2019. Based on the annual reports and the minutes of hearings made available on the commission's website, I counted everyone who was there and classified them according to the role that each one assumed at that time within that political field. The classification was performed based on a typological structure created especially for this analysis (Fig. 2). The first division to be considered in this classification involves three major types of actors: Government and state; Specialists, technical and scientific; and Civil society.

The actors for *Government and state* are the most representative and perhaps the only ones that can be considered indispensable for the functioning of the commission. The CMADS could not exist without its official members, the representatives. Therefore, the first subtype mentioned here are *politicians*, that is, *elected representatives*. Here, I consider not only representatives who would naturally be present, but also the possible presence of other politicians who occupy elected positions, such as senators, governors, state representatives, mayors, councilors.

With regard to the presence of federal representatives, according to the *Regimento Interno da Câmara dos Deputados* (RICD) [Internal Regulations of the *Câmara dos Deputados*], a permanent commission can be formed by a maximum of 66 full members and a minimum of 17—with the same number of substitute members.[6] The representative will always be guaranteed the right to integrate, as holder, at least one commission, unless they are a member of the *Mesa Diretora da Câmara dos Deputados* (Art. 26, § 3, RICD)—a type of board for the lower house. The commissions have a president and three vice presidents, elected by their peers for a one-year term, with no re-election (Art. 39, RICD).

Specifically regarding the CMADS, in 2004, the year of its creation, *Ato da Mesa* no. 40 [Board Act no. 40] set the total number of full members at 23, with 23 substitutes. In 2005, *Ato da Mesa* no. 55 reduced this to 18 representatives and 18 substitutes. Compared with other committees of the lower house, CMADS is one of five that have the fewest members. It is worth noting that the number of representatives varies significantly within the same year, as they migrate from one

[6] The internal regulations of the lower house establish that no permanent commission can have more than thirteen hundredths of the total number of representatives, currently 66 of 513, and no less than three and a half hundredths, 17 of 513, disregarding fractions (Art. 25, § 2, RICD). Considering, whenever possible, the principle of party proportionality (Art. 25, § 1, RICD).

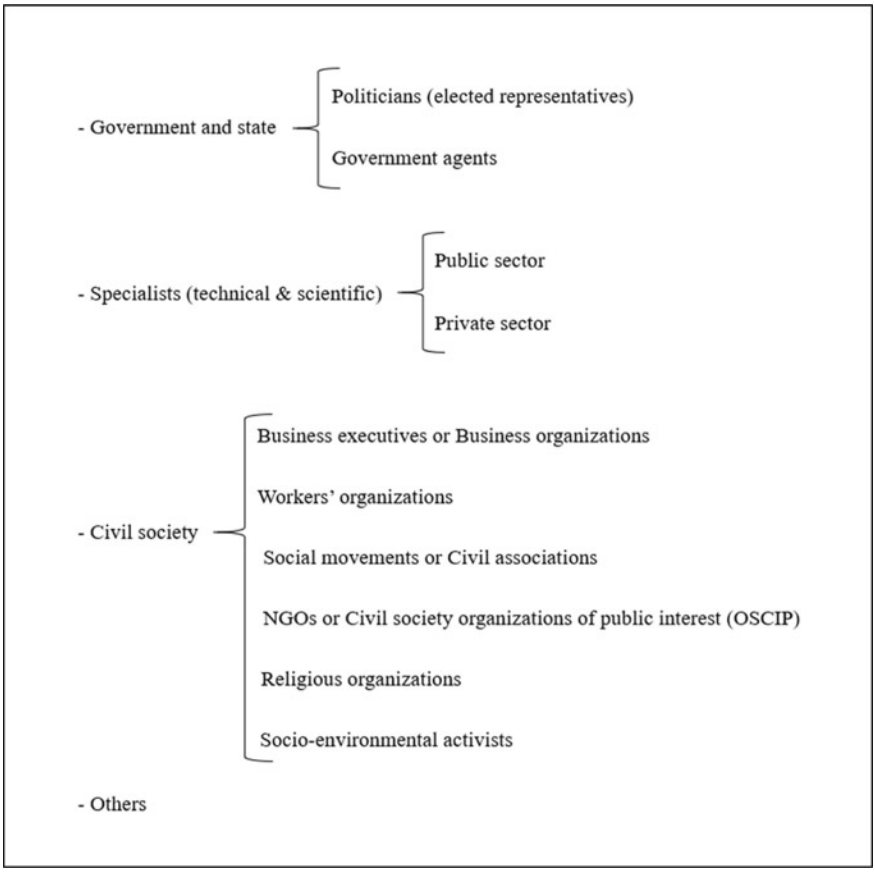

Fig. 2 Typology of the political and social actors present in public hearings

committee to another, fail to exercise their mandate, assume positions in the executive branch or even request some type of leave of absence. Therefore, the data in Table 2 only considers the full members that appear at the beginning of each annual report. It is evident that the number of women is quite low; however, this is a reflection of female representation in the *Câmara dos Deputados* itself, which has always been below 10% and only in recent years has achieved a certain increase, though it is still around this percentage (Corrêa 2018).

In previous studies, I traced the sociopolitical profile of the full members of the CMADS, who are mostly men aged between 50 and 65 years old, who have completed a college degree and who have a trajectory related to the environmental issue, even though they do not always have a profession or training directly related to this topic (Corrêa 2018).

Political parties, as collective political actors and major holders of political capital, occupy this space through their representatives. In this case, it was

Table 2 Composition of the CMADS: full members (absolute number, by year and gender)

	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
Male	20	15	17	15	16	16	15	15	15	16	14	18	18	18	18	16
Female	1	1	0	2	2	2	3	2	2	2	1	0	0	0	0	2
Total	21	16	17	17	18	18	18	17	17	18	15	18	18	18	18	18

Source Elaborated by the author

discernable that the parties with the most members in the CMADS, over the years, were also the parties that elected the most representatives and that have the largest number of affiliates, namely, PT, PMDB, PSDB, PFL/DEM. However, the actuation of representatives from the Green Party (PV), the Workers' Party (PT) and the Brazilian Socialist Party (PSB) should be highlighted, since their representatives were strongly present in this space; the representatives of these parties were the ones who most petitioned for public hearings among those held, 22% of the petitions were proposed by PV representatives, 21% by PT representatives and 11% by PSB representatives.

An important point to mention concerning the presence of representatives at public hearings is that even though they are official members of a certain commission, their presence in public hearings is not mandatory. In fact, the internal regulations of the lower house establish that "the work of commissions will begin with the presence of at least half of its members, or with any number, if there is no matter subject to deliberation […]" (Art. 50, RICD). Thus, in some hearings, only one representative is present, usually the one who petitioned for the event to be held. In other cases, it is possible to observe the presence of numerous representatives, in numbers greater than the sum of full and substitute members, because non-member representatives also decide to participate.

The other subtype that represents *Government and state* are *government agents*; these are individuals who have not been elected, but assume political positions in the government, who have been appointed to occupy a political role, such as ministers and secretaries. This category of *agent* is invited to participate in public hearings particularly to speak on behalf of the government, and represents, above all, the choices and the type of policy adopted by the executive branch. The presence of these agents in public hearings also serves to carry out an important function of the legislative branch, that of supervising the actions of the executive branch and fulfilling what is understood in the specialized literature as "checks and balances" (Acemoglu and Robinson 2012).[7]

The actors considered *Specialists* are a fundamental category in public hearings held by any legislative commission. Experts are usually called on to clarify technical details of socio-environmental issues that will be discussed at public hearings and will eventually be present in law proposals that need to be analyzed and voted on by representatives. It is normal for representatives not to dominate all matters that are discussed within the plenary sessions and commissions, so the presence of specialists is essential to facilitate the positioning and decision making of representatives, especially when it comes to complex issues. In this case, we need to distinguish two subtypes: *technicians from the public sector* (usually contracted via public sector examinations) and *technicians from the private sector*.

[7] The idea of *checks and balances* has been discussed since Federalist Papers no. 51 [50] by James Madison, among others, but for a more recent discussion that involves the importance of this instrument in contemporary democracies, I indicate the work of Acemoglu and Robinson (2012).

The third type are the actors who represent *Civil society*. This is the most complex and diverse group that participates in public hearings held by the CMADS. In order to construct a consistent analysis capable of covering the differences in social position and dispositions (*habitus*) of each actor, it was necessary to adopt six subtypes in reference to *Civil society*: *Business executives* or *Business organizations*, *Workers' organizations*, *Social movements* or *Civil associations*, *NGOs* or *OSCIPs*,[8] *Socio-environmental activists*, and *Religious organizations*. This differentiation allows for analysis regarding which sectors of civil society are most represented within public hearings. One final type, *Others*, covers those few cases that do not fit in the remaining types or subtypes, for example, representatives of international bodies, such as the United Nations and the Economic Commission for Latin America and the Caribbean (ECLAC).

The number of actors present at the 382 public hearings held by CMADS was 7521. When applying the typological classification model, the participation of representatives in this type of event is significant. The presence of all *elected representatives* in the public hearings added together is 5728, i.e. 76% of those present recorded in the minutes. This is to be expected, but the number is surprising in a positive sense, since within the social imaginary there is an idea that the quorum of representatives in public hearings is very low, given the participation of these politicians in this type of event is not mandatory. In fact, the presence of these political actors varies according to the theme of the audience and the importance of the guests. It is notable, for example, that there was a greater presence of representatives in public hearings that were attended by Ministers of State or in those held jointly with other permanent commissions (e.g. the Commission on Mining and Energy [CME]). Table 3 shows the level of representation of each subtype of actor in public hearings.

However, what interests me in particular is observing the 24% (n = 1793) of external actors who were invited to participate in public hearings and who were not *elected representatives* (Table 4). The high number of representatives registered in the minutes may distort the idea of social participation that existed in practice at each public hearing, because not all of the representatives who were present at the event actually spoke publicly. The remaining invited actors, in turn, are usually important pieces in the dialogue that is constructed during the public hearing. For this reason, I analyze the figures regarding these participants in the following paragraphs.

Government agents represent a significant portion of this participation. In the hearings held during the period analyzed here, 419 actors were from this subtype, in particular, representatives of ministries and frequently, Ministers of State themselves. The *Specialists (technical and scientific)* also stand out in terms of presence, with representative numbers of 615 (public sector) and 76 (private sector). This quantity of actors reinforces the idea that public hearings really are a space in which

[8] *Organização da Sociedade Civil de Interesse Público* [Civil Society Organization of Public Interest].

Table 3 Absolute number and total percentage of participants in public hearings by type of actor (2004–2019)

	State		Specialists (Technical and scientific)		Civil society						Others	Total
	Politicians (representatives)	Government agents	Public sector	Private sector	Business executives/ Business organizations	Workers' organizations	Social movements/ Civil associations	NGOs/ OSCIP	Religious organizations	Activists		
2004	340	18	26	4	16	2	0	14	1	0	0	421
2005	347	35	37	5	17	22	5	11	1	0	0	480
2006	28	7	12	3	0	0	2	1	0	0	0	53
2007	683	46	34	5	23	10	7	18	2	0	1	829
2008	411	27	30	1	7	5	5	9	1	0	0	496
2009	333	40	32	3	22	8	8	4	0	0	9	459
2010	128	18	15	0	5	0	8	10	0	0	0	184
2011	397	31	47	9	17	3	10	12	1	2	1	530
2012	231	26	52	4	14	3	5	9	0	0	1	345
2013	346	36	67	5	18	9	11	26	1	2	1	522
2014	127	15	18	4	4	5	6	11	0	0	1	191
2015	809	45	84	4	12	10	23	14	2	1	1	1005
2016	193	13	26	2	10	2	9	6	0	1	5	267
2017	365	24	45	10	19	10	15	17	0	1	3	509
2018	43	7	6	2	13	0	2	1	0	0	0	74
2019	947	31	84	15	17	15	18	25	1	3	0	1156
Total	5728	419	615	76	214	104	134	188	10	10	23	7521
%	76.16	5.57	8.18	1.01	2.85	1.38	1.78	2.50	0.13	0.13	0.31	100

Source Elaborated by the author

Table 4 Participation in public hearings, by type of actor (not including elected representatives)

		N	%
Government and state	Government agents	419	23.37
Specialists (Technical and scientific)	Public sector	615	34.30
	Private sector	76	4.24
Civil society	Business executives or business organizations	214	11.93
	Workers' organizations	104	5.80
	Social movements/Civil associations	134	7.47
	NGOs/OSCIP	188	10.49
	Religious organizations	10	0.56
	Activists	10	0.56
Others	Others	23	1.28
Total	–	1793	100

Source Elaborated by the author

representatives are able to dialogue with experts and obtain information and knowledge about the matters discussed within the commission. The majority of the technicians who participated represent government-owned corporations and federal government agencies specialized in the environment, such as the Brazilian Institute of Environment and Renewable Natural Resources (IBAMA), the Chico Mendes Institute for Biodiversity Conservation (ICMBio), the National Water Agency (ANA), and the National Indian Foundation (FUNAI). In addition, there was also a large presence of professors from public universities, considered specialists in the public sector.

Advocates from *Civil society* also represent an important share of participation. In total, 660 representatives of this type gave voice to their demands and exposed their experiences and knowledge in public hearings. The majority of this number corresponds to spokespersons of business organizations, followed by spokespersons of NGOs and OSCIPs, social movements and civil associations, and even workers' organizations (Table 4). Normally, invited speakers from civil society are called according to the agenda that will be discussed. For example, if the topic at hand is related to the impacts of the construction of hydroelectric dams, the company responsible for this undertaking, the riverside communities affected, the *Movimento dos Atingidos por Barragens* [Movement of Those Affected by Dams], among others, will probably be represented.

In the next section, I discuss in some detail how this participation takes place in practice and outline an analytical reflection on the importance of this space for dialogue within the legislative branch and on the possibility that the presence of all these actors (political, technical, and social) causes an impact on the position and decision making of the members of the CMADS.

4 Action. The Participation Process Within the CMADS

The action of the different social actors within the commission is essential to understanding how it works. The political field naturally houses important power games, but when it comes to decision making on the environment, within a country with such biodiversity, the struggle of interests that develops takes on even greater dimensions. The CMADS is the institutional space that hosts this debate and public hearings are the main *locus* of this action, since they provide an opportunity for actors with different trajectories, *habitus*, and capitals to speak.

Public hearings held in any permanent commission of the lower house follow a specific rite. Usually, the chairman of the commission conducts the public hearing. If the hearing is held jointly (two or more commissions), the chairman of one of these will conduct the proceedings. In the absence of the president or vice presidents, the representative who petitioned for the hearing will lead. In rare cases, any other representative who is present takes over the work.

The opening rite is usually relatively quick. The representative who presides over the hearing presents the theme and the participants, finishes with a note of thanks and cedes the floor to the invited speakers. As seen in the previous section, the 382 public hearings held by the CMADS were attended by many actors, in particular government agents, public sector technicians and representatives of civil society. The scope of action of these participants in public hearings is translated in spoken and body language. Within a predetermined period (usually 15–30 min), guests can freely express their ideas, demands, claims, knowledge, and clarifications. The qualitative analysis that I have conducted over the years (Corrêa 2017, 2018; Corrêa and Pereira 2019) of the public hearings of the CMADS demonstrates that most of the guests feel comfortable acting in this political-institutional structure, even if, in certain moments, the debates are heated and tempers are elevated.

In order to verify and exemplify the way in which action takes place in this legislative political field, I selected excerpts from the speeches of some participants. On August 13, 2019, based on Petition 8/2019, a public hearing was held on incentives to foster the recycling industry. Among the various guests was Ronei Alves da Silva, a waste picker in the *Cooperativa Nova Superação* and legal representative of the *Movimento Nacional dos Catadores de Materiais Recicláveis* [National Movement of Waste Pickers], who expressed the following words in his speech:

> I'd like to congratulate Congressman Carlos Gomes and, above all, thank the honorable congressman for the bill, for not forgetting that waste pickers of recyclable material, no matter how important they are in this chain, are the weakest part. We are aware of the difficulties that business executives have been having with the tax issue and so many others. I'm not going to take credit because I'm not a businessman, but I know that people have difficulties. [...] We waste pickers are the most precarious part of this whole system. We hope to have a more specific look at the waste picker, the structuring of cooperatives and associations of waste pickers throughout the country. This is fundamental. We are lifting millions of heads of families out of poverty, with the implementation of a treatment and reuse system for recyclable materials. We are generating work and income. I'd like to tell

> the representative of the Ministry of the Environment that we want to build a partnership. We know that the Ministry has been continuously criticized. I don't want to go into the merit of this, but I want to say that we want to build a partnership, but without ideological issues or confrontations. We waste pickers want to give continuity to this process, because we are talking about fathers and mothers. The system of cooperatives and associations of waste pickers is the only way we have for socio-productive inclusion. (Ronei Alves Silva 2019)

In another public hearing, held on November 26, 2015, based on Petition 69/2015, indigenous health in Brazil was discussed. The event was attended by several indigenous leaders and representatives of public bodies, such as the FUNAI and SESAI (Special Secretariat for Indigenous Health). Below I highlight an excerpt from the speech by Yefuka Kaiabi, from Aldeia Kaiabi, located in the Xingu Indigenous Park, in Mato Grosso:

> [...] the Unified Health System [SUS] is not meeting our demands. Regional hospitals don't have the structure to serve indigenous peoples. Our people are dying, our children are dying from diseases that could be cured. They're dying from respiratory diseases; they're dying from malnutrition. The Unified Health System doesn't offer quality care to indigenous peoples. [...] I want to take the opportunity to make a complaint here that doctors refuse to attend our patients. [...] When the patient is elderly – I've seen it myself – and this patient needs the ICU, they say: 'No! This one is already old, they're going to die. If it's a child, then yes, we'll prioritize that. You have to wait.' That's how SUS doctors talk to us. The SUS doctor himself filed a lawsuit at the Public Prosecutor's Office against the state to be transferred to work in another city. (Yefuka Kaiabi 2015)

There is no way to verify the kind of effect that these speeches have on the representatives present and whether they truly influence their vote. However, at times, an effort on the part of representatives is observed so that actors of civil society, in particular, feel that their demands and reports were heard and accepted and that often the experiences they disclose there were understood. The following is an excerpt from the speech by Representative Edmilson Rodrigues (PSOL-PA), at the last public hearing cited.

> I really want to thank everyone for their contribution, especially the indigenous presence. You give us a strength that you cannot imagine, because here we have heard of so much violence, offenses against indigenous peoples. Some who were here heard the landowner say: 'Ah, they're generic Indians, they're not Indians, they have no right to land.' Actually, aggression and violence occur all the time, but this public hearing shows that we have a future. Things have to move forward, because the science is in our favor. And our story is in our favor. We have rights. [...] why, then, so much hatred against those who have been here for millennia? It is impossible to understand! [...] Therefore, this audience is the expression of resistance and an affirmation of the future. To speak about the future, I cede the floor to Yefuka Kaiabi, who will end this public hearing singing an indigenous song. (Representative Edmilson Rodrigues 2015)

The excerpts highlighted here are just a few examples of the way in which invited speakers participate in public hearings and the way in which representatives also interact in this political field. Indeed, the presence in a political structure managed by norms and which, in some manner, requires specific dress and behavior, constrains those who are not part of the political field and who do not

have a political *habitus*. However, after an exhaustive qualitative analysis, I have come to realize that, over the years, this space has become increasingly permeable to the participation of civil society and representatives have taken advantage of public hearings to dialogue and establish their positions before different sectors of society.

5 Concluding Remarks

The purpose of this chapter was to conduct an analysis of the functioning of the CMADS, emphasizing the holding of public hearings as an opportunity for social participation in the discussion of relevant environmental issues on the country's legislative agenda. My hope was not to measure the real effectiveness of this social participation in public hearings, rather to construct an analysis of those who participate and how this participation occurs in practice.

The results encountered demonstrate that the CMADS is very active, votes on a significant number of law proposals conclusively, and holds an annual average of public hearings similar or superior to other commissions of the *Câmara dos Deputados*. The analysis also indicates the broad participation of representatives in public hearings and, above all, the participation of a very diverse set of guest speakers that include government agents (including representatives of ministries), technical and scientific specialists from the public sector, and representatives of civil society, such as business organizations, NGOs and OSCIPs and social movements.

It is very difficult to establish scientifically whether the discourse of participants in public hearings has had a direct effect on the approval or rejection of any bill in the CMADS. However, the public hearings functions as a consultative tool within the legislative branch and ensures that there is participation and social interaction based on the exposure of different social experiences and practices—an institutionalized participation that allows intercommunication between the political representatives and those they represent.

Furthermore, it is worth remembering that democratic participation is not restricted to the moment of voting, it must be encouraged in everyday life and can take place through interaction in other spheres of the social state, that is, it can and must occur inside and outside political institutions (Pateman 1970). In the case of public hearings, which are a space in the political field, the discourse of an actor of civil society carries a symbolic weight in the political game, since it can resonate intensely in public opinion, in the media, and even influence the type of positioning of political representatives.

Indeed, the environmental agenda requires this type of participation and involvement by authorities, technicians and, especially, representatives of civil society. The search for environmental justice involves valuing different types of practices and resolving environmental conflicts (Martínez-Alier 2010). This objective will only be achieved if there is a constant dialogue between the different

sectors involved in these conflicts and if everyone has had space to speak and share their experiences. Therefore, public hearings can be one of the legitimate spaces for this to happen, where the interests of different social groups are valued within the power game that takes place therein.

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Time is Needed for Raising Non-trivial Sociological and Technological Collaborations in Research: Scientists' Views on Interdisciplinarity Approaches

Paula Urze and Emília Araújo

1 Introduction

The term "interdisciplinarity" has been recurrently highlighted in documents issued by the European Commission under the framework of research policies and scientific innovation. National and international organizations in charge of defining research financing policies and programs have been almost ubiquitous in their support for it. The use of this term serves to raise funds and make explicit that research efforts in line with current trends are a necessary condition for approval, even though it may not bear any effect (Toomey et al. 2015). Thus, interdisciplinarity has often become more than a desirable approach—if it makes sense in a specific field of research. It has been vested with an almost mandatory process, which has brought out mixed consequences, including its underestimation. The concept is gradually losing its meaning in its aim to meet a dominant rhetoric, instead understanding a complex reality, that is, to unravel which conditions foster knowledge and a critical approach.

However, the increasing use of interdisciplinarity to answer the funding entities' call and ascribe a trending aspect to research makes the concept lose its depth and credibility—repetitive research agendas that do not bring to the table the merits of interdisciplinary research. The social sciences are often called upon to participate in research projects lead by fields related to engineering and hard sciences, responding to the guidelines to present proposals that insist on promoting the participation of social sciences and humanities, such as sociology, economics and history.

P. Urze (✉)
NOVA School of Science and Technology, CIUHCT, 2829-516 Caparica, Portugal
e-mail: pcu@fct.unl.pt

E. Araújo
Institute of Social Sciences, University of Minho, 4710-057 Gualtar-Braga, Portugal
e-mail: era@ics.uminho.pt

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Often, this prerogative is understood as a possible starting point for developing an interdisciplinary team. In practical terms, however, this mode of promoting interdisciplinarity lacks the knowledge about two points: (i) how "epistemic cultures" (Knorr-Cetina 1999) work and to what extent scientists are willing to collaborate in research; (ii) the extent to which research institutions and policymakers engage to make interdisciplinarity work. As we look at it, the prevailing rationale of knowledge hierarchy contradicts the framework of parity, which is necessary for its effective practice. Only in this way can the needed conditions be created for the synergistic integration of knowledge that defines interdisciplinarity. If the rationales provided by several studies are considered, it becomes evident that societal problems are complex, demanding integrated approaches that consider the centrality of people and socio-cultural elements to define methods and practices of intervention.

Current and relevant issues related to sustainability and disaster mitigation also encompass population, economic, and political dynamics, affected by many intriguing challenges for future consideration. Thus, interdisciplinarity is of great relevance and calls for a reformulation. This paper extends the concept of interdisciplinarity. It seeks to discuss the proposed idea of a non-trivial issue to problematize interdisciplinary and multidisciplinary collaborations in a social context. The text considers especially the collaboration with the social studies of science in areas referring to technological changes and innovations. From the literature review and a survey conducted in Portugal in February 2021, this paper will focus on how experts in technology and the social sciences establish such non-trivial problems, the demands for a successful collaboration, and the challenges they impose on scientists, institutions and policies.

2 Theoretical Framework

The dispute over interdisciplinarity began with the growing specialization of science in various branches and subject areas throughout the nineteenth century (Pombo 2005). Although the search to strengthen knowledge has led to the development of methods and languages in various scientific domains, it has also caused tension in the collaboration between different subject areas (Klein 1990). Since de 1970s onwords, the concept of interdisciplinarity has entered the language of various disciplines, from the natural sciences and engineering to medicine and the social sciences.

Other than the researchers' affiliated area, however, the concept does not often call for theories, methods, and practices shared by scientific research fields. Interdisciplinarity is not a novelty—academic areas are flexible and often combined to seek better answers to emerging issues. What is new is how, more recently, interdisciplinarity has played its role in the scientific community, through the collaboration of traditionally distant fields of knowledge, such as the natural and the social sciences. This is called "big interdisciplinarity," in contrast with "small interdisciplinarity," which requires cooperation among close fields of knowledge

(Bridle et al. 2013). Increasingly, interdisciplinarity enlists, not only academics but also policymakers and other non-academic partners, who can be integrated in various ways. For example, stakeholders are invited to take part in defining research questions and elaborate scientific models, as well as play an active role in data collection.

The proposal for a new scientific culture highlights the need for interdisciplinarities such as the example of knowledge production 2 (Gibbons et al. 1994) or post-normal science, arguing, in this regard, through a variety of authors who stand by interdisciplinary science as a favorable impact on the production of knowledge (Gibbons et al. 1994; Schmickl and Kieser 2008). More preemptive proposals discussed the risk that a strong emphasis on interdisciplinarity could undermine scientific disciplinary expertise and research requirement. Although these discussions on interdisciplinarity have been ongoing for several years (Klein 1990, 2008), it is still open for debate. From an epistemological perspective, it is crucial not only to understand the final result but also to follow interdisciplinary practices. Thus, it is essential to realize the following: First, the nucleus of interdisciplinarity, that is, what is being combined. Second, the kind of interdisciplinary interlace, that is, how it is performed. Third, the type of aims, that is, why interdisciplinarity occurs (Huutoniemia et al. 2010) as well as the tensions and conflicts that have emerged between scientific fields along the process itself.

Mäki and MacLeod (2016) postulate that interdisciplinarity needs to be studied *in action*, that is, to investigate interdisciplinary processes while they are occurring, through empirical techniques and case-studies. Interdisciplinary interactions and influences require complex commitments, negotiations and decision-making, possible misunderstandings, communication failures, and disputes. Conceptual and methodological challenges require time as it is an ongoing process that involves the participation of several scientific fields, themes, researchers, and institutions, requiring wide dissemination of case-studies addressed at different scales.

McCarty (2016), in turn, suggests a concept of interdisciplinarity based on a shared approach to a non-trivial problem on which experts from different disciplines can work productively together. He exemplifies this idea with case-studies on the various subjects of the humanities, among other non-technical scientific areas. Danermark (2019) argues that one of the essential aspects of interdisciplinarity is to reach the combination of knowledge, underlining the importance of an "open and tolerant mind." There are paradigmatic examples such as "true openness to the approach, perspectives, and attitudes of scientists from other disciplines" (Rowe 2008) and, contrarily, "different balance patterns and manage tensions between conflicting approaches" (Klein 2008). Danermark (2019) recalls several interdisciplinary research efforts in which collaboration is reported to fail repeatedly due to divergent scientific views. The failure mostly occurs when scientists come from manifestly different research fields and adds a reference to a particularly relevant research by Albert et al. (2008) describing the difficulties that emerge when "positivist biomedical scientists" cooperate with "non-positivist social scientists." It is also common to find reports from scientists involved in interdisciplinary investigations regarding complex disciplinary hierarchies. The methods they use are

frequently questioned because, according to the so-called radical scientists of the natural sciences and engineering, they are subjective and therefore, do not meet the objectivity criteria. However, often, those who have "negative perceptions" about the social sciences are researchers that are not used to collaborating with social scientists, unlike those who have already take parte of these teams and show greater interdisciplinary familiarity, more tolerance, and understanding in other fields of inquiry. There are ontological reasons for using a variey of methods in different ways, which are called "methodological specificity and pluralism" (Danermark et al. 2019).

The result of the interdisciplinary research process is theoretical pluralism. The point is not to become an expert in another area of knowledge but to have some fundamental insights into other theories as collaborative work requires. Variable time is critical and is often overlooked in interdisciplinary research, even by the research team. It is essential to clarify that the non-trivial problems, according to McCarty (2016), are by definition complex problems and facing them requires collaboration between experts in natural and social sciences. It is precisely the non-trivial issue that must be analysed in this way. Danermark (2019) says that even investigations with an unique focus must also strive beyond their disciplinary boundaries to reach more encompassing results.

In view of these ideas, this paper hypothesizes that the way scientists think and value interdisciplinarity deeply affects their practice and the way they can or support decision-making. It is also assumed that better planning and specific modes of analyzing societal problems shall integrate research programs as well as study plans in a wide range of study fields that, in turn, might demand better apprenticeship knowledge and training concerning the ways interdisciplinarity can be implemented and used.

3 Method

This paper was structured along three lines. First, the authors explain the most relevant and current ideas concerning interdisciplinary research and its value for future research programmes. The main purpose of this section is to highlight the way in which literature has emphasized the need to improve symmetry in research, so that different scientific fields may actually contribute to the identification and solution of societal problems. The second line is dedicated to analysing how researchers from different fields of enquiry actually think about interdisciplinary research and how do they envisage the actual trends and roles of research evaluation in defining the type of collaborations between research areas. Finally, the third line refers to the challenges identified by researchers, as well as by other authors, with the aim of paving the way for more robust interdisciplinary projects, especially

those focused on science policy procedures. Apart from the literature review, and of the documental analysis of research programmes in the EU, the paper considers the experience of the authors in multidisciplinary projects. To this end, different sources of information, mostly qualitative, were mobilized, in particular, the information provided by a short questionnaire filled in by researchers with experience in working in multidisciplinary projects, in Portugal.

Researchers were contacted in person and their selection was based on their expertise and proximity with interdisciplinary work involving the social sciences between 2 and 10 February, 2021. The questionnaire (open questions) was sent through *Google Forms* and consisted of three main questions: first, the advantages of interdisciplinarity in projects that involve research and innovation, engineering, science, and technology; second, the three most relevant constraints to interdisciplinary projects; finally, the challenges posed to interdisciplinarity in the near future.

Data were analysed according to the thematic content analysis method and presented according to the reviewed dimensions, in order to identify and map the most relevant aspects mentioned by each respondent. Throughout this article, the views of the researchers on the three dimensions above mentioned are summarized by using tables, together with direct extracts from the answers given by the respondents, which are used in between commas.

Respondents are not only from different research areas, but also from different universities. The fact that some of these universities are actually known for their efforts in fostering interdisciplinary projects should be emphasized, which gives even more relevance to the conclusions derived from this investigation. In any case, one should bear in mind its exploratory character and its purpose of identifying the most crucial questions in fostering interdisciplinarity in research and the debate on its place in research and in higher education institutions in Portugal.

Ethical requirements were followed to obtain consent from the respondents, and ensure confidentiality and anonymity. In the next table (Table 1), information is given on the respondents' field of work. For better discerning the interests of Engineering in SSH, the respondents from Sciences and Mathematics were kept separate from those of Engineering (several areas). The designation of Social Sciences and Humanities (SSH), encompasses also different fields, principally Sociology, Philosophy and Economics.

Table 1 Respondents by scientific field of work

Field of work	N	%
Engineering	31	39.2
Sciences and Maths	16	20.3
SSH	32	40.5
Total	79	100

Survey to portuguese scientists (2021)

3.1 Strengths of Interdisciplinarity: Building up Different Visions of Future

Most of the respondents from different areas agree that interdisciplinary projects represent multiple advantages for tackling the complexity of societal problems (Table 2). About 85% of the respondents assert that collaboration between scientific areas offers conditions to create "common languages," achieving a "systemic approach," which they consider is fundamental "to assure environmental, social and economic sustainability; harmonize languages, with a positive impact on society, increasing the possibility of innovation, with social impact." Herein, respondents argue that interdisciplinary projects allow scientists to develop "more robust solutions" that integrate several angles and dimensions of analysis, facilitating deeper analysis of the same problems. Besides these advantages concerning the construction of the problems to be dealt with, interdisciplinary projects are also seen as being beneficial from the methodological viewpoint.

The combination of different scientific fields opens new avenues to explore the same problem by making use of different methods, augmenting the chances for developing "disruptive and innovative" methodological strategies. From the side of respondents of social sciences and humanities, interdisciplinarity means, in particular, the possibility of showing the "social and ethical dimensions of scientific practice, the comprehension of the social determinants of technology" and making it effective in concrete projects. One of the respondents says, for instance, that Philosophy has different important contributions to give to other scientific fields, including engineering, as it provides theoretical and methodological knowledge that makes evident the "secondary and collateral perverse effects that scientific and technological innovation can represent."

Core concepts such as responsibility and innovation are considered to be of surmounting relevance for science and technology fields. This idea replicates in the majority of the answers provided by researchers from the social sciences and humanities that consider interdisciplinarity as a way to face complexity, augmenting the awareness about social implications and environmental consequences of certain types of decisions. Respondents often refer to the interest of interdisciplinarity in generating different visions of the future for science to deal with. This data is in line with the reflections made about the contributions of the social sciences and humanities, in general, and the social studies of science, in particular.

Table 2 Type of strengths facilitated by interdisciplinarity identified by researchers

Type of strengths	N	%
Approaching complex problems	67	84.8
Fostering knowledge	4	5.1
Elaborating new problems	2	2.5
Improving research quality	6	7.6
Total	79	100

Survey to portuguese scientists (2021)

3.2 *Constraints to Make Interdisciplinarity Effective: Issues of Policy and Style*

Most respondents argue that key barriers to interdisciplinarity are linked with the lack of dialogue and communication between the scientists, as well as a lack of will, time and availability to work together in different projects and areas, and the absence of an integrative science policy that can start a dialogue between different scientific fields, collaborate in diagnosing problems and set out intervention measures. Table 3 includes the main constraints pointed out by the respondents.

Scientists argue that researchers are not well prepared to make connections out of the scientific field and develop communication. Moreover, respondents mention the feebleness of a culture that valorizes the mixture of different viewpoints of the same problem. In their opinion, researchers are inserted in competitive cultures that tend to ascribe important value to specialization and individual projects. Thereby, "the majority of scientists do not have time to "talk" with colleagues from other scientific fields because they are at risk of losing the race with their peers". A researcher declares that science is still a stratified and divided world, marked by mistrust of scientists concerning each scientific field as well as the exclusive and rigid ways to perceive objectivity and certainty in science.

The respondents identify the absence of central interdisciplinary politics at the national level as a major structural consequence of the present-day evaluation framework. They assert that the evaluation is strongly sustained by disciplinary presuppositions preventing and dissuading researchers and institutions from collaborating. One researcher notes that the absence of political engagement at the national and institutional levels leads to several difficulties in building an interdisciplinary culture. A core issue pointed out by researchers is the way research units are evaluated by panels that are not interdisciplinary; thus, such panels have enormous difficulties in evaluating interdisciplinary research outcomes.

Acceleration in science and the need to present results quickly is also mentioned as a motive for researchers giving up interdisciplinary collaborations. One

Table 3 Constraints to make interdisciplinarity effective identified by researchers

Type of constraints	N	%
Absence of dialogue between scientific fields	21	26.6
Leadership in research	1	1.3
Nonexistence of collaborative culture	19	24.1
Competition between scientific fields	5	6.3
Science evaluation policy	20	25.3
Lack of academe competence	3	3.8
Another	8	10.1
No answer	2	2.5
Total	79	100

Survey to portuguese scientists (2021)

researcher states that the "difficulty to frame projects in a specific discipline blocks the access to funds and publication." They also argue that the ways and means for funding, which consider interdisciplinarity, "are not recognized and there is a lack of work opportunities for those working in more interdisciplinary areas." The respondents also consider that interdisciplinary work is a result of a long process of learning and training that should emphasize the way study plans are elaborated, so they can integrate more diverse disciplines that contribute specifically. Reinforcing this idea about the weakness of interdisciplinary study plans, one of the respondents says that: "There are only a few researchers who are prepared to do interdisciplinary work because the education is strongly specialized and I am afraid that it will get even more pronounced. If an undergraduate has only been educated in mathematics, they will have difficulties in establishing a dialogue with other areas".

In sum, respondents identify two main sources of impediments to interdisciplinarity: on the one hand, the lack of willingness for collaborating with other scientific fields and the lack of skills, such as communication abilities, to do so. On the other hand, the absence of a robust science policy that actually can foster overall interdisciplinarity, both at the national level and within higher education institutions and research centers, involving both evaluation methodologies and academic cultures. The hegemony of certain areas, hierarchization of scientific fields, difficulty in understanding the other viewpoints, and inability to learn from the others are great sources of institutional inertia in the case of interdisciplinary symmetrical collaboration.

3.3 Challenges to Reach Interdisciplinarity in Practice

The survey participants indicate that there is a need to promote more mechanisms for facilitating the analysis of the so-called "societal challenges" and lead scientists to analyze in-depth the possibilities of change to the extent innovation is fitting in with the prosecution of the common good. There is a general idea that science policy lacks globally effective participation from the researchers and is strongly determined by political and ideological objectives that miss the promotion and compensation of interdisciplinarity. Researchers pretend to be critical about the way "politicians establish certain goals according to certain "buzzwords," such as sustainability, social inclusion, decarbonization, or climate emergency without a strong scientific base, which has the perverse effect of conditioning the researchers to merely adapt their research projects to have funding". In this process, interdisciplinarity is no more but a result of the researcher's voluntarism.

Respondents opine that science policy would gain if it could integrate diversity in different ways because one of the main barriers is a strongly conservative culture that restraints disciplines within themselves and prevents people from understanding the symmetry of different scientific fields from the viewpoint of their scientific value. Respondents mention several societal problems that should be tackled from an interdisciplinary perspective. One of them refers to the climate

Table 4 Challenges to make interdisciplinarity effective

Challenges	N	%
Methods, languages, and openness of mind	25	31.6
Knowledge building incorporating academics and non-academics	6	7.6
Time available for knowledge building	3	3.8
Robust criteria and indicators to build science at the service of society	11	14
Equity and development of interaction between disciplines	10	12.7
Holist thinking and critical social analysis	13	16.4
Others	10	12.7
No answer	1	1.2
Total	79	100

Survey to portuguese scientists (2021)

emergency, which they consider needs further debate, to become a concept that can be shared and serves the purpose of proposing effective measures.

Respondents agree that interdisciplinarity cannot be regarded as a means to resolve the possible lack of understanding derived from the different scientific fields' participation. On the other hand, respondents assume that "interdisciplinarity is as much of a scientific value as any other so-called traditional area" because "the point is that there are complex problems (like the one mentioned above) that need multiple approaches." The complexities of current problems require interdisciplinary approaches for knowledge production based on a systemic perspective, grounded on social, ethical and environmental principles and is contrary to the fragmentation of scientific knowledge. Some advocate the need for a critical look; a scientist respondent argued that "although confronted with a landscape of growing social inequality at various scales, which means recovering social class as a category now neglected". The comments also stress the need to imbue all projects with a dimension to address the climate crisis.

The respondents' words highlight the fact that the construction of interdisciplinary knowledge goes beyond the aggregation of several disciplines that answer specific questions in a given scientific field (specialization). On the contrary, interdisciplinarity requires that "shared values and the capacity to respond to common goals prevail," necessitating a real openness to other scientific approaches. Moreover, it allows us to create sustainable solutions to major challenges not previously imagined. Interdisciplinarity is not an end in itself, nor does it solve the stereotypical conflicts, hierarchies, and views of scientific areas.

Still, if developed consistently, it allows "to cross the borders of very different areas such as the natural sciences and the social sciences as well as implies accepting and feeling motivated to abandon the search for perfection made by deepening a specific theme. It implies accepting certain insecurity of not, at times, mastering the themes as deeply as we would like because it is in the crossing that advances occur." It is, therefore, fundamental to identify the links and overlapping points between disciplines and show that these connections may have coherence for

the scientific problematization of complex phenomena. The variable time is explicitly expressed by 3 respondents, stating that in-depth interdisciplinary research requires time; it is a slow but rewarding process of knowledge development. It is worth adding that time is implicitly incorporated into many other responses when questioning the interdisciplinary development process. It is precisely a process, necessitating time and availability for its development.

One of the main challenges respondents point out is assuming that science and technology are not neutral. The scientists and people enrolled in innovation must anticipate and conceptualize design innovation and technology as social and political products. One area's criteria may not be the same for another area because: (1) the sustainability component and the social component are sometimes "overlooked" in technical projects, and (2) there is a need for more robust indicators to assess sustainability and the social issue in projects. A further expressed idea is that non-academic experts are actors who should participate in producing knowledge (public participation) when the innovation in question concerns them. This connection between society and citizens is an idea that permeates the discourse of the respondents, and it has even advanced the need for "translators" to bridge the different disciplines. It is argued that there is a need to review the "mindsets" linked to the conception of infinite progress and use of resources, clearly identifying the common goals that should go through ethical, social and environmental concerns.

The respondents' viewpoints include themes for which there is a convergence of crossing methodologies, visions, languages (ontologies) through the logic of knowledge fertilization. Such themes require abandoning the scientific jargon as opposed to having an open mind that is listed as equally crucial to construct interdisciplinary knowledge. It is a discourse that crosses the addressed scientific areas, hinting at openness from the natural and engineering sciences to the social scientists. The experience of complex problems underlines the fact that science is developed by the people for the people, which implies prevailing criteria that have social and environmental values. The respondents call for a balanced relationship among scientific areas, promoting a trusting share of knowledge so that different sciences can have their methodologies, research patterns and theoretical frameworks, and refusing a hierarchization of disciplines where the social sciences are usually the ones that trail behind. Scientists embed values, visions and experiences that condition the development of knowledge, and this knowledge arising from social sciences is essential to shape science and technology.

3.4 Ways to Move Forward and Improve Interdisciplinarity

Respondents are very critical about how interdisciplinarity is developed in research contexts, inside research units, or in higher education institutions. Overall, researchers agree to the need to foster cooperation and communication among scientists from different fields. They advance several concrete measures, such as workshops and seminars that allow people to think and work together, imagining

solutions for several societal problems. They say there is a need to build a culture of dialogue that is interdisciplinary because in "concrete projects it is essential to create, from the beginning, a culture of proactive meetings between all areas. It is important that, in a project, all areas see the project as a whole and not as a single sum of areas."

There are researchers who say that there is a need to "promote doctoral thesis guidance teams to involve professors/researchers from different departments/research centers, with the possibility of originating themes for interdisciplinary projects to continue the work developed within the scope of theses." The theme should be the guiding element of the projects, research and team training; it should always be seen as an object with several facets. As advanced by scientists from very different fields, it is urgent to recognize an "interdisciplinary" area in tenders for R&D projects and academic scientific fields of research. In other words, not only the practice of genuine interdisciplinarity but also the creation of a specific area to accommodate interdisciplinary projects are proposed.

It is crucial to fight for the valorization of interdisciplinarity at the level of institutions and assessment panels. Respondents put forward concrete proposals that refer to:

(i) promoting meetings between researchers,
(ii) building spaces to share and discuss different works between teachers and researchers and debates among researchers, associated with "different cultures," and
(iii) rewarding projects that include more than two fields, as a stimulus for sharing culture and knowledge.

Several researchers propose the integration of social scientists in natural sciences and technology-based projects, as well as the studies in science, technology and society—an area truly interdisciplinary—and activists who are non-academic experts to do the research, connecting both the disciplines as well as academia and civil society. We should not wait for the goodwill or despair of some scientists; the capacity for dialogue should be encouraged through academic training, at the level of the various degree levels. In short, "curiosity is not just a gift, it can also be stimulated."

One of the recurring themes in the respondents' proposals is the need to invest in advanced interdisciplinary training, thus, creating a group of researchers who know how to hold a dialogue with stakeholders from multiple areas and who can serve as a bridge between different members of interdisciplinary teams. It would be very productive, given the complexity of the problems we face today, to realize more intersections between social sciences and natural or engineering sciences. Furthermore, the valorization of more transversal themes that promote interdisciplinarity argued by a large number of respondents and reflection groups on relevant societal problems may result in genuinely interdisciplinary themes and research proposals in the funding entities and schools (particularly within the scope of the doctoral programs).

At least for the Portuguese case, there is an urgent need to raise awareness of political decision-makers and evaluators of scientific panels. The process directly linked with the dynamics of interdisciplinarity is well-expressed in the idea of "learning by doing," maintaining an open position regarding contributions or ideas that do not seem immediately related or useful, while ensuring scientific demand and quality as well as respecting issues such as ethics, which are even more complex in interdisciplinary projects. The proposal of "introducing mandatory disciplines in at least one non-nuclear area of knowledge in doctoral programs" is advanced. Several scientists propose room for interdisciplinarity at the level of doctoral programs, or even at the level of graduate courses.

Doctoral theses are often mentioned as privileged knowledge-building spaces that accommodate scientific domains in dialogue. The need to fight for the recognition of the interdisciplinary scientific domain within research institutions is also emphasized. Orienting funding programs towards major societal challenges that can only be overcome in an interdisciplinary way is also largely agreed upon along with "valuing interdisciplinary and community-oriented work in career progression (nowadays, this dimension is almost irrelevant in tenders due to no incentive for interdisciplinary work), which also involves changing the practices of hiring career teachers."

The valorization of interdisciplinary careers is still an open discussion, considering that career promotion calls are often based on a specialization matrix that can penalize or demobilize researchers who seek to investigate the interdisciplinary boundary in-depth. As demonstrated in the last decade, the inclusion of science and technology studies in interdisciplinary projects offers not only an irreplaceable critical perspective but also tools for the articulation between the engineering and science disciplines that take part in the projects. Another crucial point is to change the criteria for evaluating applications for FCT-MCTES [National Council for Science and Technology—Minister of Science and Technology and Higher Education] funding projects as well as the hiring practices of career professionals.

4 Discussion

Social studies of science and technology, in particular, elucidate what and how science can change with regards to interdisciplinarity (Jasanoff et al. 1995). Overall, these studies stress the relevance of important requites that STEM areas, in general, should be aware of when preparing innovative projects to alter or transform social realities and supporting decision-making that actually can contribute to collective wellbeing in several domains. Examples include topics concerning the preparedness and resilience to catastrophes and implications of climate change, risk proliferation and insecurity. At its core, the investigation states that education in engineering and technologies should adapt the study plans, integrating matters dealing, in particular, with concepts such as culture, values, ethics, and collective goals. The aim is to avoid any unnecessary innovation that brings about undesirable implications, such

as augmentation of social discrimination, stigmatization, social and gender inequalities. This is even more important in the case of engineering and technologies as these are at the forefront of the current digital revolution, dealing with disruptive issues such as artificial intelligence, big data, human–machine interaction and overall technologization of life. Social scientists have made their points concerning the type of visions scientists are creating about the future and what responsibility they have in promoting such images and their implications on citizens and life, in general.

In accordance, interdisciplinary projects and study plans would question the purposes of orienting research and innovation towards social and communal wellbeing and needs. Most technically-oriented projects show difficulty in understanding the role and the relevance that citizens need to have while diagnosing and co-producing knowledge and innovation. Social studies of science have proposed many ways to deal with the trends towards underestimating citizen's needs, but the main one refers to participation. Multidisciplinary projects and teams dealing with the production of innovative solutions need to integrate participatory methods that purposely count the general public's and organizations' views on the ongoing process.

A major issue in the social studies of science refers precisely to the social, emotional and political implications of innovations and how they would be resolved after being put in market circulation. Innovation should always mean something to people, tackling social needs to be directly useful and contribute to overall wellbeing. Therefore, one of the core aspects of promoting interdisciplinarity, particularly with the social sciences, is through enacting participative methods that provide means of listening to people and register their own opinion on the innovation, which can be applied just before any project begins, giving precious information for other scientif fields of work. Achieving such a goal often seems too easy as the concept of social engagement and social participation may be understood as a simple routinized manner of giving people information and obtaining the same from their evaluation and suggestions.

In practice, however, it is a very complex path that demands a delicate process of selection and contact with people, as well as the designing and planning of several modes of actually listening to people and considering their opinion to diagnose and evaluate the data (obtained from several modes) and prioritize the actions to develop further research, or take concrete actions for intervention and develop innovative technological solutions. Most of the times this path can only be conceive with the interdependency between social sciences and the the other sciences.

5 Final Considerations

Recent years have witnessed a deflating effect on interdisciplinarity and the development of discourses aimed at meeting the dominant rhetoric, which discourages criticism and knowledge fertilization, instead of striving to understand a

complex reality. Notwithstanding, when put in practice coherently and consistently, while approaching an object of enquiry, interdisciplinarity transcends the *cliché* to enrich and produce new disciplinary areas. This paper intended to demonstrate how scientists view and evaluate interdisciplinarity across all scientific fields, as well as between social sciences and humanities, as a way of identifying and tackling societal complex challenges.

Based on a literature review, and considering the results of a survey applied to Portuguese scientists working on interdisciplinary projects, this paper came across several important conclusions. It shows that scientists experience great uncertainty when embarking on interdisciplinary projects. The underestimation of interdisciplinarity, the importance of specialization in research evaluation, and the still hierarchical mode of understanding scientific fields greatly account for that experience. The results also point out a widespread common understanding of the need and relevance to foster interdisciplinarity among all areas, particularly the social sciences. In this line, it becomes relevant that research centers and universities can consider the outcomes of the social studies of science, which have proposed that scientific and technological innovation have impacts on the society that must be anticipated, diagnosed, and evaluated (Adam and Groves 2007). Moreover, such studies have dictated that planners and decision-makers should be aware of the non-intended effects of technologies in the social and organizational fabrics, as different social groups and individuals have different modes of understanding and using scientific knowledge and innovation. This is one of the pivotal reasons why in the past few years, several studies have pointed to the fact that science, technology and innovation are also culturally embedded; they respond to values and meanings people ascribe to them.

More importantly, several studies within the large field of social sciences, particularly the social studies of science, have signaled the ways social sciences can effectively contribute to engineering and technological areas in matters specifically linked to sustainability and visions of the future (Araújo 2018). For several years, social scientists have struggled to show the social, emotional and economical rewards of developing innovation through direct engagement with the population on designing the solutions, keeping them as co-producers of innovative solutions or processes that will have an impact on society and their future (Jasanoff et al. 1995). Authors state that joint efforts between scientific areas and experts, both in research and innovation, are needed to overcome and make citizens' knowledge, aspirations and desires prevail against top-down approaches that separate and emphasize the views of scientists and experts over citizens' experiences (Okamura 2019). Two important conditions must be fulfilled to make this path work.

First, it is important to pursue personal and institutional efforts to deliver science and technology to society and citizens. Authors have put forward several ways of doing so, including the composition of interdisciplinary teams, the use of cross-disciplinary research methods, and fostering genuine communication between all actors involved in the research team and stakeholders.

Second, it is important to consider the role of time for building and developing all the important ties that will allow the exchange of ideas and the information flow

to expand (Felt 2015). In this line, interdisciplinary research work is a matter of concern for the upcoming years, and it is particularly acute in the cases of small countries, such as Portugal, where additional efforts are needed to reduce dispersion. Research institutes and researchers have an individually important role to play in this matter.

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Paula Urze is Associate Professor at the Department of Applied Social Sciences, NOVA School of Science and Technology (NOVA SST), and researcher at the Interuniversity Centre for the History of Science and Technology (CIUHCT). She is author and co-author of various national and international publications on innovation, science and technology, foreign direct investment, work, and organisations. She participated in national and international projects and has served in scientific societies.

Emília Araújo is Associate Professor at the Department of Sociologia, Institute of Socioal Sciences, and re-searcher at CECS—Research Center in Communicaiton Studies. She is author and co-author of national and international publications on science, research careers and mobilities, time, science and technology. She has participated in national and international projects related to science, higher education.

Interdisciplinary Approaches and Methodologies

Environmental and Health Research Methodologies: Integrating a Transdisciplinary Approach in a Higher Education Cross-Cutting Curricular Unit

Maria Alzira Pimenta Dinis, Diogo Guedes Vidal, and Ricardo Cunha Dias

1 Introduction

There is growing evidence that human health is influenced by the way humans live and interact with the environment, with impacts caused by pollution and posing a threat to human health and well-being, and serious implications for future generations (Andersen et al. 2016; McLaren and Hawe 2005; de Almeida et al. 2011; Casimiro et al. 2006; Joas et al. 2015; Commoner 2020; Commoner et al. 1971). The associations between the environment as a whole and human health are complex. There are multiple interconnections between environmental sustainability and health problems, such as air pollution and avoidable mortality reduction (Barreira et al. 2018); energy poverty and the increase of morbidity and mortality associated with respiratory diseases; among several others (Oliveira et al. 2020, 2019; Dinis 2016). Thus, to study the interactions among these fields of knowledge, the integration of the environment and health as cross-cutting issues is crucial.

The Sustainable Development Goals (SDGs) of UN 2030 Agenda (United Nations Sustainable Development Goals Knowledge Platform 2015; United Nations 2015) requires an integrated, indivisible and balanced approach to the

M. A. P. Dinis (✉) · D. G. Vidal
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa, Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: madinis@ufp.edu.pt

D. G. Vidal
e-mail: diogovidal@ufp.edu.pt

R. C. Dias
Centre for Public Administration and Public Policies (CAPP), Institute of Social and Political Sciences (ISCSP), University of Lisboa (UL), Campus Universitário do Alto da Ajuda, Rua Almerindo Lessa, 1300-663 Lisboa, Portugal
e-mail: rdias@iscsp.ulisboa.pt

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environmental, economic, social and institutional dimensions. Developed from the legacy of the Millennium Development Goals (MDGs), this Agenda proposes an action plan foreseeing a sustainable and resilient world (United Nations 2015). In 2030 Agenda, the assessment of sustainability does not dissociate ecological problems from social ones, namely with regard to public and environmental health (Ministry of Foreign Affairs of Portugal 2017). The evolution of the SDGs in the specific case of Portugal is particularly positive with regard to health and well-being (SDG 3) (Ministry of Foreign Affairs of Portugal 2019). However, the indicators related to the environment reveal serious weaknesses, which are highlighted in the report of the Organization for Economic Co-operation and Development (OECD) (OECD—Organisation for Economic Co-operation and Development 2011a, b). Among these weaknesses, the need to invest in a transdisciplinary approach between environment and health is a commonplace. Transdisciplinary should be understood as a research approach that includes multiple scientific disciplines (interdisciplinarity) focusing on shared problems (Brandt et al. 2013). Due to the complexity in the research involving environment and health, the different methodologies and data techniques to be adopted play a vital role (Yin 2013, 2017; Phillips and Pugh 2015; Kumar 2019; Vilelas 2017). Therefore, researchers from different disciplinary and methodological contexts should work together to potentiate the dialogue between different areas of knowledge (Leal Filho et al. 2017; Oliveira et al. 2019, 2020; Salvia et al. 2019; Araújo et al. 2020; Hawe and Shiell 2000; Phoenix et al. 2013).

The aim of this text is to discuss the application of specific methodologies in environment and health research, addressing the importance of the transdisciplinary involved to conduct successful collaborative research paths. As a contribution, a new curricular unit "Environmental and Health Research Methodologies" is proposed to achieve transdisciplinary among different knowledge fields. The research method combines a background analysis, which includes a review of the relevant literature, with the experience of the authors, both in teaching, with a long experience in the University supervising students, as well as comprising the students' experience to which knowledge is communicated.

2 Method

The method combines a background analysis, which includes a review of the relevant literature, with the experience of the authors, both in teaching, with a long experience in the University supervising students, as well as comprising the students' experience to which knowledge is communicated. The proposed new curricular unit design is structured in four steps as recommended by João and Silva (2018): the objectives and intended learning outcomes definition (Leite et al. 2020), the syllabus of the unit, the teaching and learning approaches and the assessment methods. The designing process is pivotal to achieve the intedend learning outcomes, especially in trandisciplinary curricular unit. This iterative four-step method

puts the teacher and the student at the same level of knowledge transfer, considering that the discuss topics during the contact between them can be from top to down or vice-versa, i.e., from teacher to students and opposite. This is in accordance with the innovations performed in the learning method, namely the Flipped Classroom (Akçayır and Akçayır 2018) where the face-to-face (f2f) classroom becomes the place for teacher-student interaction, to answer questions and build group activities. However, educators are those who have powerful position to encourage the students' approaches to learning right from the design of the curricular unit.

3 Results

3.1 Environmental and Health Research Methodologies—A Proposal

Methodologies applied to the environment and health must rely on an indivisible vision of science and methods, aiming to train the researcher with comprehensive methodologies and skills. Sustainability science evolved from a multidisciplinary to an interdisciplinarity view, thus implying a transdisciplinary approach. However, to pursue transdisciplinary challenge, it becomes necessary: first, to break with the different scientific cultures (hard and soft sciences); and, second, to overcome disciplinary cuts resulting from different theoretical and methodological traditions (Snow 1995).

Science integrates concepts, theories and reliable methods to achieve up to date knowledge, which will never be absolute or final, and is able to be modified or replaced. The scientific approach is supported by models, either from quantitative or qualitative types, and which allow, separately or together, to achieve and describe the results (Yin 2013, 2017; Phillips and Pugh 2015; Kumar 2019; Vilelas 2017). Environmental and health sciences combine knowledge from many disciplinary fields, entailing a dialogue between theories and methods to achieve a transdisciplinary approach.

This text intends to show that the research methodologies applied to environment and health, supported by a proactive attitude and critical and decision-making capacity, allow the researcher to understand, develop and apply the different quantitative, qualitative and mixed methodological approaches. Alongside, the development and validation of specific instruments applied to research and decision support in this context results in the acquisition of significant scientific autonomy.

Considering the importance of autonomy, the researcher should be encouraged to collect relevant information in the context of the subjects studied, promoting an active discussion of the topics under analysis. This will contribute to an important alignment of participatory and autonomous research strategies, future precursors of scientific independence regarding the research to be carried out. Hence, it will be possible for the researcher to be able to build an emancipated thought, within the

scope of a continuous learning process. Table 1 shows the components and topics to be addressed in the research methodologies applied to environment and health in the context of the "Environmental and Health Research Methodologies" proposed new curricular unit, and later discussed in detail.

Each topic presented in Table 1 is addressed in detail in the following sections, followed by the specification of the "Environmental and Health Research Methodologies" curricular unit to be implemented in the context of a Ph.D. in Environmental and Health Sciences.

3.1.1 Literacy and the Indivisibility of Science in Transdisciplinary Research

This component is decisive in the learning process involved in the articulation of knowledge encompassing the environment and health, scientific areas that are always interconnected. Much of the training necessary to an environmental research involves acquiring knowledge and understanding of the main concepts and information associated with a particular area of study. A researcher who aims for a promising future of success must be trained in critical skills (hard and soft), techniques commonly used in the environment and health areas.

Science literacy in sustainability gives a clear indication to the researcher of the need to master knowledge from different areas. Sustainability science is something of complex scope, where transdisciplinary must be seen as a methodology in the approach that is made to applied research. This approach brings numerous advantages, making it possible to achieve results of practical implications, translated into an appreciation of advanced research work. Sustainability is indivisible; it cannot be compartmentalized or separated. This concept is reflected in UN 2030 Agenda (2015), highlighting the relationship between different areas of knowledge and how this connection invokes the integration of scientific areas.

It should be emphasized that global sustainability is achieved through a balance between nature, human communities and the economy, aiming to obtain, in the long term, significant gains for society. The quantitative (quantify/extensibility), qualitative (qualify/depth/intensity) and mixed (quanti-qualification) methodological approaches in sustainability science are incorporated with a deep knowledge of the scientific method and what it involves in terms of hypothesis, research design and conclusions (Augusto 2014; Creswell and Creswell 2017; Matos 2014). Choosing the best approach must be related to the questions that the researcher asks and wants to see answered, with what the researcher seeks to know and with the type of answers expected to be obtained. These approaches are crucial in the experimental planning of advanced quality training in terms of environment and health areas.

Table 1 Components of the new curricular unit "Environmental and health research methodologies"

Components	Topics	Aims	Skills
1. Literacy and the indivisibility of science in transdisciplinary research	• Science literacy; • The indivisibility of science in the field of sustainable development, namely the articulation between environment and health within the scope of the 2030 Agenda; • Transdisciplinary as a methodology; • Quantitative, qualitative and mixed methods' approaches	Familiarization with different quantitative, qualitative and mixed methods approaches in the context of transdisciplinary science	Recognition of the indivisibility of science in the field of sustainable development, motivated by transdisciplinary in the scientific areas of the environment and health; Application of different methodologies regarding planning and conception to obtain and analyse information
2. The different approaches and context of research methodologies applied to the environment and health	• Development and validation of specific instruments applied to research and decision support in environment and health; • Development of methodological strategies promoting environmental and public health; • Transdisciplinary in environment and health in an urban context; • Transdisciplinary in environment and health in the context of occupational health	Application of different instruments in environment and health research, involving data collection, treatment and validation	Training for the application of an effective broad-spectrum of instrumental methodologies in the data collection, with practical implications for society; Training to communicate and interpret science
3. Practical design of a methodological strategy for applied research in environment and health	• Analysis of case studies and scientific articles; • Development of a specific methodological approach to be applied	Preparation to use a broad conceptual approach, based on case studies; Preparation for an eventual submission process to ethics committee, if necessary within the research context	Recognition of the different methodological approaches applied in different case studies; Acquisition of autonomy for innovative work on a specific research theme; Training to synthesize ideas, arguments formulation, and to reframe concepts to accommodate new information; Development of autonomous critical thinking

3.1.2 The Different Approaches and Context of Research Methodologies Applied to the Environment and Health

This topic discusses the design and validation of methodological instruments to be applied to environment and health research. Much of what a researcher does is based on the ability to link possible causes and effects of a problem and then being able to propose appropriate solutions. Cause-and-effect relationships can be better achieved using validated instruments, which will result in practical applications, relevant in societal terms and thus contributing to practical knowledge. In environmental and public health, the design of strategies that call for transdisciplinary has a great impact on society, a desirable output in any research. Decision support systems, defined as adaptive structures designed specifically for the identification and assessment of options in solving complex problems, are of fundamental importance. It is necessary to be capable of an analytical approach that justifies the conclusions achieved in the context of the research. Due to the fact that the complexity of a research problem is often high, it is not always possible to achieve an exact solution, with additional limitations inherent to the specific research and the work carried out. Then, decision support instruments are of paramount importance to allow the assessment of specific knowledge, being increasingly common in the field of sustainability science.

3.1.3 Practical Design of a Methodological Strategy for Applied Research in Environment and Health

The analysis of case studies and scientific articles is crucial to the proposed "Environmental and Health Research Methodologies" curricular unit. It allows the researcher to see what is possible to study and achieve, namely when accessing the knowledge translated into scientific articles indexed in the international recognized databases. Through this analysis, the researcher learns how to be able to locate, assimilate, assess and correctly cite information obtained from various sources (main scientific sources and grey literature/not peer reviewed). The issues involved in research at this level are often complex and it is necessary to acquire the ability to think critically, which helps in problem solving. Some of the main attributes of a critical thinker are the objective analysis of facts, the assessment of evidence, being able to assess rationally and skilfully and reconstructing own thinking, and making judgments in a logical and rational way. The acquisition of such competences will allow to develop a methodological approach and specific design to the theme chosen by the researcher, resulting in a clear progress in relation to what was previously planned.

3.1.4 Environmental and Health Sciences Syllabus Implementation

The recommended transdisciplinary approach, detailed above, is in fact part of a proposed curricular unit to be implemented in a Ph.D. syllabus in Environmental and Health Sciences. The addressed curricular unit, entitled "Environmental and Health Research Methodologies", aims to contribute to a solid advanced preparation of Ph.D. candidates in this area. It will encompass different methodological approaches with a view to build autonomous and relevant knowledge in different scenarios, based on the need for continuous learning and progress in the fields of environment and health. The teaching methodology will comprise a total of one hundred hours, corresponding to four ECTS, with an estimated contact time of fifteen hours, in f2f regime, fully corresponding to the theoretical-practical typology. Considering the nature of the topics to be covered in the Ph.D. course, twelve hours will correspond to classes that will be simultaneously expositive (theoretical), of explanatory character, in a systematic and constant articulation with other classes (practical) of application and research, appropriate to the subjects discussed in the scope of the course unit. The remaining three hours will relate to the presentation, discussion and assessment of the work done by the Ph.D. candidates in the final part of the course. The bibliography to be allocated to the course is a fundamental part of the themes covered in all classes, as it allows contextualizing the methodological path presented in the syllabus of the course, and will include specific references present in this text. In addition to important bibliographic references in the context of the topics covered, the non-mandatory bibliography will also necessarily include scientific articles from the areas covered, part of which reflect the extensive scientific production already developed within the scope of the supervision of Ph.D. candidates in Environmental and Health Sciences. The learning outcomes are expected to cover the adequacy of the conceptual models inherent to the transdisciplinary approach applied to the research in environment and health areas, involving the different phases of development and application, necessarily reflecting a set of substantial improvements arising from the different topics covered in the f2f context, discussed and deepened throughout the course, focusing on aspects related to the most relevant scientific areas within the scope of the research theme that each Ph.D. candidate specifically intends to carry out.

4 Discussion

A transdisciplinary approach is a persistent claim of sustainability science and Anthropocene science. Modern science has established itself based on a paradigm of division and simplification of the world. The methodologies of modern science must be adapted to an Anthropocene science. The Anthropocene highlights the need for a paradigmatic change at the scientific level that overcomes and replaces the disciplinary cuts typical of modernity, with holistic approaches to coevolution (Crutzen 2006; Steffen et al. 2011). This change must be associated with a set of ethical values indispensable to transformative societal changes. The proposed

"Environmental and Health Research Methodologies" curricular unit in this text aims to contribute to this paradigmatic change. Although the traditional quantitative and qualitative methodologies can be used and combined, the problems of sustainability imply the search for new approaches, more adjusted to the complexity and specificity of the studied areas.

Despite the importance of such an approach, Brandt et al. (2013) have identified five challenges that are undermining its implementation: the lack of coherent framing (1), materialized in a poor interaction among scientists from different fields, due to dissimilar language, concepts and methods; methods integration (2), related to the need to integrate different disciplinary methods and development of new research ones; research process and knowledge production (3) relating the problem definition, analysis and solutions proposal; practitioners' engagement (4), visible through the connection between science and civil society/practitioners. This is the main potential of a transdisciplinary approach, by combining both scientific and technical knowledge to solve specific problems; and impact generation (5) that goes beyond the local scale or community, and where science communication has an essential role.

By presenting the five above main challenges involved in the transdisciplinary approach implementation, it is necessary to discuss how the new "Environmental and Health Research Methodologies" curricular unit could help to easily implement this proposed approach. First, this curricular unit calls for dialogue among different concepts, theories and methods. This will strengthen knowledge and enable mutual learning, resulting in new terminology that embodies this combination (Lang et al. 2012). Second, the curricular unit proposed is motivated by the mission to integrate different methods to allow more effective research designs and to promote a science-society interface. As a result, the researcher will face the challenge to create coherent and innovative methodological procedures. Third, the knowledge production is enhanced in this curricular unit since its beginning. The students will need to identify and structure the problem, then analyse and discuss it with colleagues to co-create a possible solution and finally integrate and apply the developed approach (Pohl 2008). Fourth, in the proposed curricular unit, communication and collaboration among practitioners is from the utmost importance to provide non-technical knowledge, resulting in crucial inputs to the research design. The presentation of case studies as learning cases can be an innovative approach to solve wicked problems. Finally, and fifth, science communication in this curricular unit is assumed as pivotal to assure that the outputs of the transdisciplinary approach design by the Ph.D. candidates are well disseminated, far beyond the local scale (Abraham 2020).

5 Conclusion

It is important to note that research methodologies applied to the environment and health in the context of the research to be developed are of fundamental importance given the need to contribute to a more balanced society, as advocated in the 2030 Agenda.

Despite the efforts done to implement transdisciplinary approach to solve wicked problems, i.e., health and environmental ones in the context of the present text, more initiatives are needed to fully integrate this approach as a powerful and effective methodology within the environment and health studied areas of knowledge. The need for a societal transformation, or transition, requires to shift the dominant paradigm of multiple views of the world (multidisciplinary). It is necessary to integrate these views, to achieve a global solution that leaves no-one-behind. This is more evident when facing social, health and environmental current challenges. Due to its complexity, future practioners in the addressed areas of knowledge, currently students, need to be empowered with new tools and approaches, and, most importantly, with user-friendly communication techniques that can be easily understood from policy-makers and later allow future practical application. Even though representing a small contribution, the suggested "Environmental and Health Research Methodologies" new curricular unit aims to be an important step to achieve transdisciplinary sustainability science within a Ph. D. syllabus in Environmental and Health Sciences.

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Professor Maria Alzira Pimenta Dinis is graduated in Metallurgical Engineering (1992), master's degree in Materials Engineering (1995) and Ph.D. in Earth Sciences (2010). She is currently Associate Professor in the University Fernando Pessoa, Porto, Portugal, researching in FP-ENAS, UFP Energy, Environment and Health Research Unit. Her main research domains include Reservoir Modelling and Environmental Engineering, with scientific outputs translated by numerous publications.

Diogo Guedes Vidal is graduated in Sociology (2014) and M.Sc. in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability. He is currently a Ph.D. research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the

Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Professor Ricardo Cunha Dias is graduated (2015) and has a master's degree (2017) in Sociology and is currently a Ph.D. student in Public Administration, specialization and Public Policy. He is Invited Assistant Professor at the Institute of Social and Political Sciences (ISCSP) at the University of Lisbon and a collaborating researcher at the Center for Administration and Public Policy (CAPP). His main areas of research are transformational governance and sustainable development.

Behavioural Mapping of Urban Green Spaces Users: Methodological Procedures Applied to Corujeira Garden (Porto, Portugal)

Diogo Guedes Vidal, Cláudia Oliveira Fernandes, Catarina Patoilo Teixeira, Ricardo Cunha Dias, Paulo Castro Seixas, Nelson Barros, Helena Vilaça, and Rui Leandro Maia

1 Introduction

1.1 Socioecology in Cross-Cutting Issues Research

Over the decades, the externalization of nature from human beings has led to the desire to control and overexploit it to meet human needs. This worldview, linked with the "Human Exceptionalism Paradigm" (Catton and Dunlap 1980), is now considered obsolete by some authors and novel frameworks have emerged (Grimm et al. 2008). The constant landscape changes that mainly derive from anthropogenic actions imply the need for a complex framework in line with a "New Ecological Paradigm".

D. G. Vidal (✉) · N. Barros · R. L. Maia
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: nelson@ufp.edu.pt

R. L. Maia
e-mail: rlmaia@ufp.edu.pt

C. O. Fernandes · C. P. Teixeira
Faculty of Sciences, Research Centre in Biodiversity and Genetic Resources (Cibio-inBIO), University of Porto (FCUP), Rua do Campo Alegre s/n, 4169-007 Porto, Portugal
e-mail: cofernandes@fc.up.pt

R. C. Dias · P. C. Seixas
Centre for Public Administration and Public Policies (CAPP), Institute of Social and Political Sciences (ISCSP), University of Lisboa (UL), Campus Universitário do Alto da Ajuda, Rua Almerindo Lessa, 1300-663 Lisbon, Portugal
e-mail: rdias@iscsp.ulisboa.pt

P. C. Seixas
e-mail: pseixas@iscsp.ulisboa.pt

H. Vilaça
Faculty of Arts and Humanities (FLUP), Institute of Sociology (ISUP), University of Porto, Via Panorâmica Edgar Cardoso s/n, 4150-564 Porto, Portugal

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The usefulness of socioecology derives from the framework of sustainability and knowledge, i.e., the relationship between social and natural systems (Petrosillo et al. 2015; Olmos-Martínez and Ortega-Rubio 2020). Socioecology incorporates the human-nature relationship as a component that integrally affects the ecosystem evolution, which is an inseparable and dependent association (Skandrani 2016; Fitzhugh et al. 2019; Kluger et al. 2020). Socioecological systems thus refer to systems where social, economic, ecological, cultural, political, and technological dimensions are strongly linked and are an important contribution to study human-nature dynamics (Petrosillo et al. 2015).

Socioecology is gaining more attention from the scientific field due to human-induced changes in ecosystems. These changes are visible in the fragmentation and habitat loss assumed as the greatest threats to biodiversity and ecosystem services (Tilman and Lehman 2001; Haddad et al. 2015; Jacobson et al. 2019).

The Millennium Ecosystem Assessment (2005) and, more recently, the Common International Classification of Ecosystem Services (Haines-Young and Potschin 2018) have provided a crucial contribution to a worldwide recognition of the interdependence among humans and nature. In this context, the acknowledgement of the human interactions, perceptions, and behaviours, on ecosystem structure and function, is an extraordinary achievement that contributed to the valuation of the socioecology approach (Innes et al. 2013; Preiser et al. 2018).

Alongside this contribution, Sociology has provided important frameworks that can help to better understand the relationship between human behaviours and the environment, especially in urban spaces. In this sense, the Chicago School of Sociology's, which emerged in the early twentieth century, has devoted attention to human ecology and the benefits of nature in cities (York and Mancus 2009). This sociological school is focused on how human behaviour is shaped by social structures and physical environments. According to the evolution theory developed by scholars of Chicago School, the natural environment shapes human behaviours (Park 1915). The combination of this ecological theory and socioecology can be of the greatest importance to understand the complex interactions that shape the social and ecological systems and to provide knowledge to be used in urban landscape planning and management (Abbott 2020). Behavioural Mapping (BM) is one of the methodologies that allows to investigate human and nature interactions by combining both social and ecological viewpoints, helping to reinvigorate Chicago school.

1.2 Behavioural Mapping: Emergence, Consolidation and Overview of Its Usefulness and Advantages in Socioecology Research

The first insights on observation mapping occurred in 1962 through an individual-centred mapping performed by Weiss and Boutourline (1962). The authors observed and registered pedestrian movement in "The Century 21 Exposition" (also known as the Seattle World's Fair), a world's fair held from April to October 1962,

in Seattle, Washington, where nearly 10 million people attended. Later, the need to develop a new technique to observe human behaviour in natural settings was proposed by Barker (1968) in his book "Ecological Psychology". The main challenge was to provide an approach that keeps the behavioural free from intrusion, ensuring that the observations recorded are spontaneous reactions to the natural elements of the settings (Sanoff and Coates 1971).

BM was further explored by Ittelson et al. (1970) in the field of environmental psychology to capture and record behaviour that occurs in a specific setting, i.e., to understand the interaction between people and space. It is acknowledged that aesthetics represent an essential factor that influences the use and enjoyment of the spaces (Maraja et al. 2016; Dai et al. 2019), but it is also necessary to assess how people interact with their surroundings (Cooper Marcus and Francis 1998). Thus, despite the importance of observation and survey techniques, BM proposes a systematic approach based on space function rather than aesthetic values.

Since the seventies, BM started to be commonly used by environmental psychology and considered a research method in person-environment studies (Pinheiro et al. 2008; Klein et al. 2018). The word "person" refers to a person-centred approach, commonly used "…when the goal is to learn about a person or a group's activities in relation to location and time, for example, where and how teenagers spend their time after school" (Ng 2015, p. 30). On the contrary, the place-centred approach aims to show "…the locations of people in a particular setting at a particular time engaging in various activities" (Ng 2015, p. 30), therefore more suitable when the goal is to assess the usage of a particular area or location.

The BM consolidation derives from its application in studies that contribute to public policy design. Ward Thompson (2013) argues that when acknowledged by planners and designers as key components, data available about the surrounding environment from landscape users' perception may support human experience and activities in different spaces. Several studies have contributed to the consolidation of BM. Sanoff and Coates (1971) were pioneers to map children's outdoor behaviours in a residential setting. Cosco et al. (2010) tested the technique in two preschool centres to associate outdoor environmental characteristics with children's physical activity levels. Cox et al. (2018) studied children's behaviours in outdoor play spaces to promote informed natural play spaces.

Furthermore, some works have devoted attention to open public spaces. Zacharias et al. (2001, 2004) performed an intensive observational study in plazas of San Francisco, correlating the users' behaviours with microclimate, other people and design. Concerning urban green spaces (UGS), Goličnik and Ward Thompson (2010) applied BM to UGS in two European cities to identify patterns of behaviour and how they are correlated with layouts and details, providing useful information to designers. Rodrigues (2015) mapped the occupation pattern of the five contemporary urban parks to suggest which kind of model is the best appropriate regarding users' needs and preferences. Similarly, in Portugal, Fernandes (2017) studied the human behaviour in the Botanic garden (Porto) to understand the use of space, making evident the pattern of distribution of users in the garden. The information obtained can, therefore, become a strong complement to the UGS management.

Many advantages have been pointed out in literature regarding BM but only some will be presented. The most important relates to its effectiveness. Sommer and Sommer (2002) state that BM is most effective than interviews or questionnaires, especially when dealing with sensitive populations, such as children. Moreover, people may not provide an honest answer for many reasons, namely those relating to daily practices or with whom they usually are. Alongside, when asking, the researcher cannot have the complete answer because people may not remember or do not know what is important to know, being sometimes not aware of their behaviours (Ng 2015). Also, BM is a non-intrusive technique, resulting in accurate data collection, recording the behaviour in its context. In socioecology research, BM provides the opportunity to combine both social and ecological variables and to analyse how they are mutually influenced. Nevertheless, the combination of multiple techniques, such as survey, interviews and BM may be more productive than applied only one.

The present work describes the methodological steps of the Behavioural Mapping (BM) application in a public garden located in the city of Porto, Portugal, and the results obtained regarding users' behaviours. The objective was to understand how the characteristics of the UGS can influence the way that users use it. The results are expected to contribute with knowledge that will allow proper intervening, in terms of its design and quality, to improve that interaction. UGS are spaces where city dwellers can get close to the natural world so, if these spaces do not provide them with that experience, they are not fully fulfilling their function. Therefore, it is important to understand how people use it, to identify where to act.

2 Methodology

2.1 Study Area

This chapter presents the methodological procedures of BM through the illustration of its application in a UGS located in the Campanhã parish—Corujeira garden (founded in 1915)—, in the city of Porto, a coastal city in the north of Portugal (Fig. 1).

The Campanhã parish has a long tradition of a demographic decline, losing more than 10.000 inhabitants in 10 years (1991–2001) (Alves 2012). Also, this parish experiences a higher incidence of the unemployment rate (three times more than the western parishes of the city), having 43% of its population living in social estates houses which highlights the poverty risk (Alves 2016). The Socioeconomic and Environmental Deprivation Index (Monteiro et al. 2013) also corroborates this pattern by integrating this parish in a high socioeconomic and environmental deprivation cluster. For these reasons, this UGS could play a vital role by providing recreational activities and to enhance the social cohesion and wellbeing of nearby residents, especially in a deprived community (Elands et al. 2018; Jennings and Bamkole 2019).

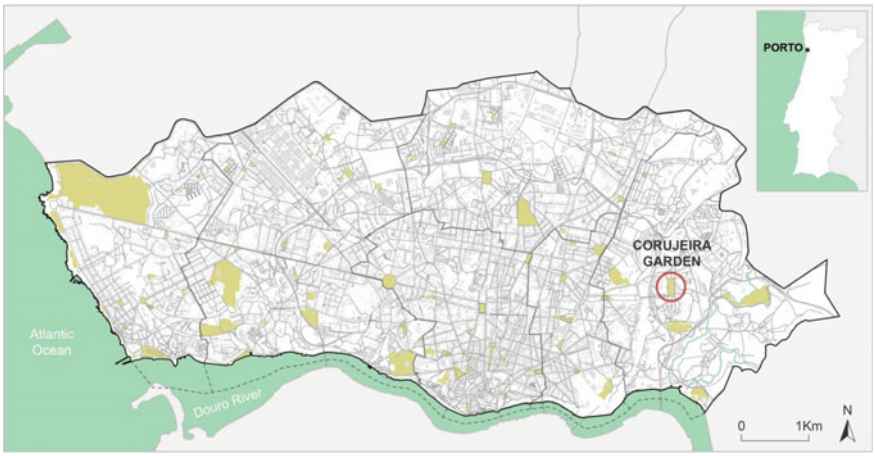

Fig. 1 The geographic location of Corujeira garden, Porto, Portugal

Regarding the UGS physical characteristics, the Corujeira garden is a square, of rectangular configuration, with almost 2 ha, dominated by the massive presence of plane trees for about 120 years. The high density of tree cover produces intense shade during spring and summer, which limits the integration and growth of lower vegetation strata, so that, apart from the plane trees, there are no other types of vegetation (with exception to lawn). It is bypassed by a wide promenade (with car parking) and crossed by one main path and 10 diagonal small paths that connect the main surrounding arteries. There are many benches along the sidewalks that create opportunities for rest, relax and socialize, some of them needing maintenance. Also, many garbage is present in the grass, close to the trees, reflecting poor maintenance of the UGS. There is a small bridge that crosses a fountain without water, one multipurpose pavilion whose roof serves as an open space that can be used and where is possible to see the whole UGS. The pavement in cement is in good condition which favours mobility. In the middle of the UGS two small squares connects different diagonal paths.

2.2 Protocol Design

The protocol design is anchored in the five elements proposed by Ittelson et al. (1970): (i) a base map to identify physical elements that could be of interest to the research objectives; (ii) the definition of behavioural categories and codes to be used when registering behaviours; (iii) the construction of an observation schedule; (iv) a systematic observation procedure; and (v) a system of coding and counting. Once this research aimed to study the behaviour of the Corujeira garden users, the approach chosen was place-centred.

2.2.1 Step 1—Base Map Creation

Corujeira Garden is a small to medium size UGS, with a geometric shape that facilitates the registration of the users' behaviour. Thus, it was decided that all area should be included in this analysis. As Sommer and Sommer (2002) stated, the map should contain all elements that can influence or determine users' behaviour. In this sense, a map was created with the main elements of Corujeira Garden: trees, shrubs, lawn, paths, benches, stairs, and water and built elements (bridge and multipurpose pavilion) (Fig. 2).

Fig. 2 Map used to register users behaviours

2.2.2 Step 2—Observation Categories and Codes Definition

Hereupon, it is necessary to define the behavioural categories and their correspondent codes. This process will facilitate the registration in situ, which allows making more observations in a small amount of time. These categories should be precise, relatively narrow and aligned with the research objectives. A possible strategy to reduce categories that may not be registered is to perform some free rounds in the UGS beforehand, observing the main behaviours. After this step, each category should correspond to a code to be used at the moment of observation (e.g., Teenager = TEN) (Table 1).

To clarify some of the previous behavioural categories, Table 2 presents their description and how they are classified.

After defining observation categories and codes, a grid to register the observations needs to be developed. This grid should be friendly-user and easy to manage during the observation in situ. Each user is marked through a number in the base map (Fig. 2) and then in the grid (Fig. 3) by identifying some characteristics

Table 1 Observation categories and codes

Gender	Code	Behaviour category	Code	Physical activity level	Code	Mobility	Code
Male	M	Using the mobile phone	PHONE	Walking	WAL	Walking stick	STICK
Female	F	Talking	TAL	Running	RUN	Wheelchair	WHEEL
Age		Eating	EAT	Laying	LA	Baby carriage	BABY
Child	C	Doing a picnic	PIC	Stop	STOP	Without restrictions	WR
Teenager	TEN	Sleeping	SL	Seating	SET		
Young Adult	YA	Photographing	PHOTO				
Adult	A	Playing	PLAY				
Elderly	E	Reading/ studying	RS				
Status		Dating	DAT				
Alone	AL	Observing	OB				
Accompanied	AC	Doing maintenance	MAN				
Social interaction		Crossing	CROSS				
Two persons	2	Other	Other				
Small group	SM (n)						
Big group	BG (n)						

Adapted from Rodrigues (2015) and Fernandes (2017)

Table 2 Observation categories description

Categories	Description
Age	
Child	Clearly below 10 years old
Teenager	Clearly below 18 years old
Young Adult	Looks between 18 and 30 years old
Adult	Looks between 30 and 65 years old
Elderly	Cleary above 65 years old
Status	
Alone	When a user is isolated without making contact with anyone
Social interaction	
Small group	A group with more than 2 persons and less than 10 persons
Big group	A group with more than 10 persons
Behaviour category	
Using the mobile phone	When a user is only using the mobile phone
Dating	When a couple is withholding hands, kissing, hugging or intimately talking
Observing	When a user is only contemplating, looking to UGS, to the sky or another place
Doing maintenance	When a user is doing maintenance work on the UGS
Crossing	When a user is only crossing the UGS, using it as a place of passage, not staying there
Physical activity level	
Lay	When a user is laying down on the grass, bench or in another place
Stop	When a user is standing upright, not sitting
Seat	When a user is standing and sitting somewhere (bench, wall or other)

predefined in the categories (Table 1). It is essential to register the date of observation, hour (moment of the day) and the environmental variables, i.e., those important to the research objectives. In this research, the temperature was chosen as a variable that can influence UGS users' behaviours, as well as the weather conditions, i.e. sunny, cloudy, fog or rainy day.

2.2.3 Step 3—Development of an Observation Schedule

According to Ng (2015), behavioural observation can be event or time-contingent at each fixed intervals (e.g., every 20 min) or random intervals. The main goal is to observe every time that an area is used. However, this can lead to some bias due to the probability to observe the same person more than just one time. Sommer and Sommer (2002) suggest spreading out the sessions throughout the day to minimize the probability to observe the same people performing the same activity more than

UGS								
Date		Hour			Temperature			
N	Gender	Age	Status	Social Interaction	Behaviour/Practice	Physical activity level	Mobility	Obs.

Fig. 3 Grid to register behaviours observed

one time. So, UGS should be visited, at least, during the morning and the afternoon, and during the week and weekend as well (Table 3). Rodrigues (2015) suggests 12 observations in total to register the main UGS behaviours patterns.

Concerning the observation's timeline, the literature reveals different perspectives. Rodrigues (2015) has performed the BM only during the summer season, arguing that it is in this period that most people use UGS. This argument could not be valid in the Mediterranean region, such as southern Europe. In this region, the mean temperature is not very low in autumn and winter, and there are sunny days. On the other hand, summers can be very hot and limit the use of green spaces for part of the day due to excess heat.

Goličnik and Ward Thompson (2010) conducted a BM study only during May (May 2002 and May 2003), without specifying the schedule of observation. The authors stated that in Edinburg (Scotland) and Ljubljana (Slovenia), where the study took place, the weather was likely to be warm and outdoor activity pleasant during this month.

Regarding our study area, which is located in Porto (Portugal), the annual average temperature is 15.3 °C, the maximum annual average is 19.6 °C, and the minimum annual average is 11.1 °C (Pordata 2020). So, in this specific case, the BM should include both hot and cold seasons, as recommended by Fernandes

Table 3 Observation schedule applied to Corujeira garden

Period	Week	Weekend	Total
	N	N	N
9:00–13:00 AM	3	3	6
13:00–19:00 PM	3	3	6
Total	6	6	12

(2017). Corujeira garden was then audited from August to November 2020, on different days and periods to avoid intrusiveness.

2.2.4 Step 4—Observation Procedure Definition

Concerning the observation procedure, its definition should be based on the UGS characteristics. If the UGS is relatively small (i.e., it is possible to see, from one corner, the entire UGS and walk through it in about 10 min), the round should be of 15–30 min to reduce the bias. This definition should be based on the free rounds that should be performed before applying the protocol. Alongside, it is also crucial to observe during the free rounds who are the users of the UGS, i.e. if is a UGS that is mainly used by the same users. This information is of utmost importance because it will help the observer to define its observation strategy. If the UGS is usually used by the same users, the observer needs to be careful to not be recognized, which could result in its identification as an intruder and lead to a change in users behaviours when they feel they are being observed (Ittelson et al. 1970). To minimise this bias, the observer needs to change the observation routine and route. These constraints should be registered at the moment to be later discussed when the results are being analysed. Another important aspect relates to the expected number of observations. Although it is intended to record the largest number of observations possible, being a qualitative approach it must end when theoretical saturation is reached, i.e. when no new properties and dimensions emerge during analysis in terms of observed behaviours (Bloor and Wood 2006).

2.2.5 Step 5—Training Observers and Pre-test

The final step consists of the observer training and pre-test application. This allows the familiarization of the categories and their codes, with the UGS layout and the designed protocol. Also, the pre-test is useful to identify certain problems regarding the protocol and categories that could need an adjustment, alongside the determination of the time required to scan the UGS.

2.3 Data Analysis

Data was analysed through descriptive and inferential analyses. A Chi-square test was used to check the association between sociodemographic characteristics of UGS users and their behaviours. All statistical procedures were performed by IBM® SPSS® Statistics 25.0. To map users' behaviours ArcGIS 10.6 software was used.

3 Results and Discussion: Preliminary Outcomes of BM Applied in Corujeira Garden

After the methodological steps were presented, this subsection will discuss the preliminary outcomes of the BM applied to the Corujeira garden. Figure 4a presents an example of a base map where the behaviours were registered, Fig. 4b presents their cartographic representation through ArcGIS. Each number in map A corresponds to a user observed. Some notes were taken during this visit and were written in the limits of the base map.

In Corujeira garden, 175 users were observed. This garden has a relatively low-frequency intensity which is partly related to the fact that it is located in the middle of urban fabric but not in a central or historic area of the city. So, its users are commonly nearby residents. The majority are males (56.6%), elderly (42.3%) that frequent the space with someone else (70.9%), mainly with one more person (44.4%), during the morning (67.4%) and on sunny days (87.4%) (Table 4).

To identify a possible association between users' gender and the number of people interacting in the UGS, as well as the physical activity level, a Chi-square test was applied and Table 5 presents the results of this relation. Regarding other

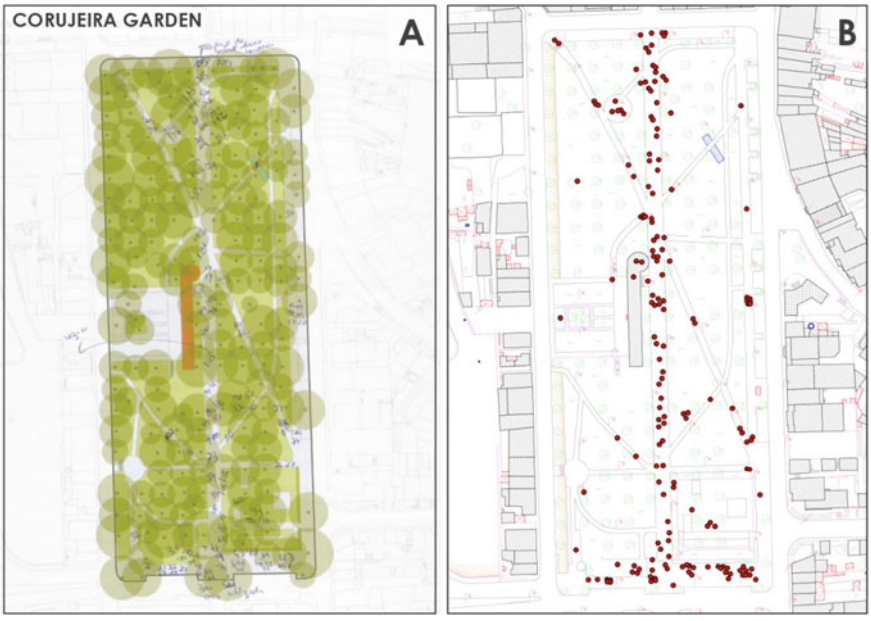

Fig. 4 Users behaviour registration. **a** Example of Corujeira garden base map with behaviours registered in situ; **b** Cartographic representation through ArcGIS of user's behaviours

Table 4 Corujeira garden user's characteristics identified through BM

Variables		N	%
Gender	Female	76	43.4
	Male	99	56.6
Age	Child	17	9.7
	Teenager	1	0.6
	Young adult	29	16.6
	Adult	54	30.9
	Elderly	74	42.3
Status	Accompanied (*n* person)	124	70.9
	2	55	44.4
	3	16	12.9
	4	33	26.6
	5	6	4.8
	6	13	10.5
	8	1	0.8
	Alone	51	29.1
Behaviour	Crossing	12	6.9
	Talking	91	52.0
	Photographing	2	1.1
	Playing	16	9.1
	Reading/studying	1	0.6
	Observing	23	13.1
	Walking the dog	7	4.0
	Using the mobile phone	23	13.1
Physical activity level	Walking	60	34.3
	Seating	100	57.1
	Stop	15	8.6
Day period	Morning (9:00 am–13:00 pm)	118	67.4
	Afternoon (13:00 pm–19:00 pm)	57	32.6
Weather condition	Sunny	153	87.4
	Foggy	8	4.6
	Overcast sun	14	8.0
Total		175	100

variables, there was no significant association between users' age and their behaviours, as well as between users gender and day period when they use the UGS ($p > 0.05$).

There is an association between the gender of Corujeira Garden users and the number of people that they are interacting with ($p < 0.005$), as well as with the physical activity level ($p < 0.001$). Male users tend to be in the garden with a larger group than females (more than 6 persons). Alongside, female users are more likely

Table 5 Association between users' gender, number of people interacting, and physical activity level

		Gender (%)	
		Male	Female
Number of people interacting	2	35.8	54.4
	3	11.9	14.0
	4	26.9	26.3
	5	4.5	5.3
	6	19.4	0.0
	8	1.5	0.0
	χ^2 (df = 5, N = 175) = 14.451, $p < 0.013$		
Physical activity level	Walking	20.2	52.6
	Seating	67.7	43.4
	Stop	12.1	3.9
	χ^2 (df = 2, N = 175) = 20.966, $p < 0.001$		

to be walking (52.6%), while males prefer to be seated (67.7%). This pattern has been previously identified in an ethnographic study carried out in a public garden (Marquês garden) in the city of Porto by Gouveia (2016), where male elderly prevailed. However, this evidence is aligned with Martins (1995) study, which referred that UGS were often used by male elderly to play traditional games, such as cards.

Figure 5 presents the sum of all observation and combines users' gender and age group and its correspondent location along the UGS.

A preliminary analysis of the data reveals an expressive trend: this UGS is mostly used through its built elements, i.e., paths and, urban furniture, i.e., benches. Table 4 shows that the most prevalent behaviour of the users is to talk (52.0%), followed by observing (13.1%) and being with the mobile phone (13.1%) (a dimension that should be further explored in the future to address perspectives on emerging phenomena related to the penetration of technology in people's lifestyles, which affects the use of public spaces (Smaniotto Costa et al. 2019). These activities that are mostly performed are being seated (57.1%) on the benches. To further explore this association, a Chi-square test was applied to users' physical activity level and behaviours (Table 6).

As can been seen in Table 6, talking (72.5%), reading/studying (100%), observing (73.9%) and using the mobile phone (69.6%) are behaviours that users mostly have sitting ($p < 0.001$). This result needs to be further explored but could be explained by the fact that this UGS is mainly used by the elderly, that prefer to seat on the bench instead of on the grass or due to the poor maintenance of natural elements such as lawns. Vidal et al. (2021) have previously visited this UGS in a study where a grid to assess ecosystem services combined with a socioeconomic spatial analysis was applied. The authors stated that this space, mainly used by the elderly, has deficient maintenance of both natural and urban furniture elements, and

Fig. 5 Cartographic representation through ArcGIS of users regarding sex and age group

a low level of cleanness, thereby considering it "unpleasant". These constraints may explain why these users do not perform certain activities such as play sports, lay on the grass or doing picnics. Another possible explanation, which should be further confirmed by comparing it with other UGS, could be related to the number of urban furniture once it is known that in UGS with many of those, users are more likely to use them instead of the natural ones. In a study by Ferret (2020), although focused on children, this issue is properly addressed, stating that UGS should be spaces where nature is dominant, allowing children to imagine new ways to play that goes beyond the physical and predefined features, such as the playgrounds. Regarding this evidence, a survey applied to UGS users in the city of Porto, Portugal, have concluded that, in some cases, an over-equipped UGS restrains a more creative and full experience of the space (Vidal et al. 2021).

Table 6 Association between users' physical activity level and behaviours

Behaviour	Physical activity level (%)		
	Walking	Seating	Stop
Crossing	100.0	0.0	0.0
Talking	16.5	72.5	11.0
Photographing	0.0	0.0	100.0
Playing	87.5	0.0	12.5
Reading/studying	0.0	100.0	0.0
Observing	26.1	73.9	0.0
Walking the dog	100.0	0.0	0.0
Using the mobile phone	26.1	69.6	4.3
	χ^2 (df = 14, N = 175) = 99.052, $p < 0.001$		

Table 7 Association between weather conditions and users' status

Weather conditions	Status (%)	
	Accompanied	Alone
Foggy	37.5	62.5
Sunny	73.9	26.1
Overcast sun	57.1	42.9
	$\chi 2$ (df = 2, N = 175) = 6.252, $p < 0.05$	

A second trend reveals that the south part of the UGS is more used than the north, emphasising that sunny areas are more wanted by users. These areas are regularly used by groups of male elderly to talk. However, the presence of groups of trees are important once is under and around them that users tend to be placed. This finding is corroborated by the study of Goličnik and Ward Thompson (2010), which stated that sitting or lying down are more often observed in the area where trees are present in abundance, even if people prefer sun or shade. In this regard, the Corujeira garden presents a considerable tree cover, dominated by mature, tall and deciduous trees that provide shading, mostly during the summer. To further explore how weather conditions are associated with other variables, a Chi-square test was applied and significant associations ($p < 0.05$) were found between them and users status (Table 7).

Table 7 suggests that on sunny days users are more likely to use UGS accompanied rather than alone (73.9%), which occurs mainly on foggy days (62.5%). It can be stated that sunny days attract many people to UGS, namely to socialize and relax with family and/or friends.

Regarding the UGS users, since the third visit, it was verified that they were usually the same. Likewise, the observer presence started to be noticed as a stranger and this could have led to a change in users' behaviours. To minimise this situation, the remaining observations were performed differently, by entering in the UGS

from other sides and doing different observing rounds. This description is fundamental since BM is not an intrusive technique, and data must be accurate as possible to reduce the bias.

4 Final Remarks

This chapter aimed to reaffirm the importance of the socioecology approach to meet socioenvironmental contemporary challenges. BM represents a technique that combines both social and ecological views by recording UGS users' location on a map to identify behaviours patterns. The main advantage of this technique is to be a more objective measure of behaviours than self-reports, by studying it in their physical and social contexts. However, several steps need to be followed to assure the data accuracy and reliability, especially to reduce bias, ethical issues, intrusiveness and reactivity. Also, BM could be potentiated when combined with other techniques, such as surveys and interviews. Due to the need for systematic observation, the time consuming needs to be taken into account. Once the data collection depends on the observer/researcher, the familiarization with the map, categories and UGS needs to be guaranteed.

The combination of both social and ecological/environmental variables makes this tool useful for environment-behaviour research and supports landscape planners and decision-makers with empirical evidence on the relationship between UGS design and its uses. Regarding the Corujeira garden, the poor quality of urban furniture and the deficient overall maintenance of the garden strongly discouraged its full exploration by its users. Instead of lying on the grass to restore, talk, or relax, the UGS users prefer to seat on the benches mainly located in the paths and, also, close to the warm area (south side). It is relevant to remark that this UGS is located in the middle of the urban fabric but outside the city centre, more often used by nearby residents, namely by the elderly to socialize with their friends and neighbours. So, it would be important to improve both built and natural elements, as well as urban furniture, to attract more users, especially the younger, which are those that less use this UGS. The opportunity to play on the grass and explore the UGS enhances creativeness and promotes physical activity, contributing to increasing well-being.

Lastly, although more than fifty years have passed since BM development, its potential has not been fully realized and seized. However, the recognition of the mutual influence between Humans-Nature will, in the future, certainly imply the need to explore this method further.

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Diogo Guedes Vidal is graduated in Sociology (2014) and M.Sc. in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability (2014–2019). He is currently a Ph.D. research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Cláudia Oliveira Fernandes is graduated in Agricultural Engineering (1997) and in Landscape Architecture (2010), M.Sc. in Natural Resources Management (2001) and Landscape Architecture (2011), and Ph.D. in Environmental Sciences (2009). She is currently Assistant Professor in the School of Sciences, University of Porto, Portugal, and researcher at the Research Centre in Biodiversity and Genetic Resources (CIBIO—InBio Associate Laboratory) leading the Landscape Planning, Design and Management research group (LPDM). Her main research interest includes the assessment, planning, design, and management of a wide-ranging of habitats and ecosystems, especially in urban environments.

Catarina Patoilo Teixeira holds a degree (2014) and master degree (2016) in Landscape Architecture, from the University of Porto. Currently, she is a Ph.D. candidate in Landscape Architecture, at the same institution, with a Ph.D. grant funded by the Portuguese Foundation for Science and Technology. Her Ph.D. research project aims to understand the constraints and opportunities of novel urban ecosystems, namely the role they can play in the creation of adaptive strategies for more resilient cities in the future.

Ricardo Cunha Dias is graduated (2015) and has a master's degree (2017) in Sociology and is currently a Ph.D. student in Public Administration, specialization and Public Policy. He is Invited Assistant Professor at the Institute of Social and Political Sciences (ISCSP) at the University of Lisbon and a collaborating researcher at the Center for Administration and Public Policy (CAPP). His main areas of research are transformational governance and sustainable development.

Paulo Castro Seixas is graduated in Anthropology—specialized in Sociology of Tropical Regions, M.Sc. in Sociology of Education and Ph.D. in Social and Cultural Anthropology—Urban Anthropology. He is Associate Professor with Aggregation at the Higher Institute of Social and Political Sciences of the University of Lisbon and Coordinator of the Public Administration and Territorial Policies Unit. His main research areas are transnational urban studies (with fieldwork in Portugal, Brazil, Romania and Timor-Leste), the socio-anthropology of Timor-Leste and, recently, culture policies in the Portuguese-speaking space.

Nelson Barros is graduated in Environmental Engineering, M.Sc. in Thermal Engineering an Ph. D. in Environmental Sciences. Member of the Editorial Board of the Journal of Ecological Engineering. Currently, is Associate Professor at University Fernando Pessoa, coordinator of the Ph.D. program in Ecology and Environmental Health and coordinator of the Laboratory of Research in Energy, Environment and Environmental Health (3ERL), a Research Group of the Fernando Pessoa Research Unit in Energy, Environment and Health (FP-ENAS).

Helena Vilaça holds a degree in sociology from the Faculty of Social and Human Sciences at Universidade Nova de Lisboa and a doctorate in sociology since 2003 from the Faculty of Arts and Humanities of the University of Porto (FLUP). She is Associate Professor with Aggregation in the Department of Sociology at the Faculty of Arts and Humanities of the University of Porto, where she teaches since 1987. Between 2008 and 2010 she did a post-doctorate in sociology at FLUP and at the University of Padua (Italy) on the topic of immigration, ethnicities and religion. In 2011, she was a Visiting Professor in the Department of Theology at the University of Uppsala (Sweden) and in 2017 she was in the USA with a scholarship from the State Department, under the Fulbright Program "Religious Pluralism". She is a member of the Council of the International Society for the Sociology of Religion, representing the Iberian Peninsula, and national coordinator of the EUREL network (Sociological and Legal Data on Religions in Europe and Beyond). She is an integrated researcher at the Institute of Sociology of the University of Porto (IS-UP), having been one of the founders and member of the first board. Currently coordinates the research group "Social Recompositions and Territory". His scientific work has focused predominantly on religion, e.g., religious pluralism; migrations, ethnicity and religion; Portuguese Catholicism, Protestant and Evangelical communities.

Rui Leandro Maia is Ph.D. in Sociology (2002), M.Sc. in History of Populations (1995) and graduated in History (1988). He is currently Invited Associate Professor at Fernando Pessoa University, Porto, Portugal, and researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit. His main research domains include demography, sociology, food safety, environment and treatment, analysis and criticism of sources, with scientific production translated into several publications.

Climate Change and Gender-Based Violence: Outcomes, Challenges and Future Perspectives

Sónia Maria Martins Caridade, Diogo Guedes Vidal, and Maria Alzira Pimenta Dinis

1 Emerging Climate Change and Gender Disparity

Climate change (CC) is often described as an environmental problem raising political concerns and debates but also perceived as a social human problem (Clayton 2019; Dias et al. 2020). CC presents a broadly systemic health risk, making the world more dangerous to live in, further enhancing social and psychological stress of people (Johnson 2020). Translated into extreme weather events or natural disasters, such as droughts and desertification, floods, forest fires and cyclones, CC is extremely complex and has implications in several areas of life. These events often result in undeniable social, economic and environmental consequences, impacting more significantly on the most vulnerable populations.

According to the Fourth Assessment Report (AR4) "…socially and economically disadvantaged and marginalized people are disproportionally affected by climate change." (IPCC 2014), exacerbating social inequalities. Accordingly, CC impacts are somewhat biased since they tend to be regressive, falling more heavily on the poor than the rich (Skoufias 2012). It has been reported by Islam and Winkel (2017) that socially and geographically disadvantaged people, i.e., those who face discrimination based on gender, age, race, class, caste, indigeneity and disability, are particularly vulnerable to climate hazards. This suggests that the impacts of CC are not gender-neutral. Peoples' adaptation, vulnerability and resilience to CC

S. M. M. Caridade (✉)
Psychology Research Center, School of Psychology, University of Minho, Campus de Gualtar, 4710-057 Braga, Portugal

D. G. Vidal · M. A. P. Dinis
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: diogovidal@ufp.edu.pt

M. A. P. Dinis
e-mail: madinis@ufp.edu.pt

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depend upon a range of conditions. These relate to the degree of exposure and dependency upon weather patterns for livelihoods and food security, but also to gender, social status, economic poverty, power, access, and control and ownership over resources in the household, community and society (Nellemann et al. 2011).

Some studies show that their adverse impact on men and women has different effects on women experiencing greater inequality during any situation of climatic stress (Rezaeian 2013). Women are documented as experiencing and reacting to the impact of a disaster in different ways (Memon 2020). In developing countries, women are among the most vulnerable to CC. They do not only account for a large proportion of the agricultural workforce but have also few alternative opportunities of income. Being the ones that manage households and care for family members, limiting their mobility, they are more exposed to natural disasters and other local sudden CC (Costello et al. 2009).

Although efforts to address gender issues in the United Nations (UN) environmental convention texts and negotiations took place in 1995 since the 1st Conference of the Parties (COP), the Women and Gender Group (WGC) was only formally recognized in 2009 by the United Nations Framework Convention on Climate Change (UNFCCC) (Gay-Antaki 2020). Over more than two decades of the existence of the UNFCCC, the discussion on the integration of gender perspectives in climate negotiations has marked the work agenda, emphasizing the importance of women in Sustainable Development (SD) (UN Women 2020). However, the gender-differentiated impact of CC on women is known, their contributions as agents of change to intensify the climate actions are often overlooked, as they are categorized as a vulnerable group. Nevertheless, recognizing the existence of multiple potential synergies between gender equality and climate action, spreading them across four key sectors of CC, i.e., energy, agriculture, urban development and natural disasters, constitutes considerable opportunities to promote greater gender equality in this domain (UN Women 2016).

CC also poses threats to SD (Basha et al. 2017), which implies a fair, prosperous and sustainable society, with equal opportunities for all. However, Christenson et al. (2014) states that in countries with lower human development indexes, the exposure to CC impacts is much greater (almost 50% more) than in countries with higher development indexes (which is 14%). Regarding the main CC impacts, such as droughts and floods, this unequal exposure could rise by between 9 and 17% in 2030 if CO_2 emissions are not reduced (Winsemius et al. 2015). In developing countries, many people live in a floodplain, with houses constructed of flimsy materials which are more susceptible to damage from floods. In many cases, women are more likely to be at home, cooking or caring of family members, resulting in higher exposure to CC impacts. Alongside, this cumulative level of poverty results in a vicious cycle which is hard to revert. Specifically, these social groups are more likely to be the target of CC impacts, causing natural disasters, and are simultaneously those with less capability to recover (Wodon et al. 2014). The multidimensionality character of these events consequences is far from being fully known. Nevertheless, there is some evidence highlighting that these events trigger

gender-based violence (GBV), namely by the loss of household income and disorientation.

The goal of this chapter is to describe and summarize some of the relevant research about the effects of CC on GBV, in the context of SD, also trying to identify some of the practical and research challenges in this area.

2 (In)direct Effects of Climate Changes on Gender-Based Violence

GBV is an endemic problem around the world, that result from gender inequalities and environmental instabilities interfering with a community's well-being and undermining its development (Memon 2020). GBV is based on the unequal distribution of power, particularly gender and normative inequalities, comprising the practice of various types of violence, e.g., physical, emotional, psychological or sexual. Among the various types of violence contemplated by GBV are sexual aggression and coercion, physical violence and intimate partner violence (IPV) or domestic violence (UN Refugees Agency 2016). Although GBV covers both men and women as victims, in the present work, the focus is on women, as they are one of the most vulnerable groups. According to the European Union Agency for Fundamental Rights (FRA) (2014), gender violence is based on a culture of asymmetry between the sexes, historically legitimized and that affects mainly women, constituting the main obstacle to gender equality. Moreover, the World Health Organization (2015) also reports that women are a group of greater vulnerability, experiencing an increase in the rate of sexual and domestic violence with serious and harmful consequences to their reproductive and sexual health during any type of disaster, either natural or not. In most countries, women reportedly suffer more violence than men (Castañeda Camey et al. 2020). In fact, there are studies that point to global estimates that 30% of women have already experienced some type of physical and/or sexual violence (Trabold et al. 2020). According to the Center for Disease Control and Prevention in the United States (2016), one in five women experienced some kind of rape, physical abuse and harassment by a loving partner. The WHO (2013) documents that one in three women has already experienced some type of physical and/or sexual violence by their intimate partner. European Union Agency for Fundamental Rights (FRA) (2014) interviewed 42,000 women and found that 32% of them suffered psychological violence and 33% suffered physical and/or sexual violence since the age of 15. In turn, environments affected by conflicts (Human Security Research Group 2012) and natural disasters, e.g., tsunami, hurricane, earthquake, and flood, resulting from CC have been identified as having a potential impact in increasing different types of interpersonal violence (Rezaeian 2013) or raising the risk for major disruption and violence within the family (Harville et al. 2011).

The direct and indirect threats of CC to the health of the population and to the increase in health inequities thus pose important and growing challenges for public health (Johnson 2020). At the same time, it has been argued that extreme weather events resulting from CC are not only a threat to the planet's ecosystems but have also been associated with an increase in interpersonal violence (Clayton 2019; Miles-Novelo and Anderson 2019; Molyneaux et al. 2020; Whittenbury 2013; UN Women 2016). Thus, researchers from different scientific areas, such as psychology, sociology, political science, economics, history or geography argue that rapid global warming can increase the incidence of violent behaviour (Anderson and DeLisi 2011; Miles-Novelo and Anderson 2019), identifying three different possibilities: (i) the direct effects of uncomfortably hot temperature on increased irritability, aggression and violence; (ii) the indirect effects of global warming on factors that put children and adolescents at risk of becoming adults subjected to violence, with a special focus also on women; (iii) and also the indirect effects of CC on populations whose livelihoods are suddenly at risk, effects that interfere with economic and political stability, migration and violent conflicts between groups (Anderson and DeLisi 2011).

Although the impact of CC is particularly evident in developing countries, as known, the literature has shown that this is not the exclusive reality of these countries. Even though developed countries have more resources to mitigate the effects of CC, it has been argued that no country will be immune to the consequences of the violence of CC, either directly (e.g., the effect of heat on individual levels of aggression and violence applies to all countries, risk exposure are an indicator for a future crime) or indirect (global economy and the need for resources). The relationship between natural disasters and violence has been documented by several authors (e.g., Parkinson 2017; Rezaeian 2013), showing that extreme weather events are related to the increase of GBV, more especially domestic violence and/or IPV and crime against women and girls (Parkinson 2017; Sety 2012), both in developing countries (e.g., Chad, Somália), but also in developed countries (e.g., Australia; USA) (Anderson and Delisi 2011; Molyneaux et al. 2020; Whittenbury 2013). For example, a study conducted in Australia by Whittenbury (2013), which sought to investigate the impacts of water decline on women's health and well-being, found significant levels of family breakdown and increased incidence of violence against women associated with drought and stress related to income, a well-known reality.

Parkinson (2017) analysed and discussed some explanatory hypotheses to explain how CC may enhance GBV, thus becoming an important risk indicator to be considered in this area: (i) natural disasters tend to unmask GBV with an increase in cases being perceived, which seem to reflect not a real increase in incidence, prevalence or notifications, but a greater demand for services by victims in the face of the disaster situation they were subjected to; (ii) increase female vulnerability to violence and enhance male aggression, i.e., the occurrence of a disaster causes other vulnerabilities for women, and consequently creates opportunities for violent men to exploit these vulnerabilities, intensifying abusive and controlling behaviours towards them, (iii) and, finally, promote the culture of

denial. Violence against women increases in the wake of a disaster, with an increase in new incidents involving men who had not been violent previously. However, there is no report of the situation on the part of the victims, who choose to silence, mainly to protect the men, now more vulnerable, or by other many reasons, e.g., exhaustion, self-guilt, fear of not being believed, fear of escalating violence, lack of options, protection of children now traumatized (Parkinson 2017).

Other authors, such as Molyneaux et al. (2020), document the impact that natural disasters have on the aggravation of violence and the multiplication of situations of domestic violence, given the discrimination that persists even after the disaster and with interference in the physical and social well-being of those involved. A qualitative study conducted in Pakistan by Memon (2020), with a sample of 20 women integrated in flooded settlement camps, showed that most women experienced different types of violence, both physical and emotional, committed by partners and even by strangers. The rate of violence increased when women were displaced and were in temporary shelters during a post-disaster period. Another study by Harville et al. (2011) examined the relationship between the experience of Hurricane Katrina and the occurrence of violence and conflict in a sample of 123 women, proving that certain hurricane experiences are associated with an increased likelihood of conflict, as well as violent conflict resolution methods. It is also known that job loss, poverty and the disappearance of loved ones trigger mental stress and potentiation of domestic violence (Molyneaux et al. 2020). Physical displacement, loss of support and protection from the community, economic difficulties and gender differences in coping are other factors mediating this impact (Reddy and Goodman 2019).

A work developed by Masson et al. (2019) sought to establish the links between violence and people's resilience capacities to survive and adapt to CC, particularly those living in fragile economic and political contexts. The authors show that violence interferes with building resilience, hindering the victims and their dependents can manage proactively and positively with the challenges and crises experienced. In addition, violence against women results in numerous problematic consequences, from poor reproductive health to a low literacy rate.

Analysing the impact of women's mental health following natural disaster and the relationship with GBV, specifically domestic violence, constitutes an important line of research. A review developed by Bell and Folkerth (2016) comprising 58 articles found that certain mental health outcomes, including post-traumatic stress disorder (PTSD), depression, and other significant mental health concerns, were very prevalent in women post-disaster, who are also minorities, i.e., poor, elderly, or the primary caregivers for their children. The authors concluded, therefore, by a cumulative impact, as vulnerability to health trauma increases as socioeconomic status decreases.

The reduction in access to social services and social networks available after disasters has been identified as important predictors of the implications of natural disasters in increasing the prevalence and severity of victimization by IPV. In this context, a study from Lauve-Moon and Ferreira (2017) who sought to examine the relationship between a technological disaster, such as the BP oil spill on residents,

and IPV, as well to examine the extent of perceived social and emotional support among IPV victims, is relevant. The authors concluded by a high level of vulnerability of post-disaster IPV victims. The authors also concluded that post-disaster IPV victims are highly vulnerable and that they are five times more likely to feel that they have never or rarely received the social and emotional support they need after the disaster. This reported vulnerability was made worse by the reduced access to resources by IPV victims, e.g., unemployed, low income, without health insurance, do not feel socially and with emotional support (Lauve-Moon and Ferreira 2017).

3 Practical Implications and Further Challenges

The literature in the area of CC and its impact on GBV is still scarce and further research in this field is needed to make it possible to obtain a more solid understanding of this reality in developing countries, but also in developed countries, which do not they are immune to the implications of CC in what relates violence. Accordingly, and to better understand the impact of CC on the population and GBV in particular, it is important, therefore, that developing countries in particular gather baseline data, such as the type and extent of violence in the community before the occurrence of a natural disaster, information that must integrate the most diverse surveillance systems. The existence of an efficient surveillance system for reporting violence is vital to better manage the underreporting of violence so prevalent in these countries (Rezaeian 2013). It is also necessary to develop a rate-based measure of GBV that could support the field epidemiologists in humanitarian settings (Stark et al. 2020).

Additionally, all this evidence documenting the direct and indirect effects of CC on GBV poses new challenges for professionals who work in this field. It is therefore opportune and relevant to identify and discuss future theoretical and practical perspectives in this field of knowledge. Taking into account the scope and complexity of CC, some experts suggest the need for combined efforts of researchers from different disciplines to collaborate and cooperate with policymakers, also considering the important contribution that social sciences can provide in this domain (Clayton 2019).

Since gender inequalities are the norm regarding CC, the need to adopt a cross-cutting gender approach aligned with the intersectoral protection recommended by humanitarian defenders is crucial, to incorporate the principles of protection in the surveillance programs, promoting both significant access to humanitarian assistance and the safety, dignity and respect of people in the affected communities (Masson et al. 2019). In reality, some authors such as Külcür et al. (2019) denounce the lack of knowledge and omission on the part of environmental non-governmental organizations (ENGOs), regarding the growing evidence on the connections between gender and CC. This justifies that these organizations, which have a decisive role in environmental policies and the mobilization of mass public

opinion, adopt policies of intervention in CC which are sensitive to gender differences. It is also important to continue to invest in development programs that aim to build resilience, but also seek to avoid the perpetuation of gender inequalities, and above all to promote processes of social change that can combat violence and build resilience at the individual, family and community levels (Masson et al. 2019). This is in line with one (SDG 5) (UN Department of Economic and Social Affairs 2020) of the main UN SDGs from Agenda 2030 (United Nations 2015) and involves promoting mechanisms for building capacities for effective planning and management concerning CC, especially in the least developed countries and developing countries, with a special focus on women, youth, local and marginalized communities.

Given the well-known differentiated gender impact in terms of CC, it is therefore important to promote gender mainstreaming, ensuring an effective increase in women's participation in CC. It is consequently important to invest in the development interventions that benefit men and women equally and to transform social, economic and institutional structures for gender equality and women empowerment in climate action and building resilience (UN Women 2016).

Indicators that women are more likely to have symptoms of PTSD and other indicators of poor mental health should be considered in disaster preparedness planning, defining early treatment and intervention. More specifically, it is important to think about the development of interventions around mental health care adapted to women after a natural disaster, such as those caused by CC, to produce awareness campaigns aimed at combating IPV within CC or even the creation of refuges for women in post-disaster planning. In the face of evidence reporting the increase in GBV triggered by economic and social stress associated with incremental CC, drive the need to create adequate and relevant services to address GBV, focused on women, in affected communities (Whittenbury 2013). The adoption of an intersectionality approach is necessary to guide effective interventions, taking into account the cumulative impacts of race, gender and economy (Bell and Folkerth 2016).

4 Conclusions

Gender-induced climate violence is an emerging area of study that should be included in the main CC studies and related issues, focusing on women. This also seems relevant to fulfil the essential objective of the SDGs towards gender equality, specifically SDG5, with important consequences to all the other SDGs, representing an accelerator of UN 2030 Agenda implementation.

The multidimensionality of SDG5 is visible not only on sexual and GBV but also in reducing poverty (SDG1), since when women have more money they are able to contribute to better education, nutrition and health outcomes for all household members; in ending hunger (SDG2), since women are the ones playing a critical role in food production, processing and distribution in many cultures; in

better health outcomes (SDG3), by expanding access to quality healthcare for women and girls, especially regarding sexual and reproductive health; in improving education level (SDG4), resulting in the reduction of early marriage and enhancing the possibility to have a flourishing life; in clean water and sanitation (SDG6), because women are those that provide, manage and safeguard household water and sanitation in most of the developing countries. Moreover, SDG5 impacts on the establishment of peace and justice, by preventing crimes against women and girls and reducing inequalities. The latter one is strongly linked with CC impacts, which are deeply amplified by gender inequalities.

CC related gender issues requires a global, cross-cutting response from the most diverse policymakers, both from developing and developed countries. Continuous analysis of the impacts that CC has on the most vulnerable populations is necessary, through mainstream gender and intersectional approaches addressing violence that allow providing responses and interventions to help people and communities to adapt to the changes that have occurred and will persist over time.

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Supporting Urban Climate Adaptation Governance Through Citizen Sensing

Marisa Graça, Tina-Simone Neset, Sirkku Juhola, and Sara Cruz

1 Introduction

As climate change sets increasingly threatening challenges for ecosystems worldwide, societies are ever more facing the need to cope with the impacts of a rise in average temperatures and in extreme weather events. Cities are particularly exposed to the risks linked to climate change. The dense structure of the built-up environment of urban areas, in combination with a low share of green spaces, enhances the risks related to e.g. high temperature and heavy precipitation. One prominent impact is the urban heat island effect in which exacerbated temperatures have been shown to cause negative impacts, such as the formation of smog and air pollutants that lower the air quality, increasing thermal stress of citizens, the level and risk of morbidity caused by heat (Mohajerani et al. 2017) and the disruption of urban ecosystems (Wilby and Perry 2006). These effects are likely to intensify, given that cities currently accommodate more than half of the world's population, and this value is expected to reach 68% in 2050 (United Nations 2018). Therefore, due to

M. Graça (✉) · S. Cruz
Faculty of Engineering, Research Centre for Territory, Transports and Environment (CITTA), University of Porto, Rua Dr. Roberto Frias, s/n, 4200-465 Porto, Portugal
e-mail: mgraca@fe.up.pt

S. Cruz
e-mail: scruz@fe.up.pt

T.-S. Neset · S. Juhola
Department of Thematic Studies—Environmental Change, Centre for Climate Science and Policy Research, Linköping University, 581 83 Linköping, Sweden
e-mail: tina.neset@liu.se

S. Juhola
e-mail: sirkku.juhola@helsinki.fi

S. Juhola
Ecosystems and Environment Research Programme, University of Helsinki, Helsinki, Finland

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the increased exposure of urban populations to negative impacts of climate change, it is vital to develop and implement adaptation policies and measures.

Climate adaptation is "*the process of adjustment to actual or expected climate and its effects. In human systems, adaptation seeks to moderate or avoid harm or exploit beneficial opportunities*" (Intergovernmental Panel on Climate Change [IPCC] 2014, p. 5). Climate adaptation policies and measures focus on climate impacts that are already occurring and those that might not be possible to be avoided in the future, addressing the heterogeneous impacts of climate change across the globe (European Commission 2013, 2021). Therefore, understanding the impacts of climate change in the medium to long term across various geographical contexts and sectors of society is fundamental for the development of successful adaptation governance. Climate change impacts are most felt at the community level, prompting the need to implement adaptation measures at a matching scale. To increase preparedness and adaptive capacity, urban local authorities such as municipalities and civil protection agencies need effective and reliable communication channels to interact with citizens. Yet, municipal and other local-level officials report that difficulties in communication and in engaging citizens are hindering progress on urban climate adaptation (Moser and Pike 2015).

Although awareness campaigns focusing on potential risks related to extreme events are very important, several studies have concluded that people tend to regard climate change as a global phenomenon that affects others living far away and so they ignore and are ambivalent to local threats until they become very serious and tangible (Ballantyne et al. 2018; IPCC 2014; Sheppard et al. 2011; Wibeck 2014). Moreover, top-down climate adaptation strategies tend to promote the passive involvement of citizens as mere recipients of relevant information, but research has shown that there is not a direct progression from information and awareness towards action concerning climate adaptation (Collins and Ison 2009; Domingues et al. 2018; Hügel and Davies 2020; Klein et al. 2018). Consequently, successful adaptation to climate change inevitably entails the broad support of affected communities, including the active involvement of citizens in assessing and responding to climate risks (Hügel and Davies 2020; Moser and Pike 2015; Wamsler 2016). Yet, citizens in general are seldom engaged in devising solutions to climate-related challenges affecting their communities, even if the need for public support and the potential for positive impacts stemming from civic involvement in climate adaptation has been acknowledged in recent studies (Bremer et al. 2019; Wamsler et al. 2020). So far, only a few studies provide evidence of the impact of participatory approaches in adaptation planning in general (Hügel and Davies 2020; Wamsler 2016).

This chapter presents the example of an innovative participatory approach that fosters bottom-up initiatives to climate adaptation, in which citizens are actively involved and engaged in monitoring and communicating on urban climate impacts. The participatory approach is supported by citizen sensing (CS), defined as *citizens acting as sensors to collect and send information using e.g. mobile devices or participatory online platforms* (cf. Sheth 2009), and draws on the experience and insights obtained through the European Project "*Citizen Sensing—Urban Climate*

Resilience through Participatory Risk Management Systems", developed between 2017 and 2021 and funded by the Joint Programming Initiative "Connecting Climate Knowledge for Europe" (JPI Climate) through the European Research Area for Climate Services (ERA4CS), co-funded by the European Union and national research councils involving partners from Sweden, Norway, the Netherlands and Portugal. The project aimed to co-develop a participatory risk management system with citizens, local authorities and organizations to promote urban climate resilience and create a two-way communication channel enabling citizens to not only *receive* relevant information but to also *provide* critical information to feed the system. Citizens report site-specific information otherwise not accessible to authorities on local climate impacts, and receive recommendations on climate adaptation. The project takes advantage of the ubiquity of new technologies, such as smartphones to engage citizens in contributing to urban climate resilience, by promoting their active role in identifying and overcoming climate risks and thus in informing urban climate adaptation processes. The *Citizen Sensing* project co-developed a system consisting of an interactive digital platform combining site-specific data with relevant adaptation guidelines. The project focused on four European cities: Norrköping (Sweden), Porto (Portugal), Rotterdam (Netherlands) and Trondheim (Norway), featuring a wide diversity of climatic, political, socio-cultural and economic contexts.

This chapter is structured in 4 sections drawing on the experiences of the *Citizen Sensing* project, which is used as an example to discuss how CS as a methodological approach can contribute to urban climate adaptation governance. In Sect. 2 we briefly discuss the dimensions of risk and uncertainty related to urban climate impacts, framing how the involvement of different actors can contribute to overcome specific issues related with these dimensions in urban climate adaptation. Section 3 explores the concept and potential of CS to support urban climate adaptation governance. Lastly, Sect. 4 synthesizes insights and challenges emerging from the project and reflects on the potential of CS to increase engagement by citizens, while enhancing the preparedness of authorities to take appropriate risk management actions and strengthening communication to support urban climate adaptation governance.

2 Risk, Uncertainty and Urban Climate Adaptation

Climate change exposes urban areas to risk. Climate risk, according to current thinking, translates the interaction between hazards, vulnerabilities and exposure (IPCC 2014). Hazards are caused by an event or trend linked to climate change and weather, vulnerability refers to the propensity or predisposition to be negatively impacted (Kiparsky et al. 2012), and exposure refers to what degree people, assets or ecosystems are unprotected (IPCC 2014). Extreme weather events comprise temperature extremes (heat and cold), precipitation extremes (heavy precipitation, floods, water scarcity and drought), storms and critical weather phenomena (e.g.

tropical cyclones, strong thunderstorms, tornadoes, and other extreme wind events). The impacts of such events depend on the interaction between the weather conditions and components of the physical and societal systems, intermediated by vulnerability and exposure (Morss et al. 2011). Particularly in cities, the dense and patchy urban fabric coupled with heterogeneous socioeconomic patterns result in the coexistence of different types of vulnerabilities and exposure to hazards, which can contribute to differentiated climate risks in the same city, or even in the same neighborhood (Thomas et al. 2019). The drivers of vulnerability can also be related to non-climatic factors, thus highlighting the need to connect local hazard information with an understanding of socio-economic development (Räsänen et al. 2016). Identifying and understanding local climate risks in cities is therefore a complex but essential process to outline adaptation strategies that can effectively reduce harm when unforeseen events occur.

Although significant progress regarding long-term estimations of some risks have been made (Rosenzweig et al. 2018), the fact remains that climate information is unavoidably uncertain, especially in relation to forecasting rare events (Morss et al. 2011). Uncertainty is an intrinsic characteristic of natural-social systems, resulting from the complexity of natural processes and interrelationships with human activities, and their unpredictable effects (Yuan et al. 2017). It is also inseparable from climate change assessments, as the complexity of both ecological and societal systems, their behaviors and the incomplete knowledge about the full functioning of present and future systems make it almost impossible to have reliable predictions and probability distributions. To reduce uncertainty, there is a need to understand the complexity of systems, and increase capacity to identify and map future conditions and events.

One frequent source of uncertainty is the difficulty of obtaining information about local climate risks at a suitable spatial resolution, which facilitates local decision-making (Zhao et al. 2021). Often, climate scenarios and projections are at the global and regional scale, but risks and their impacts occur locally. This gap between scales is even more important in the case of extreme events when local and isolated phenomena occur unexpectedly due to context-specific weather conditions. In the case of temperature changes or sea level rise, errors are more controlled and future projections are more reliable due to climate modelling being typically underpinned by coupled ocean–atmosphere general circulation models set at a coarser spatial scale; when it comes to precipitation and rainfall patterns, estimations are more uncertain because of a greater incapacity to model these events at regional and local levels (Jones et al. 2017). Furthermore, the interplay between extreme events and local social-ecological conditions may determine very different outcomes in terms of impacts, as vulnerability and exposure may vary considerably across different contexts.

This accentuates the need for local knowledge and communication with the affected communities, resulting in calls for more local, urban specific climate services (Cortekar et al. 2016) in the wider field of climate services (Vaughan et al. 2018). This is because managing risks is not only about understanding how hazards and impacts are related to risks, but rather about adopting iterative, adaptive and

participatory risk analysis and management. Hence there is a need to develop new approaches that engage citizens in a dialogue in order to obtain feedback and better contextualize climate services. Efficient communication systems are crucial in critical periods, e.g. through warning systems that can notify communities facing threats and guide them to protect themselves. However, the way people perceive risk is influenced by the values and cultural features of the communities or organizations in which they interact, thereby affecting their subsequent reactions to risks. Hence, adaptation as a dynamic social and institutional process (Munaretto et al. 2014) can benefit from citizen engagement.

Equally important for urban adaptation is the type of governance arrangements and actors included. The active involvement of citizens in climate adaptation strategies can increase their understanding of the natural processes and risks that are caused by climate change in their local environments, prompting an appropriation of climate issues as something tangible, individually experienced, while simultaneously empowering individuals and their communities in developing and implementing adaptive measures.

Research has shown that urban adaptation has been steadily progressing (Kern 2019) despite still lagging behind climate mitigation (Araos et al. 2016), and the engagement of different actors in society is considered to aid efforts to adapt (Hügel and Davies 2020). Cities and city governments are the natural entry points for urban adaptation, since they are the closest formal decision-making authority to the citizen (van der Heijden et al. 2019). It has also been shown that urban adaptation advances in stages (Araos et al. 2016) with stakeholder engagement increasing as adaptation progresses and different types of steering instruments are adopted (Klein et al. 2018).

However, when examined in detail the types of instruments used to engage different types of stakeholders vary (Klein et al. 2018). Citizens are mainly receivers of information regarding adaptation, and this is often based on a one-way dialogue with no structured engagement plan that encourages active participation (Klein et al. 2018). In addition to the type of instrument used in steering, there is a need to examine who is invited to participate in adaptation governance processes. So far, there has been limited research regarding who participates in adaptation, and to what extent vulnerable groups are part of decision-making (Yang et al. 2021).

As urban governance of adaptation moves towards inclusive forms, the types of communication, its benefits and learning become increasingly important (Wolfram et al. 2019). Communication and learning are key in enabling participation and building networks and engagement at the local level for successful implementation (Bellinson and Chu 2019). Due to the direct exposure of citizens to local climate impacts, their participation in decision-making processes may generate information and insights critical to better understand specific processes and unforeseen outcomes, which may assist local decision-makers in allocating resources and devising suitable planning strategies while reducing uncertainty concerning local risks.

3 The Role of Citizen Sensing in Urban Climate Adaptation Governance

While technology has contributed to boost scientific knowledge on complex social-ecological systems such as cities, and on biophysical processes related to climate change, the integration of people with traditional sensing networks now offers novel opportunities that need to be explored for the governance of urban climate adaptation. As Sheth (2009) notes, the inclusion of citizens to complement physical sensor systems provides a host of additional data that includes recording and interpreting events from a multitude of perspectives, coupled with spatiotemporal metadata that frame perceptions of environmental elements within time and space and embedded in specific meanings. As such, people have the capacity to overcome the limitations of machines in contextualizing and eliciting relevant information when dealing with uncertainty and inconsistent or ambiguous data, and in using that information to leverage existing knowledge, inform new observations and adapt accordingly (Sheth 2009).

The European research project *Citizen Sensing* aimed to develop and test a participatory approach underpinned by CS to engage citizens in urban climate adaptation. The participatory approach was co-designed with stakeholders and citizens of the four pilot cities involved in the project, and included the development of several digital tools (Navarra et al. 2021) embedded in an interactive platform. The *CitizenSensing app* enables citizens to interact with sensors, report weather events and related impacts associated with photos, thermal comfort assessment and relevant comments, and obtain adaptation recommendations. A web portal allows citizens and stakeholders to see and filter individual reports available in the pilot cities according to type of weather event and/or time period (Navarra et al. 2021). During the testing phase, hundreds of reports were uploaded by participants through the *CitizenSensing app*, as part of several field campaigns (Neset et al. 2021).

In this section, we explore the role of CS to support urban climate adaptation governance, with a focus on four aspects that were identified as pertinent in the *Citizen Sensing* research project. These key aspects are: (i) *the capacity of CS to meet the need for high-resolution data*, (ii) *how CS can enable citizens to provide feedback on monitoring systems, such as local sensors* (iii) *the role of CS to increase citizen engagement on climate adaptation,* and (iv) *the potential of CS to enable communication between citizens and municipal authorities*. These four aspects bear specific relevance to climate adaptation governance, in terms of increasing the available local information and knowledge for climate adaptation as well as enabling engagement and communication.

To enhance preparedness and the security of urban populations, municipalities and civil protection agencies require *high-resolution information* concerning where risks occur, which is particularly important in the case of extreme and unforeseen events. In particular with respect to urban heat, site-specific information is required to assess risk for urban heat islands for e.g. specific neighborhoods, where

assessments related to socio-economic and other parameters of the local population can guide urban adaptation (Madureira et al. 2021; Rød and Maarse 2021). CS allows the collection of information that is relevant to citizens on the local scale, where and when impacts are observed.

While many cities have weather stations that provide information on local temperature and weather warnings, the local conditions can deviate strongly from these measurements, frequently located outside the city center (e.g. Rød and Maarse 2021). Automated personal weather stations, typically providing sensor data on e.g. temperature, humidity and air pressure, have become widely available and an increasing number of citizens are currently sharing real time meteorological data via online platforms (e.g. Weather Observations Website; http://wow.metoffice.gov.uk), providing a higher density of local temperature measurements (Meier et al. 2017; Rød and Maarse 2021). While these automated personal weather stations lack the quality control and calibration of official meteorological facilities, and might be placed in less adequate locations (e.g. temporarily exposed to sunlight) which defers their correctness, they allow for a more detailed spatial analysis, comprising data processing and validation (Rød and Maarse 2021). Data from local sensors might also for other reasons deviate from the experiences of urban citizens, as temperature in urban areas can vary with several degrees Celsius over short distances, depending on e.g. the design of the build environment or the prevalence of green spaces and shade (Connors et al. 2013; Gago et al. 2013; Sun and Chen 2017; Unger 2004). Nevertheless, local sensors can provide a point of reference for citizens to relate to and comment on if data is easily accessible. As such, a CS system that enables citizens to *provide feedback on monitoring systems*, such as urban sensor networks, by validating and commenting on real time data obtained from urban sensors, can provide valuable local information on the extent and experience of heat in urban areas.

Based on this interaction with urban sensor systems, but also by enabling the reporting of citizen observations, CS enables *increased citizen engagement on climate adaptation*, bringing challenges of adapting to e.g. urban heat islands and the impacts of heat waves to the forefront and facilitating a dialogue on risks, as well as potential adaptation measures amongst citizens. As such, CS challenges the traditional unidirectional communication processes, and contributes to including citizens, no longer seen as mere recipients of information nor passive actors providing responses to predefined questions. By nurturing active citizen involvement and engagement, CS creates the potential to increase awareness on local climate risks and impacts, and to empower citizens to participate in urban climate adaptation.

As CS frequently employs digital participatory formats, such as apps or online participatory tools, it bears potential to facilitate a two-way *communication channel between citizens and municipal authorities.* While a growing number of studies have reported on the use of online participatory tools employed to enable citizen participation, so as to change the common formats of urban planning (e.g.Afzalan et al. 2017; Billger et al. 2016; Ertiö 2015; Glaas et al. 2020; Hjerpe et al. 2018), these are predominantly limited to gathering input from citizens without facilitating

responses from municipal authorities. In the context of urban heat events, an interactive two-way communication system could provide both access to the official warnings and adaptation measures, potentially also taking real time measurements and citizen reports into consideration. An increasing number of applications for smartphones for interactive communication purposes might also enhance the potential for rapid communication with groups of citizens that are commonly marginalized in urban governance processes, while digital literacy might imply a significant barrier for others (Czaja et al. 2006; Martins Van Jaarsveld 2020).

4 Insights for Improving Urban Climate Adaptation Governance

Urban climate adaptation involves continuously dealing with incomplete information and making decisions in a context of high uncertainty and unknown risk. Many studies point out that the engagement of citizens is crucial because these are ultimately the enablers of specific adaptation measures that accrue to the urban scale (Hegger et al. 2017; Klein et al. 2018; Tompkins and Eakin 2012; Wamsler and Brink 2014). CS can be conceived generally as a process involving observation, perception and communication (Sheth 2009). In the scope of urban climate adaptation, CS can leverage all three dimensions of traditional sensing to generate more detailed, contextualized and meaningful information related to the urban heat island effect that can support real-time decision-making processes concerning pressing risks and vulnerabilities. Due to the interactive two-way communication channel that CS can provide, fast and reliable exchange of information can take place between institutions and citizens, supporting not only local authorities in deciding on civil protection or socioeconomic measures to address risks or vulnerabilities, but also individual citizens that can receive tailored, contextualized recommendations for climate adaptation and for acting in face of extreme events.

Drawing on the experiences of the *Citizen Sensing* project, several insights can be systematized to further enhance the potential of CS to the governance of urban climate adaptation:

- *Exploring diverse climate impacts.* The CS based approach is particularly suitable to strengthen urban climate adaptation governance related to heat issues, as citizens and local authorities may easily take advantage of existing sensor networks that provide high-resolution information on the heterogeneous distribution of e.g. temperatures, humidity and air pressure. On one hand, such information may raise citizen awareness concerning the incidence of the urban heat island effect and associated risks, thus facilitating engagement in adaptation strategies. On the other hand, authorities can pinpoint hotspots in the urban fabric that increase risk for vulnerable groups and act preventively in those areas (Madureira et al. 2021; Rød and Maarse 2021). However, the CS approach can also be expanded to other types of climate impacts more pressing in different

latitudes or seasons of the year. In the *Citizen Sensing* project, the variability of climate impacts and concerns across the pilot cities ranged from flooding events to heat, guided by the concerns expressed by stakeholders from relevant institutions in the pilot cities. The results of the *Citizen Sensing* project showed that the CS approach can be adapted to include different types of climate impacts which may vary even within the same city according to the season or user needs.

- *Co-designing participatory processes supported by citizen sensing*. The level of participation of citizens affects how societies embrace climate adaptation measures (Hegger et al. 2017; Wamsler et al. 2020). However, research has shown that current forms and conditions of citizen involvement in climate adaptation often fail to generate positive outcomes, and may even hamper sustainability goals (Brink and Wamsler 2018; Klein et al. 2018; Wamsler et al. 2020). Successful collaboration between municipalities and citizens depends on increasing legitimacy, equity and proactive engagement of citizens in decision-making processes to support urban climate adaptation (Brink and Wamsler 2018). Local knowledge held by citizens can also play a relevant role in supporting long-term monitoring and collective learning processes targeting adaptation, but may result in citizen-driven contestation if no institutional support exists to capitalize on citizen input (Brink and Wamsler 2018; Wamsler et al. 2020). Additionally, the disconnect between producers and users of information has been identified as a constraining factor to using climate information in decision-making processes, particularly if those most vulnerable to impacts are not involved in the production of the information itself, thus reducing their ownership of issues and influence in adaptation governance (Jones et al. 2017). Taking these considerations into account, the *Citizen Sensing* project explored how to untap the potential of CS in effective participatory processes by means of co-designing a participatory process together with citizens and stakeholders. The experiences gained in the project pointed to the need to identify very clearly at the onset who are the target end-users of the system and involve them in framing the issues at stake, their motivations, information needs as well as modes of communication among different actors. In the case of citizens, besides receiving tailored recommendations for individual adaptation, added value and engagement may be achieved if they are aware that the information is used to inform real decision-making processes, thus increasing trust and citizen empowerment. Furthermore, expectations among different groups of citizens vary and therefore specific groups can be best involved if their particular motivations and needs are addressed. Hence, co-designing climate services with stakeholders and end-users contributes to adjust the production of climate information with the needs of users, to better inform institutional and individual action, legitimacy and equity in urban adaptation governance (André et al. 2021; Vincent et al. 2018). However, some challenges were evident in the *Citizen Sensing* project, such as the heterogeneous levels of digital literacy among the urban population and particularly among the most vulnerable groups (e.g. elderly population), which may affect

the use of CS in participatory processes, and require the development of tailored mechanisms to ensure inclusion.

- *Improving human interaction with sensors to address urban heat-island effects*. In the *Citizen Sensing* project, complementing the data provided by sensor networks with observations by citizens aimed to generate additional layers of information with high spatial, temporal and thematic detail that can contribute to urban climate adaptation governance. While citizens can certainly contribute to validate and align sensor data with their individual experience of urban heat-island effects, the experiences in the *Citizen Sensing* project point towards the importance of a user friendly and engaging interface that facilitates two-way interaction. One way to tackle this issue is to develop interfaces that visually communicate the climate impacts at stake in relation with the information provided by sensors. For example, displaying the sensors over a background city map with a gradient of colors according to real-time heat levels could raise citizens' awareness of the heat-island effect even across short distances, thus increasing the enthusiasm of participants to contribute with data and follow adaptation recommendations. Another suggestion to raise citizen's awareness would be to provide information on the interface about how the human-sensor interaction may assist decision-making processes led by local authorities. As some stakeholders in the pilot studies referred, overlaying sensor and citizen data could lead to better identifying areas requiring specific adaptation measures for vulnerable groups (e.g. homeless citizens). Sensor networks coupled with citizen feedback also provide effective means for local authorities to assess the validity and relevance of citizen reports and to filter possible outliers in reported events. Nevertheless, realizing the full potential of citizens and local authorities interacting with sensors to enhance urban climate adaptation governance is dependent on the availability of sensor networks, which may need to be augmented to ensure sufficient coverage of the urban fabric and high-resolution data.
- *Supporting urban planning and design with the purpose of climate adaptation.* Long-term climate information is commonly used to support urban planning and infrastructure decisions, as large investments are expected to endure extended time horizons and it is necessary to avoid the risk of maladaptation, irreversible losses or costly interventions (Jones et al. 2017). Climate information also allows the identification of urban areas highly vulnerable to climate risks, in which increasing e.g. green spaces may be more suitable as adaptation measures. Different scales of adaptation planning and governance require climate information with matching spatial resolution. However, at the local scale there is limited climate information with high spatial resolution required to assist urban planning and design (Graça et al. 2021; Jones et al. 2017). To better support practitioners and local authorities, climatic data needs to be disaggregated into fine-scale units that relate with the spatial scale of planning and design practices, but municipal institutions frequently lack the capacity to generate such information, hence requiring scientific support or alternative pathways. Furthermore, climate vulnerabilities are determined not only by risks (e.g. hotspots in the

city), but also by social, cultural and economic drivers that interact in complex ways in cities and influence the level of sensitivity and adaptive capacity. The CS approach offers the possibility to address the need for high-resolution climate data in cities, while providing unique insights from citizens that are commonly not involved in urban planning and design, and which might otherwise go unnoticed by practitioners not acquainted with specific sites.

5 Conclusion

Facing the challenges of urban climate adaptation governance requires novel, flexible and inclusive approaches to ensure the availability and accessibility of relevant information to urban citizens, planners and decision makers. CS provides a multitude of methodological approaches, some of which we outlined in this chapter, exemplifying with insights from the European research project *Citizen Sensing*. While the potential to increase the relevance of tools and applications designed for urban climate adaptation governance seems to be unlimited, we conclude that the perspectives of practitioners, local authorities and urban citizens, as well as the specificities of urban contexts need to be considered in the process design.

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Marisa Graça is a postdoctoral researcher at CITTA—Research Centre for Territory, Transports and Environment/Faculty of Engineering of the University of Porto. She holds a Ph.D. in Landscape Architecture (concluded in 2018) from the University of Porto. Her research interests include assessing, quantifying and mapping urban ecosystem services, landscape planning, management and design, urban resilience and climate adaptation. She is particularly interested in developing interdisciplinary research to support decision-making processes. Since 2004 she has also worked as a landscape architect in Portugal, coordinating and developing several landscape architecture projects and studies ranging from public to private investments, both within private offices and in the public local administration.

Tina-Simone Neset is an associate professor at the Department of Thematic Studies—Environmental Change at Linköping University Sweden. She is the Director of the Centre for Climate Science and Policy Research (CSPR). She holds a Ph.D. in Water and Environmental Studies (2005) from Linköping University. Her research interests concern climate change, climate vulnerability and adaptation with a methodological focus on interactive visualization, participatory processes, gaming, and citizen science. Her research further includes studies on resource management and vulnerability assessments related to agriculture and food security. She is the PI for the JPI Climate/ERA4CS funded project Citizen Sensing (citizensensing.eu).

Sirkku Juhola is professor of urban environmental policy in the University of Helsinki, Finland and a guest professor at Linköping University in Sweden. She holds degrees from the University of East Anglia and University of Sussex in international relations and development and her area of expertise is environmental policy and governance. She leads the multidisciplinary Urban Environmental Policy (@UEP_group) research group at the University of Helsinki and is the Director of the Doctoral School of Environment, Food and Biological Sciences, UHEL. She is a contributing author in the IPCC 6th Assessment Report, a lead author in Third Assessment Report on Climate Change and Cities, UCCRN, and leads the International Scientific Council of NORADAPT, Norway.

Sara Cruz is an assistant professor at the University of Porto, Spatial Planning and Environment Division, and senior researcher at CITTA—Research Centre for Territory, Transports and Environment. She concluded her Ph.D. in Urban Planning in 2004, and since then her work has been divided between teaching and researching. Her main research interests focus on urban and environmental planning, namely urban development, production and management in urban areas. In particular, she is interested in studying uses and appropriations in public spaces, urban changes and the processes that shape the city, looking at the physical and socio-economic context, and the role of communities in promoting urban climate resilience.

Ecological Walk: A Proposed Digital Game to Reduce Solid Waste and Safeguard Marine Ecosystems in Brazil

Regina Célia Soares Pereira, Luis Borges Gouveia, and Maria Alzira Pimenta Dinis

1 Introduction

Marine ecosystems worldwide suffer the impacts of solid waste (SW) discharges from residential, commercial, and industrial activities, with consequences in economic, biological, and social dimensions (Chen et al. 2020; Beaumont et al. 2019; da Silva and Krelling 2019). Plastic stands out for its quantity and further durability, which causes damage to water resources and marine biota. It is necessary to properly manage SW due to its direct effects on air, water, and soil, impacting public health (Debrah, Vidal and Dinis 2021). In addition to damage to tourism, expenses with cleaning the beaches and the impact of reducing visitors' interest in local tourism must also be considered.

This scenario reflects the economic dimension perceived in several cities in Brazil, a vast coastline (Freitas et al. 2020). Cabo Frio, RJ, Brazil, one of the seven municipalities in the Lagos region, does not escape this reality, as tourism is considered a central pillar of the local economy due to the diverse historical and natural heritage. In periods of the high season, there is a considerable increase in the SW on the region's beaches caused by the large flow of tourists (Pereira et al. 2018, 2021, 2020), generating losses to the marine biota.

R. C. S. Pereira (✉) · L. B. Gouveia
University Fernando Pessoa, Praça 9 de Abril, 349, 4249-004 Porto, Portugal
e-mail: lmbg@ufp.edu.pt

R. C. S. Pereira
Educational Affairs Technician Fluminense Federal Institute—IFF, Estrada Dos Búzios, S/N, Cabo Frio, RJ, Brazil

M. A. P. Dinis
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: madinis@ufp.edu.pt

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Considering the impacts on marine biology in the city of Cabo Frio, de Almeida Schuindt et al. (2018) and de Oliveira et al. (2021) indicate that the Araruama Lagoon, with an area of 220 km^2, is one of the largest hypersaline lagoons in the world. SW is disposed into its banks, sewage and illegal effluents. To corroborate this information, the data provided by Instituto Brasil (ITB 2018) confirm this reality, by indicating that 40.3% of the population of Cabo Frio does not have access to sewage collection, which explains the current scenario that this situation entails, among other problems, damage to environmental and human health, with serious consequences for the marine ecosystem, reduction of the variety of aquatic species and even an increase in algae biomass (de Almeida et al. 2018; de Oliveira et al. 2021). The impacts of the inappropriate disposal of SW on the marine environment have consequences for the economy, marine biota and the social sphere.

In the social dimension, it is possible to perceive that the uptake of SW by marine animals, especially microplastics, has severe consequences on the food chain, threatening the food security of humans, Sustainable Development Goal (SDG) 2, when consuming contaminated fish and crustaceans (Sousa et al. 2019). These and other impacts suffered by the various social actors demonstrate the need for consolidated bases for critical environmental education, which involves individuals, the community, specialists, and the government itself (Bezerra and Iared 2019), reflecting the local socio-environmental problems (Guimarães 2016). Therefore, this chapter aims to identify the Brazilian students' perception of a High School Hosting course (HSH), about the damage to the marine environment and the proper disposal of SW, through the contents presented in the digital game *Caminhada Ecológica/Ecological Walk*, accessed via a mobile device. To achieve this goal, actions are needed to integrate the SDGs within issues involving waste management and its environment impact.

2 2030 Agenda—The Integration of the Sustainable Development Goals (SDGs)

The SDG integration actions aim to raise awareness concerning sustainable attitudes, proposed by the UNESCO Action Plan (UNESCO 2015) to implement the 2030 Agenda. Therefore, it is necessary to develop pedagogical actions (SDG 4) aimed to sensitize social actors in the protection of natural heritage (SDG 11.4) at local level, avoiding deforestation and beach pollution (SDG 14), thus integrating specific sustainable development objectives (CNM 2017).

Therefore, the digital game *Caminhada Ecológica/Ecological Walk*, available at https://play.google.com/store/apps/details?id=com.GSanchoDev.CaminhadaEcolgica, is a proposal for pedagogical action on the addressed issues. It is designed to high school students, and addresses specific SDGs, related to SW in beaches, and aims to stimulate interest and awareness among students about the

need difficulties of keeping the beaches clean. According to the 2030 Agenda (SDG 4.7), education should enable sustainable development (SD), while SDG 14.1 points to the need to reduce marine pollution in all directions, which is in line with SDG 8.9, aiming to promote sustainable tourism that stimulates knowledge of local culture and products (UNESCO 2015).

The National Curriculum Parameters (Brasil 1997; Brasil 2000) highlight the importance of developing significant environmental pedagogical actions, using information and communication technology (ICT) to sensitize citizens and lead them to reflect on the environmental problems in the community. This case refers to basic sanitation, to provide behavior, change, and thus act on the local and global reality. Pereira et al. (2020) indicate that mobile devices' use with environmental themes stimulates the focus and interaction between students searching for solutions to environmental issues.

3 Digital Games and Their Importance in the Learning Process

As emphasized by Vasconcellos et al. (2018), digital games promote the educators' attention to games, aimed at solving problems stimulating active environmental behaviors in students. To support the acquisition of knowledge, the dame authors emphasize that "gamification" is the dissemination of digital games to other fields of knowledge and not just for fun. Elements of digital games as points, medals, and rankings are adopted, thus increasing the user's interest. When developed based on reality context, the game additionally stimulates the senses and imagination and, therefore, can be applied to the teaching and learning process, adapted to the contents worked through the narrative constructions that can be performed by the students themselves or by the teacher (Hildebrand 2018). The scenario of the digital game *Caminhada Ecológica/Ecological Walk* takes place in a fictional Hotel in Cabo Frio, considering that the target audience for which the game was designed are students of a HSH Course. In the game's narrative, the hotel owner invites the player to participate in a campaign that rewards with punctuation and medals the most engaged in ecological practices. The player's mission is to collect as much SW as possible on the beach and dispose of it in the l containers appropriate to the waste type. If successful, it will reward the player. The context game was developed based on the local reality of Cabo Frio city. The contextualization makes the teaching–learning process viable by bringing theoretical concepts closer to the student's reality (da Silva and Bianco 2020). Accordingly, significant learning is developed, as it is related with the student's context inside and outside the school space.

4 Materials and Methods

The methodological procedures adopted in this study aim to offer the necessary guidelines for conducting social research in line with a specific area of knowledge (Prodanov & Freitas 2013). Therefore, the proposed strategies can guarantee the objectivity and precision in studying social facts (Gil 2008). The target audience of this investigation is 47 students, aged between 15 and 20 years old, enrolled in the HSH Course at the Federal Fluminense Institute of Campus Cabo Frio (FFI/CF). Student participation took place freely and spontaneously. It is essential to highlight that, due to the pandemic triggered by COVID-19 and the need to maintain social isolation within the 2020 classes, the year of application of this study, the application occurred remotely. However, the educational process throughout this period was carried out in a way that the link between students, teachers and other education professionals could be established, as suggested by Arruda (2020). The research participants were invited via WhatsApp by professors of the disciplines of biology, tourism and hospitality. The research is in full compliance with the objectives of the mentioned disciplines, with integrate principles of socioeconomic and environmental responsibility, the identification of practices that minimize the impacts on the environment, and the promotion of critical student awareness to develop sustainable tourism (PPC 2019). The resource used in this research is the digital game *Caminhada Ecológica/Ecological Walk* accessed via a mobile device, available on the Play Store platform for the Android system, developed by the first author. Google Forms, enabling the creation of forms and questionnaires, was used the disseminate the instrument. These digital resources are part of the Google Classroom platform, which is the most used for mediation of remote classes in times of COVID-19 (dos Santos Junior and da Silva Monteiro 2020).

This research was conducted in three stages:

Stage 1: *Convocation*. Contact was made with the students by the teachers of the course, through the WhatsApp application, for guidance and sharing of materials such as the game links and the Google Forms tool on the development of the activity phases. This application used in the educational context enables teaching and learning, as it is commonly used by people in general through the world (Martins and Gouveia 2019a, b).

Stage 2: *Guidelines*. Students were instructed to download and play the game *Caminhada Ecológica/Ecological Walk*.

Stage 3: *Survey*. Application of a questionnaire, through Google Forms, with five objective questions (**Q1** to **Q5**) using the Likert Scale, generally used for satisfaction research with questions that demonstrate the need to know the preferences and perceptions of users about social situations (Feijó et al. 2020) where the score ranges from 1 (strongly disagree), with values 2, 3 and 4 (intermediate) to 5 (strongly agree). As a result, five objective questions were presented. **Q1**: "Is it common to find SW on Cabo Frio's beaches, particularly in high season?", **Q2**: "Does the concept sensitize the player about the need and difficulties to keep the beach clean?", **Q3**: "Does the content show the importance of correct SW

disposal?", **Q4**: "Is the context of the "Government Campaign" rewarding the hotels most engaged in ecological practices related to the idea of tourism as a sustainable practice?", **Q5**: "Is the content relevant to the Hosting Course?".

Additionally, it is intended to know the students' opinion about two subjective questions. **Q6**: "How does *Caminhada Ecológica/Ecological Walk* contribute to learning the correct disposal of SW?" **Q7**: "How does the game contribute to sustainable thinking and care for the environment?".

5 Results and Discussion

Figure 1 represents the distribution of student responses for questions **Q1** to **Q5**, using the Likert scale 5 points, with variation from Totally Agree to Totally Disagree. The proportion of responses made it possible to verify the students' perception of the damage caused to the marine environment and the correct destination of SW through the contents presented in the digital game *Caminhada Ecológica/Ecological Walk*, accessed through a mobile device. On the *x*-axis are the number of participants and on the *y*-axis the percentage of responses (%).

For a better understanding, the content of the questions answered is described below:

Q1, "Is it common to find SW on Cabo Frio's beaches, particularly in high season?". **Q1** shows that the perception regarding the increase of SW faced by the city is unanimous on the part of the students. Cabo Frio experiences an exponential rise in SW, especially in the high season. Environmental education is therefore a strategy to raise awareness of behavior change (Pereira et al. 2018). This scenario is perceived across the entire Brazil. It is worth mentioning that, according to the panorama of the Brazilian Association of Public Cleaning and Special Waste Companies (ABRELPE 2020), Brazil registered an increase in SW production from 67 to 79 million tons per year between 2010 and 2019. This scenario requires great reflection on the form of high consumption is made in today's society.

Fig. 1 Answers to **Q1** until **Q5**, with more significant percentages

Q2, "Does the concept sensitize the player about the need and difficulties to keep the beach clean?" From the 95.47% of students who agree with **Q2**, it is possible to perceive that educational digital games are effective pedagogical proposals for the learning process within environmental education. Therefore, educational digital games and recreational activities enable interaction between students and expand their cognitive capacity (Costa et al. 2019).
Q3, "Does the content show the importance of correct SW disposal?", agree on the importance of the content presented in the game, and 3 responded that they are indifferent. This result reveals the need to develop pedagogical practices that can contextualize and critically analyze social relations and their economic and socio-environmental impacts to develop skills for greater awareness and socio-environmental ethics in both the local and global dimensions (Brasil 2017).
Q4, Is the context of the "Government Campaign" rewarding the hotels most engaged in ecological practices related to the idea of tourism as a sustainable practice?" 40 studants responded that they totally agree, 14 that agree, 3 replied that they are indifferent. The responses indicate how relevant it is to contextualize the content to the student's reality so that learning has meaning. As a result, the pedagogical process must use different forms of language and textual genres. Digital technologies can critically and reflectively produce student's knowledge and have a role in searching for solving social problems (Brasil 2017). Also, the use of the tools available by mobile digital technologies can expand and enrich educational opportunities through different languages to reach students in different environments (UNESCO 2014).
Q5, "Is the content relevant to the Hosting Course?". It is worth mentioning, as previously mentioned, that this research was applied to students enrolled in HSH, so this is a straightforward and specific question for these students. Thus, it was found that 37 participants responded that they totally agree, 9 that agree, and only 1 student replied to be indifferent. The agreement in the responses of the total 46 students indicates the importance of implementing policies that encourage sustainable tourism, mainly since the target audience of this research is students from the hospitality and leisure sector. Thus, pedagogical practices by SDGs 8.9 and 11.4 indicate that the development of sustainable tourism promotes the creation of jobs aimed at strengthening means to protect natural and historical heritage and local culture (UNESCO 2015).

Table 1 show the students' responses, whose purpose is to present their perceptions regarding the two subjective questions. Thus, when analyzing the students' observations, on **Q6**, " "How does *Caminhada Ecológica/Ecological Walk* contribute to learning the correct disposal of SW?" and **Q7**, "How does the game contribute to sustainable thinking and care for the environment?", iIt was noticed the importance of playfulness in the learning process (de Araújo and Gouveia 2020), which in the case of this research is through a digital game, aiming to arouse the student's interest in the correct destination of SW, and in the maintenance of the marine ecosystem through actions that have a positive impact on the environment.

Table 1 Participants' responses from **Q6** and **Q7**

Participant	Q6	Q7
1	Reinforces the idea of the importance of conscious SW disposal	The game warns about selective SW collection, the importance of sustainable tourism and the need to keep beaches always clean
2	Teaches the right containers for the disposal of each object and material	The game encourages to keep a clean beach and to properly dispose of each waste so that the sea does not take, so I believe that it encourages sustainable thinking and, perhaps, initiates a conversation about the great amount of waste in the sea and the environmental impacts that this brings for us and for future generations
3	The presentation of respective containers for each type of waste, leads us to remember the recycling that is often not carried out daily	The game leads us to think about our practices and their consequences for the environment. We consider this reflection as a steppingstone for attitude changes and a better relationship and care for the environment
4	The amount of waste shows that this task cannot be left to just one person (or group), it would be easier if everyone did a little	It helps by showing us that it is very simple and easy to dirty the streets, beaches and cities, but it is more difficult, sometimes and complicated to clean everything, and thus showing the importance of not dirtying or injuring the environment
5	During the phases of the game there is a color indication where each type of waste must be discarded	The accessibility of the game is an important factor for more people to learn in a fun way, creating this sustainable thinking not only discarding waste, but preserving the beaches, the environment and that sustainable tourism is possible
6	It contributes directly to remind people of the right colors of recyclable waste containers, encourages players to always dispose of their waste in the containers and not on the beaches and streets, among others	
7	It has an influence for people to learn in a simple way about the correct disposal of waste	
8	It significantly contributed to the insertion of technology in the classrooms, as the game encompasses this practice in a subtle and differentiated way	

(continued)

Table 1 (continued)

Participant	Q6	Q7
9	By identifying the colors of containers where each waste must be discarded depending on the material, which also occurs in real life	
10	The sum of these factors leads the player to reflect on his conduct through the disposal of waste	

Accordingly, the games' playful character provides a pleasant environment that enhances learning concepts that are not always perceived only in the face-to-face (f2f) expository classes (da Silva et al. 2019). Similarly, digital games developed as pedagogical resources stimulate learning, imagination, creativity, and cooperation, in addition to providing the user with appropriate and fun challenges to be overcome, motivating the learning of content, with clear objectives for achieving learning successfully (Farias and Hoed 2019; Skalee et al. 2017). Thus, the application of educational games enables the construction of learning beyond the classroom space, promoting critical thinking and care for the environment.

6 Conclusions

The inadequate disposal of SW in the oceans is a critical threat to the world's marine ecosystem, particularly in the Brazilian reality. Consequently, this chapter highlights the relevance of working with sustainable policies and practices in research that address the themes directed to the environment and health as corss-cutting issues applied to pedagogical practices. It does it in such a way that aligns with the student's background context and the objectives proposed by the student course to which it belongs, making learning meaningful.

To achieve the study's objective, dealing with the analysis of the perceptions of 47 students at the HSH, involving the damage to the marine environment, and SW disposal, the digital game *Caminhada Ecológica/Ecological Walk*, accessed via device mobile and available to Android in the Play Store, was used. The following pedagogical strategies were developed and applied to work with students, such as: (i) calling to participate in the activity via the WhatsApp application, as this work was all produced remotely due to the pandemic triggered by COVID-19; (ii) guidance, so that students could download and play the digital game *Caminhada Ecológica/Ecological Walk* and at the end, (iii) students had to fill out a questionnaire through Google Forms. 95.47% of the participants agreed that the concept worked in the game digital awakens the player for the need and difficulties to keep the beach clean and the importance of correct disposal of SW.

By the students' responses to the form, the influence of playfulness, mediated by the digital game *Caminhada Ecológica/Ecological Walk* developed by the first author, involving educational concepts and content, was noticed, arousing greater interest and motivation on the part of the students. The results thus demonstrate greater awareness and reflection by students on the issues surrounding SW and the safeguard of marine ecosystems in Brazil. They also demonstrate the ability of the mobile game tool to promote awareness towards environmental issues, throught digitalisation, an important tool within the sustainability field of knowledge.

Considering the students' more significant interest in learning educational content through digital play materials, it would be possible to develop other educational digital games involving different socio-environmental problems that significantly impact the social and tourist activities in the city of Cabo Frio, Brazil in future contributions. Accordingly, it will be possible to create pedagogical actions inside and outside the school universe that may involve the SDGs implemention within the context of 2030 Agenda.

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Regina Célia Soares Pereira professor at the Fluminense Federal Institute (IFF), Cabo Frio, RJ, Brazil, and a Ph.D. candidate in Information Sciences at University Fernando Pessoa (UFP), Porto, Portugal. Her research area is in Environmental Education involving active methodologies and digital games.

Luis Borges Gouveia Hab, Ph.D., M.Sc. and Full Professor at University Fernando Pessoa (UFP), Porto, Portugal. Researcher at CITCEM, University of Porto (UP), Digital Culture Group a R&D on Information Science. He is a Ph.D. advisor and coordinator of the PhD program in Information Sciences, at UFP, Porto, Portugal. His main interests are the digital transformation and the use and exploration of the digital to support human activity, namely its applications to teaching and learning.

Maria Alzira Pimenta Dinis Ph.D., M.Sc. and Associate Professor at University Fernando Pessoa (UFP), Porto, Portugal. Researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit, Porto, Portugal. Her specialised expertise includes CO_2 geological storage, Reservoir modelling, Environmental science, Environmental education, Environmental and Human Health, Waste management, Sustainability and others. Editorial Advisory Board Member in Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, Taylor & Francis, Editorial Board Member in Rudarsko-geološko-naftni zbornik (The Mining-Geological-Petroleum Engineering Bulletin), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Guest Editor in Sustainability, MDPI AG, Environmental Institutional Awareness in the Context of Sustainable Development and PUBLONS Academic Advisor. Author of numerous indexed publications, as well as experienced reviewer.

Designing Healthier Cities. An Empirical Study of the Ecosystem Functioning and Mortality in the Districts of Turin (Italy)

Stefano Salata

1 Introduction

Natural resources are increasingly affected by threats and pressures of climate change (Chelleri 2012; Lennon and Scott 2014; Pelling and Manuel-navarrete 2011). As a result, new emerging issues are becoming increasingly relevant for future urban planning. One of the most challenging problems for the future is how to increase the resilience of socioeconomic systems to adapt cities and territories to these new emerging conditions (IPCC 2014). Resilience is a typical slippery concept that includes adapting the socio-ecological and technological systems to internal stresses and external pressures and shocks (Brunetta et al. 2019; Brunetta and Salata 2019). The evaluation of resilience in urban areas is rooted in the empirical measurement of people's vulnerability, settlements, infrastructure, environment, holistically considered a unique interactive system with different degrees of relations among the parts (Maragno et al. 2021).

A growing body of literature analyses the positive associations between natural environments and citizens' health (Lelieveld et al. 2019; Phelan et al. 2015). The kind, quantity and decay of green and blue space in urban districts might be critical factors determining the quality of life, especially for less mobile populations, such as children and some older people. However, the empirical measurement of associations between greenspace and fundamental health indicators is at its infancy, particularly concerning the traditional spatial analysis and considerations regarding land-use decisions (Smith et al. 2017). Nonetheless, human health and the urban environment are at the base of adaptive resilience since socio-ecologic vulnerability is determined by the degree of intrinsic predisposition to being affected by damages by any event or shock.

S. Salata (✉)
Department of City and Regional Planning, Izmir Institute of Technology, IYTE Gülbahçe Kampüsü Urla, İzmir 35430, Turkey
e-mail: stefanosalata@iyte.edu.tr

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GIS metrics are not yet established, and methodologies to reveal associations between Quality of green and Quality of life are far from being reached. This constitutes a weakness in the current understanding of public health benefits derived from natural environments and Ecosystem Services (ES) provisioning (Crossman et al. 2009; Lafortezza et al. 2013).

The abovementioned problem can also be viewed at a planetary scale, since the relation between zoonoses, as in the case of Coronavirus and the quality of the environment, has been addressed by the main world intergovernmental organizations such as the World Health Organization, United Nations and the International Union for Conservation of Nature. Once the first outbreak has taken place, the World Health Organization reports of the late '90s demonstrated the relevance of their predictive capacity to clarify the high relationship between epidemiological crisis, environmental decay, and climate change. The phenomenon is associated with the contemporary unsustainable utilization and consumption of ecological resources (Brenner and Schmid 2015; United Nations-Department of Economic and Social Affairs-Population Division 2018). The same World Wide Fund for Nature in a recent document entitled "Communicable diseases and climate change" (https://www.wwf.it/cambiamenti_climatici_e_malattie_trasmissibili.cfm) demonstrated the major epidemics of recent years comes from animals who get in contact with humans due to the reduction of their natural wild habitat.

Moreover, great attention is posed to climate change induced by the increased quantity of carbon emissions, while it is clear that there are correlations between the presence of pollutants (especially air quality and the concentration/resuspension of fine and extra-fine atmospheric particulate matter on sealed surfaces) and virus transmission speed (Carvacho et al. 2004; Salata 2017). This relationship will make critical the Anthropocene phase, whereas large masses of people tend to concentrate in large and dense urban agglomerations (Brenner 2013; Brenner and Schmid 2015).

Therefore, a direct relationship between environmental emergency, climate change and socioeconomic crisis, and citizens' health condition in urban space is self-evident while requiring a new approach to the development of assessment and monitoring reports that supports the governance of urban areas.

It is evident is that spatial knowledge of the potential relations between the quality of the urban environment and the citizen's heath is too weak. Despite some North American and North European studies (Mercer et al. 2011; Miranda et al. 2015; Nowak et al. 2014), there isn't a systematic assessment of the ES performance of urban green areas and the potential relations with the mortality rates in urban districts (Madrigano et al. 2015).

Nevertheless, this relation is crucial since ES are defined as the direct or indirect benefits that the Natural Capital provides to humans, thus revealing their importance to the wellness and the health status of the urban environment. But are these properties of ES somehow measurable or empirically evident? Is there the possibility to map ES in a specific catchment and determine if the measured biophysical values are associated with particular diseases or mortality rates?

To answer this question, in this chapter, an analytical background has been established to furnish an empirical measure of the quality of ecosystem service of the public green areas in the city of Turin (Italy) while comparing the ES values with a selection of health indicators measured at the district level. Ecosystems are measured by Geographic Information System (GIS) mapping using the software Integrated Evaluation of Ecosystem Services and Tradeoff (InVEST), freely accessible at the Natural Capital online (Project made by Stanford University). At the same time, health indicators are taken from the report of mortality rates for cardiovascular and pulmonary diseases in the city of Turin provided in the ASL TO3 (Local Sanitary Agency n. 3 of Turin). Besides these datasets, even an analysis of the accessibility to public urban green areas has been employed to see if, and to what extent, the proximity (instead of the quality) of the urban green areas can be related to disease distribution.

The data are used to make a GIS spatial analysis of the cluster of high/low ecosystemic values, threats and green accessibility and their association with high/low mortality clusters in the urban catchment. While doing so, the ES dashboard already presented in the publication entitled "The utilization of Supervised Classification Sampling for Environmental Monitoring in Turin (Italy)" (Stefano Salata 2021) has been employed to set the environmental analytical background of this new study while verifying the relations between ecological status and health consequences. The Environmental Dashboard has been used to evaluate the health status of the public green areas in Turin, looking at how they are clustered in the city's territorial administrative boundary. Similarly, the Local Sanitary Agency data were employed to create a new digital map of the mortality rates while reaching two comparable datasets.

2 Method

For this study, it has been employed an ES approach combining a high-resolution spatial dataset of landcover to produce two ES maps and the sub-district division to combine fatality numbers due to cardiovascular and respiratory diseases. This allowed for a comprehensive characterization of a densely populated, sub-district related visualization.

Habitat Quality and Habitat Decay's maps were employed to discover spatial patterns along the city's sub-district sanitary zones while revealing the mutual relations between the number of deaths and the environment's quality.

A third element considered has been the accessibility to green public areas while accessing the Turin city's regulatory land-use zone layer and selecting all the urban public green spaces to measure their degree of concentration employing a Kernel Density.

The analytical workflow can be synthesized as follow:

1. Habitat Quality and Habitat Decay were mapped using the auto produced Land Use Land Cover by employing a Supervised Classification Sampling on a Sentinel image downloaded by Copernicus program on the 29th September 2020 using Esri ArcGIS (ver. 10.8). The image has been selected via Onda DIAS to L2A products (for this step, results of the work entitled "The utilization of Supervised Classification Sampling for Environmental Monitoring in Turin (Italy)" published in the Journal Sustainability, 2021, were used).
2. Download the report of mortality rates for cardiovascular and pulmonary diseases in Turin's city provided in the ASL TO3 (Local Sanitary Agency n. 3 of Turin) for each Local Sanitary District of the city (Sanitary District Authority 2006).
3. Creation of the Local Sanitary district's map. For this scope, an editing session has been opened while georeferencing the original raster image of the Sanitary Districts founded in the hard copy document of the ASL TO3 and designing its borders (see Fig. 1).
4. Analysis of the accessibility to green public spaces in the city of Turin. This operation has been conducted by selecting all the public green areas of the city's parcel-based land use plan. The selected futures were transformed from polygons to point and then a kernel density has been applied. Then, for each urban district, has been measured the degree of presence of urban green areas while assuming the density (and not the extension) as the parameter to observe. The more districts are barycentrically accessible to the centroids of green spaces, the more where considered well-located.
5. Utilization of the ArcGis zonal statistic tool to produce local statistics on average spatial distribution of each indicator in each urban sanitary district. The mapping outputs were then compared using an easy-to-understand comparative layout to discover spatial cauterization among the selected variables.

2.1 The City of Turin

The analysis has been carried on the city of Turin (northwest Italy) while using its administrative boundaries (see Fig. 2). The city is located on the Po Fluvial Valley's western side, at 240 m above sea level. It is the fourth most populated municipality in the Country (according to the national census, it is the fourth Italian city in terms of inhabitants): around 850 thousand citizens in an administrative area of 130 km^2 (ISTAT 2018).

The city is placed at the foot of the western pre-Alpine system, characterized by a heterogeneous morphology composed of the eastern hill and the south-western pre-alpine plain. The urban settlement is distributed in the Po fluvial valley's incision, which crosses the dense built-up system streaming from south to north while generating a vertical ecological corridor that connects the rural land and the

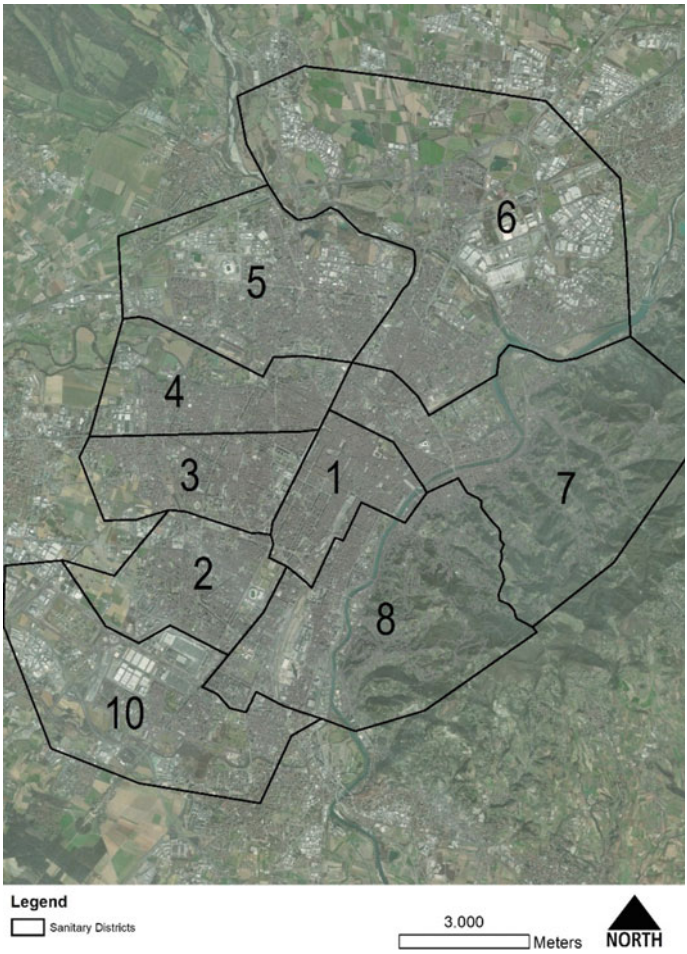

Fig. 1 Map of the local sanitary districts

adjacent fluvial valley. Agricultural land covers the most significant portion of the metropolitan area. Simultaneously, the eastern hill emerges from the city landscape and comprises mixed anthropic and semi-natural environment with a jeopardized forest environment highly accessible by local streets that serves luxurious residential units. Thus, human settlements have historically occupied the hill, therefore being considered the most exclusive and selective city's built-up environment.

Overall, the metropolitan built-up system is heterogeneous and goes toward Turin's central city to the semi-dense surrounding urban systems. Villages in the countryside are placed at a certain distance in the sub-urban region where it can be found an urban–rural continuum composed of small natural and semi-natural patches.

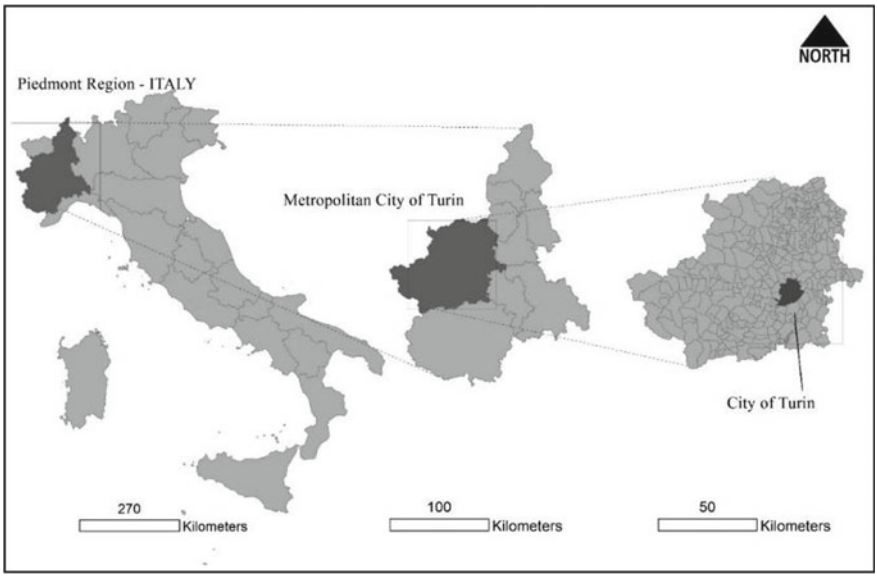

Fig. 2 The study area at various geographical scales

The Land Use Land Cover in the area of interest has been defined using a Supervised Classification Sampling method employing a cloud-free image by accessing ONDA-DIAS (Copernicus) dataset. The originally downloaded product consisted of a multispectral (12 bands) photo acquired on 28th September and characterized by a second-processing level with a total weight of 1.10 gigabytes. The footprint covered an area that spans between the following geodetic points: 7.74888294664043 44.1585153096049, 9.12207449093611 44.1653012748966, 9.12416639718779 45.153769755991, 7.72745034166859 45.1467471878356, 7.74888294664043 44.1585153096049.

The classification of land use takes several steps and has been made while clipping the composite band image with the administrative boundary of the City of Turin; then applying the "Image Classification" tool with ESRI ArcGis (ver 10.8.1) and drawing different ground samples by the "training sample manager". Eight land use land cover classes were detected by 71 sampling features:

- Urban (6 samples);
- Industry/High impermeable urban layers (4 samples);
- Streets (5 Samples);
- Barren Land (6 Samples);
- Grassland (4 Samples);
- Agricultural Land (26 Samples);
- Natural Land (5 Samples);
- Water (15 Samples).

Land classification for agricultural purposes takes several passages since the automatic classification for these elements required multiple interactions between different samples to avoid conflicts between similar land covers.

2.2 *Habitat Quality and Habitat Decay*

As already mentioned, Habitat Quality has been mapped by InVEST (Nelson et al. 2011; Stefano Salata et al. 2020; Sharps et al. 2017) while employing the auto produced Land Use Land Cover Classification. Habitat Quality is a primary indicator that gives a picture of one of the fundamental supporting ES category (Maes et al. 2016; Mononen et al. 2016; Roy and Potschin 2013; ten Brink et al. 2009). The Habitat Quality Index (which is a relative index ranging from 0 to 1 in the area of interest) represents a proxy of the overall environmental condition of the context; therefore, it is considered a status of the environment's health.

The inputs of the model are four: a raster image with the Land Use Land Cover classification, a raster image of Habitat Threats, the table of threats which assign a weight to each identified threat and a sensitivity table for each Land Use (see Tables 1 and 2) to the selected threats.

The model's output consists of two rasters: the quality and the decay and of habitats in the area of interest (see Fig. 3) represented from red to green colours.

Table 1 Table of threats

Threat	max_dist	Weight	Decay
Motorways	1.50	0.90	Exponential
Primary roads	1	0.70	Exponential
Secondary roads	0.90	0.60	Exponential
District roads	1	0.70	Exponential

Table 2 Table of sensitivity

Lulc	Name	Habitat	L_motorway	L_principal	L_secondary	L_urban
7	Urban	0.05	0.8	0.6	0.4	0
4	Industry	0.02	0.2	0.1	0	0
6	Streets	0	0	0	0	0
2	Barren	0.5	0.9	0.8	0.6	0
1	Agriculture	0.40	0.8	0.7	0.5	0.6
3	Grassland	0.60	0.9	0.8	0.6	0.6
5	Natural	0.9	0.9	0.9	0.7	0.8
8	Water	1	0.10	0.9	0.6	0.8

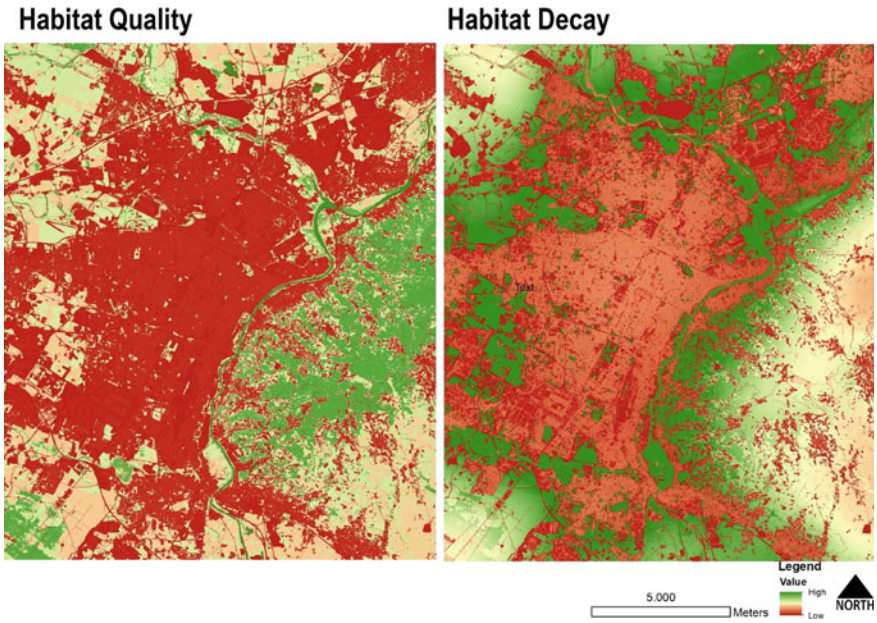

Fig. 3 Habitat quality and habitat decay in Turin. In the left figure, red areas are all those who perform low ecosystem value, while green is those that perform well. On the right figure, red sites display a higher decay and green that indicate a low decline

2.3 Accessibility to Urban Green Areas

The map of green accessibility to urban green areas is hereafter reported (Fig. 4).

The map has been designed using the Kernel Density function. The dark blue areas present a higher relative number of the public green urban feature using the point centroid as the evaluation source. Concentrations are clustered along the densest (not extended) and diffuse urban public facilities in the city. The map also reveals that there are uncovered zones, meaning that the distribution of public green areas in unequally spread in the urban catchment.

2.4 Mortality Rates for Cardiovascular and Respiratory Diseases

The map below represents the average mortality rate for cardiovascular and pulmonary diseases in the city of Turin provided in the ASL TO3 (Local Sanitary Agency n. 3 of Turin). Yellow to Read colours indicate the concentration of higher rates if compared to the average value in the same sanitary district, while "cold"

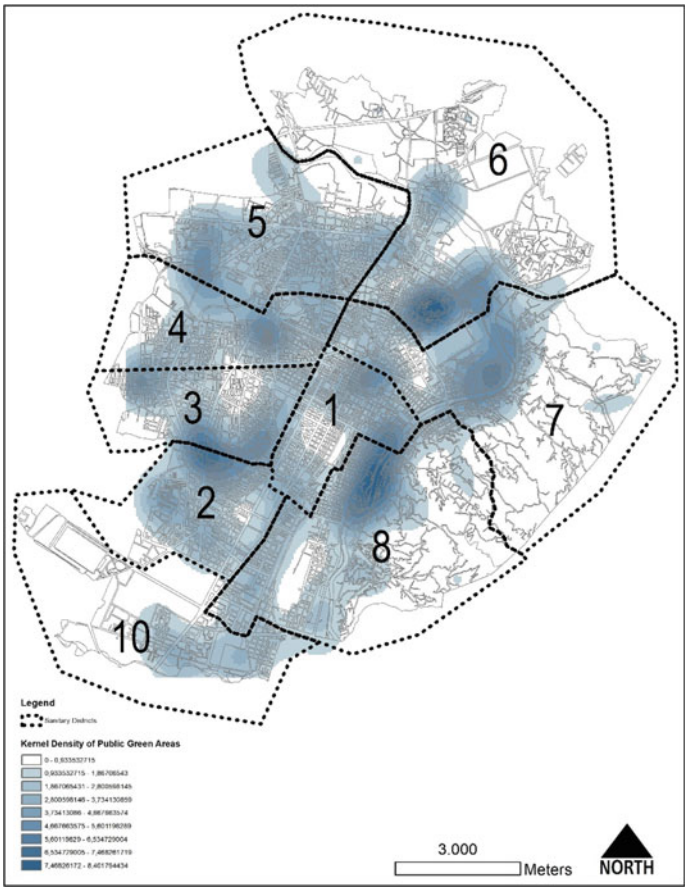

Fig. 4 Accessibility to public urban green areas

colours from light blue to dark blue indicates a district concentration below the average (Fig. 5).

3 Results

All the abovementioned spatial layers were analyzed through a comparative visual level to obtain a direct understanding of potential overlaps or asymmetries among the different indicators. The basic assumption is that mortality rates can be checked against some basic indicators such as the presence or absence of a good environmental condition (Habitat Quality), the presence or absence of threats in the environment that generates noise, pollution and generally decay the quality of the

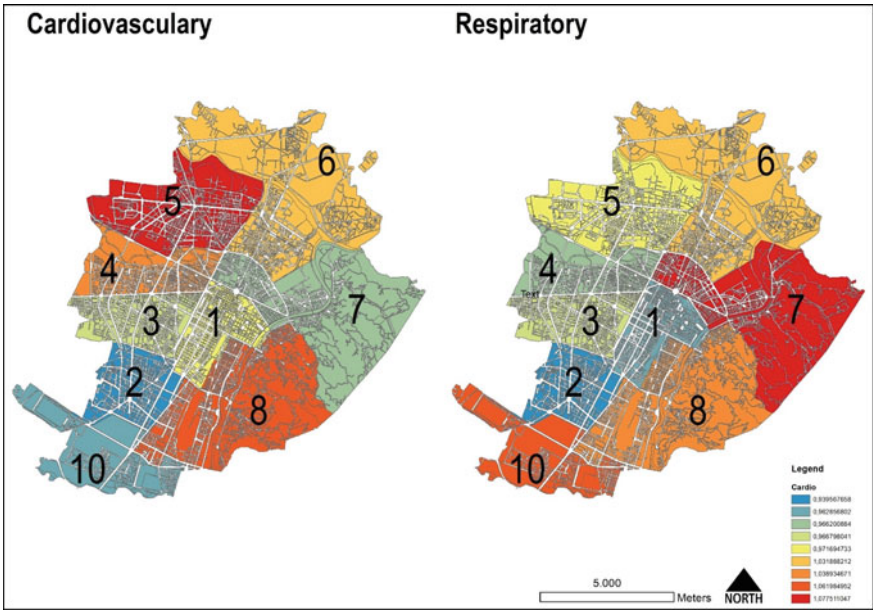

Fig. 5 Distribution of cardiovascular and respiratory death rates in the sanitary districts of Turin

space and, therefore, the human's wellbeing (Habitat Decay) and, finally, the degree of proximity with public urban green spaces while considering that the more green urban areas are equally distributed, the more citizens will have the same opportunity to benefit by their tangible and intangible services, do sports, recreational and outdoor activities while enjoying a healthy lifestyle.

The latter layer has been added since there is no visible relationship between the overall habitat quality and the public accessibility to green space: citizen's that lives in a healthy neighbourhood can have limited access to public green facilities and therefore don't receive any benefits directly from them, especially in large metropolitan areas.

3.1 Habitat Quality and Decay

Higher values of Habitat Quality are mainly concentrated in the eastern part of the city, as expected, along the Po River (which constitutes the major green corridor of the city), and along with some districts that benefit from the water stream tributaries to the Po river, such as (from south to north) the Sangone, the Dora and the Stura. These natural elements have historically conditioned the city's development around big urban parks (Pellerina and Colletta) that provide a suitable habitat quality. The clusters of low quality are concentrated in the western part.

From a higher-scale perspective, the city and its surroundings constitute a strong ecological barrier between the Alpine system and the eastern hills, which hosts a degree of naturalness while supporting ES. Moreover, the plain riverbank of Po is heavily anthropized from north and south, still an agro-ecosystem with intensive farming is present in the periurban land. Here, the ecosystemic functioning is confined to narrow strips or connection areas between the urban environment and the adjacent protected zones such as the Regional Parks of the Superga hill.

Ecosystem connectivity is reduced in core areas through a few internal connections; these define some green corridors where the multifunctional ES delivering capacity is identified. Overall, the city of Turin suffers from poor permeability and the scarcity of urban green features. Some West-Est core ecological corridors connect through a narrow strip of the Dora River and its adjacent green spaces composed by Parco della Pellerina, Parco Dora, Aurora district and Giardini Reali.

Nevertheless, Habitat Degradation displays a different pattern since the indicator reveals how much the hill and the Rivers Sangone, Dora and Stura are affected by anthropic threats; thus, this indicator reveals the disturbance of natural features by human-made elements. As expected, the hill, the Po river banks and all the urban areas that contain huge natural elements suffer of high decay due to the urban surrounding system.

3.2 Accessibility to Green Areas

The layer of accessibility to green public urban spaces is highly clustered in the eastern border, meaning that even if the hill and the north and southern parts of the city has an abundant presence of open spaces and parks, these Sanitary Districts suffers from low accessibility to public green features because of a more decentralized settlement system and a less diffused presence of urban green publicly accessible green facilities.

3.3 Mortality Rates

Higher Cardiovascular mortality rates are clustered in the northwest and southeast zones, while Respiratory mortality is clustered in the city's eastern border.

To get an overall picture of how the abovementioned analytical layers can be interpreted, an easy-to-comprehend comparative visualization has been designed to check how, and if, a relation between the different variables can be found (see Figs. 6 and 7).

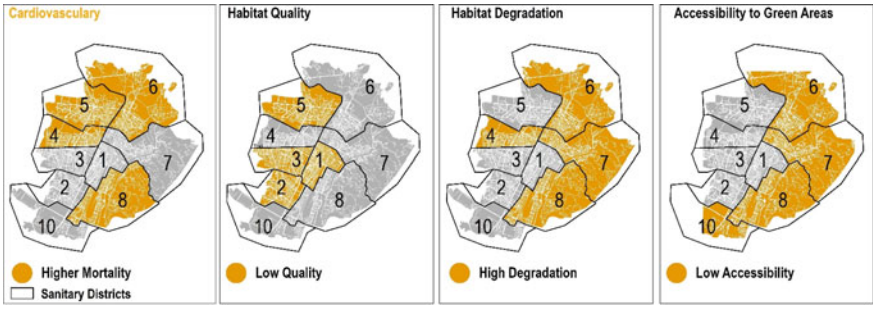

Fig. 6 Cardiovascular mortality against other layers in the sanitary districts of Turin

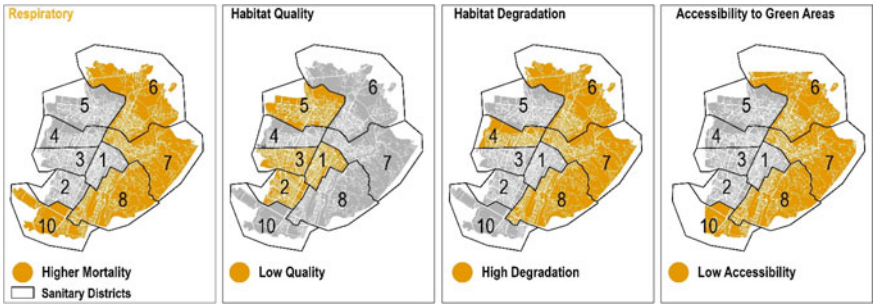

Fig. 7 Respiratory mortality against other layers in the sanitary districts of Turin

3.4 General Results

The first empirical visual result is that the mortality trend, in both cases, seems to be related much more with the Habitat Decay instead of its Quality. This first assumption is important because the Habitat Decay indicator relates to vegetation and permeable areas with structural anthropic threats such as the urban features and the streets. The more habitat is disturbed, the more humans are exposed to sources of threats too. Therefore, decay can also approximate humans' exposure to sources of pollution and noise that affect wellbeing.

This empirical evidence contradicts the more expected result of considering the overall quality of habitats an effective driver of mortality, while this preliminary study seems to demonstrate the opposite.

To what concern the Respiratory diseases, the low relation between mortality and Habitat Quality is clear, since all these areas with a poor Habitat Quality did not appear on the map of mortality. On the other hand, several areas with a high Decay of the Habitat are among the ones that register higher mortality.

For Cardiovascular diseases, this relation with Habitat Decay is less evident but still present. Despite zone 7 (northern hill), all the other Sanitary Districts that are

highly threatened by Habitat decay are experiencing higher mortality, too, while indicating the direct relation between the spatial cauterization of the two indicators.

On the other hand, accessibility seems to be the dominant parameter for mortality by Respiratory Diseases. In that case, the spatial cluster matches perfectly, meaning that all those areas that suffer from low accessibility to urban public green space are the ones that are affected by high mortality for pulmonary/respiratory problems.

These results confirm that living in a natural sound but the less accessible environment of a medium-dense urban area (such as the Turin hill) where public green spaces are not diffused and equally distributed can affect citizens' health and wellbeing. In other words, a naturally-sound environment with a diffused private green is not a sufficient condition to guarantee the health of citizens if these areas suffer from a high spread of settlement that threatens the environment. Turin hill is a typical case where respiratory diseases' mortality is higher than in the low-land city.

The hypothesis suggests that it is better to guarantee a public, diffuse and spread number of green areas instead of building the typical monofunctional neighbourhoods in a naturally-sound environment. Citizens are much more prone to use public spaces if they are close to home, accessible and enjoyable by a few travel distance. They are less dependent on cars and less stressed by travelling distance. Therefore, even if less permeable, the dense ancient city guarantees capillary and efficient accessibility to urban green futures, making the difference in the distribution of Respiratory mortality rates. Even unexpected, this result seems to confirm that the compact urban settlement system is healthier than the low-rise type, even if the habitat quality is lower. This implies that other kinds of dynamics directly influence the mortality rates in urban areas, for example, the stress, the lifestyle, the travelling distance to the workplaces, and other living factors. Nevertheless, this result confirms these factors are more related to the Decay of Habitats instead of their quality, and on the distribution of public green accessible areas instead of a lovely surrounding green (but inaccessible) environment.

4 Discussion

Many studies investigate the influence of ES on health; nonetheless, it is difficult to define the exact relationship between the habitat quality and the quantification of the benefits derived. In the Sustainable Food Trust's report The Hidden Cost of UK Food, published in 2017, the loss of biodiversity accounts for 10% of the UK food system's hidden costs. The estimate is based on a study conducted by the European Commission's Directorate-General for Environment, which stated that biodiversity loss amounted to €50 (£44) billion in 2000 across the EU (Meisner et al. 2015). Similarly, an article in the International Union for Conservation of Nature (IUCN) entitled Biodiversity: The costs of inaction (2015) states that "Europe's biodiversity is in rapid decline and our ecosystems are being consistently degraded. A quarter of European species are currently threatened with extinction due to habitat loss, urban

expansion, agriculture and climate change, according to the European Red List of Threatened Species drawn up by the International Union for Conservation of Nature, and the trend is accelerating at an alarming rate. Economists estimate the loss of biodiversity in Europe costs the EU around 3% of GDP per year and global biodiversity loss is valued at around €50 bn.

Estimates vary considerably, leading to scepticism about how this kind of information helps realistically achieve genuine awareness on this issue. Nonetheless, it is easy to demonstrate the relationship between ES provision and the effect of its degradation on health in a specific area of study. Modelling ES helps provide this kind of assessment and is directly dependent on providing a land use transformation scenario.

Land-use changes should be adequately monitored through the procedures that form urban planning projects and programs that affect the composition of the landscape. Conserving biodiversity in the urban environment, make it equally accessible and in good condition is not an environmental issue, it is social and economic.

A study published by a restricted international research group in the European Health Journal entitled Cardiovascular disease burden from ambient air pollution in Europe reassessed using novel hazard ration functions (Lelieveld et al. 2019) explains that atmospheric pollution is responsible for 120 additional deaths per 100,000 people worldwide and 130 other deaths per 100,000 people in Europe. In this study, the estimate in absolute terms states that in 2015, excess pollution in the air caused 8.8 million deaths globally and almost 800,000 in Europe. These figures are double estimates made in previous research.

This empirical downscaled research has demonstrated something more: that it is not a sufficient condition for citizens' health to provide conservation and valorization measures of big sub-urban green hotspots if the dense urban built-up settlement of the city is not capillary accessible to urban green features. Even if it is well-known that big suburban green features play a dominant role in regulating various ecosystem services and maintaining the overall Habitat Quality, human's health is more determined by other parameters, such as the accessibility, the quality and the distribution of public green areas in the city.

While stating these final discursive remarks, it has to be considered that this study has several limits since the mortality rates come from a single detection year instead of a temporal detection series; therefore, they did not indicate a trend. Even the Sanitary Districts are too few to make a proper relationship between human exposure to environmental threats and health conditions.

Nevertheless, this first tentative wants to underly publish mortality data with higher frequency and open-up a new systematic investigation on the ES provision changes and the quality of life. To what concerns the first, the monitoring of the environmental conditions is nowadays ready to be employed in ordinary research: land use data are available with high temporal frequency. On the other hand, the data on different diseases remains less accessible, limiting the research in this field.

5 Conclusions

The influence of urban green infrastructures on population health is mediated by greenspace form, quantity, accessibility, and vegetation health. People in urban neighbourhoods are disproportionately healthy if their neighbourhoods contain accessible, good quality public greenspace. This has implications for strategies to decrease health effects and define international initiatives, such as the World Health Organization's Age-Friendly Cities programme. Public, accessible green space should be capillary present in urban areas, even where the environment's natural condition seems to be overall high.

In this study, the relation between fatalities caused by Cardiovascular and Respiratory diseases was measured at the sanitary district level while employing the most recent and updated data on the supporting ecosystem characterization of the urban environment in Turin (Italy).

The findings demonstrate a less predictable trend of higher mortality associated with Habitat Decay and Public Green Accessibility. This first empirical research wants to demonstrate that the scientific knowledge of the cause-effect mechanism between land uses and citizen's health and wellbeing is far from being achieved. More research is needed in this field, and an accurate district-level measurement should be employed systematically to see if and how the environmental condition of the built-up system affects the quality of life.

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Stefano Salata Born in Grado (GO) 1983, is Ph.D. in Territorial Government and Urban Design XXVI Cycle at the Department of Architecture and Urban Studies (DAStU), Politecnico di Milano. He is Assistant Professor in ecological planning and the Izmir Institute of Technology. He has been a Research Technologist of the Interuniversity Department of Regional and Urban Studies and Planning, Politecnico di Torino and worked on the project LIFE SAM4CP for the same Department. He worked at the intersection of ecosystem service assessment and urban planning, and his actual research focuses the examination of how increase the sustainability and resilience of urban systems in the face of climate change. His interests concern both the theory and practice of urban and territorial planning. He is a member of Ecosystem Service Partnership (ESP) and a member of National Research Centre on Land Take—ITALY (CRCS). Co-editor of Italian National Reports on land take (2010, 2012, 2014, 2016, 2017 and 2018) of CRCS and author of many empirical research on scientific international journals.

Sustainable Solutions in Urban Health: Transdisciplinary Directions in Urban Planning for Global Public Health

Agnieszka Olszewska-Guizzo, Anna Fogel, Diana Benjumea, and Nazwa Tahsin

1 Introduction

Modern urban planning concepts, having emerged from industrial cities in the nineteenth century, are heavily linked to addressing the deterioration of public health. At the time urban reforms for public health surrounded issues of water, sanitation, and air quality. Initially, public health concerns were mostly focused on physical health aspects, but in the late twentieth century, the discourse on mental health and spatial order gained momentum, observed even today as cities have evolved into more populous and technologically-dependent spaces. At the same time, a rising concern for planetary health and global environmental justice for

A. Olszewska-Guizzo (✉)
Institute for Health Innovation and Technology (iHealthtech), MD6, 14 Medical Drive, Singapore 117599, Singapore
e-mail: a.o.guizzo@neurolandscape.org

A. Olszewska-Guizzo · D. Benjumea · N. Tahsin
NeuroLandscape, ul.Suwalska 8/78, 03-252 Warsaw, Poland
e-mail: d.benjumea@neurolandscape.org

A. Fogel
Singapore Institute for Clinical Sciences, Agency for Science, Technology and Research, 12 Science Drive 2, Tahir Foundation Building #12, Singapore 117549, Singapore
e-mail: anna_fogel@sics.a-star.edu.sg

D. Benjumea
Centre for University Core, College of Lifelong and Experiential Learning, Singapore University of Social Sciences, 463 Clementi Rd, Singapore 599494, Singapore

N. Tahsin
Institute of Water and Flood Management (IWFM), Bangladesh University of Engineering and Technology (BUET), Dhaka 1000, Bangladesh
e-mail: n.tahsin@neurolandscape.org

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existing and future generations popularized the concept of sustainability (Stephen 2013; Verbeek 2014), which has gained widespread attention since the publication of "Our Common Future" in 1987 (Brundtland et al. 1987). Sustainability, alongside environmental and public health, in terms of both mental and physical well-being, have since been percolating in the theories and practice of urban planning.

In the last three decades, there has been an emerging interest specifically in the causal influence of urbanization on public health, which has given rise to the concept of *Urban Health* with the number of scientific publications growing exponentially since the beginning of the twentieth century (Fig. 1). More recently, Urban Health research has begun to integrate with environmental sustainability studies for evident links between human health and the environment. We are now witnessing a rise of Urban Health and sustainability studies (Fig. 2). Scientific research has defined the many links between various environmental characteristics and the mental/physical health of individuals and communities. Emerging evidence also suggests that we can counteract negative health effects through nature-based solutions. Urban Green Spaces (UGS) could potentially be one of the most powerful tools to foster Urban Health. This is an emerging transdisciplinary and policy-relevant area, with the goal to inform planning and design of greener and healthier cities, through connecting planning and design disciplines, urban/environmental studies with public health, and the biomedical and social sciences.

Over half of the world's population (54%) lives in cities, half of which is now located in Asia. This number is increasing nearly 2% annually (Gatzweiler 2020). The new urban agenda published by UN Habitat in 2020 suggested that virtually all future growth of the world's population will be absorbed by urban areas (Fig. 3, (UN 2020b)). Therefore, the value of Urban Health studies to ensure sustainable planetary and public health and to promote holistic urban planning is significant worldwide. The most rapid growth rate of urbanization is seen in the Global South, where urban primacy of the major cities compared to small and medium ones is a growing challenge. More than two billion urban dwellers are expected to be added over the next three decades, a significant proportion of whom will be living in informal or slum settlements of the Global South, which raises issues of economic development and the climate crisis. It is therefore crucial to ensure sustainable planning practices for the Urban Health of these regions.

In this chapter, we provide a comprehensive review of emerging trends in Urban Health and wellbeing connected with nature-based solutions in cities or UGS, in the context of the widely understood sustainability. Importantly, we evaluate the examples of successful strategies based on case-studies from around the globe and set them within the conceptual frame of the *Harmonious Ecosystem for Sustainable Solutions in Urban Health* (Fig. 4). We further provide directions for relevant agents to improve the health ecosystem with sustainable solutions.

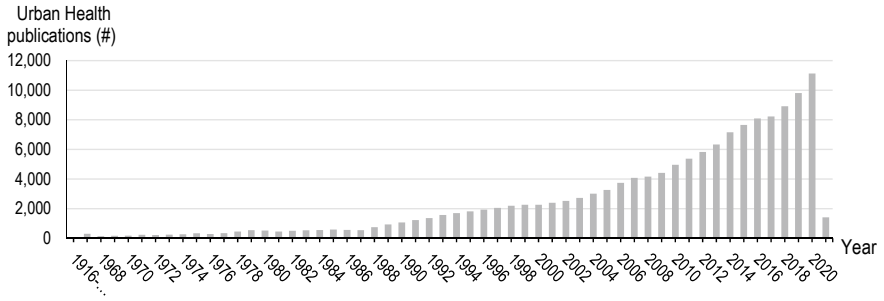

Fig. 1 Number of scientific publications on Urban Health since the first study in 1916 to January 2021 (PubMed search 01.02.2021), demonstrating an exponential annual increase over time

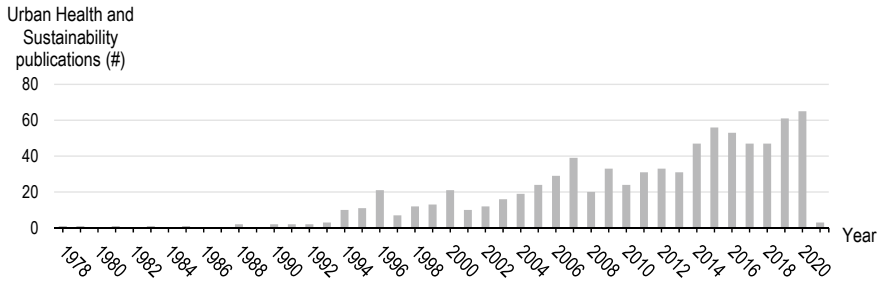

Fig. 2 Number of scientific publications on Urban Health and Sustainability since the first study in 1978 to January 2021 (PubMed search 01.02.2021), demonstrating fast growth since the first publication

2 Urban Health

2.1 Mental Health

Broadly speaking, living in cities is bad for mental health. This is a scientific consensus, which researchers have demonstrated through multiple mixed-design studies, including meta-analyses (Gruebner et al. 2017; Peen et al. 2010). Living in cities is associated with a considerably higher risk of developing almost all mental disorders and higher disease severity compared to living in rural areas.

Considering the associations between mental health and urbanization around the globe, the results are quite consistent. Studies in Latin America and Asia have confirmed higher rates of mental health diseases, like schizophrenia or paranoias, and anxiety disorders, including post-traumatic stress disorder, in urban populations compared to their rural counterparts (Phillips et al. 2009; Prina et al. 2011). Mood disorders, such as depression, and addictive disorders, like substance addictions, were observed in cities more than rural areas in Europe (Achab et al. 2011; Jacobi et al. 2014). Further, international epidemiological studies have demonstrated the

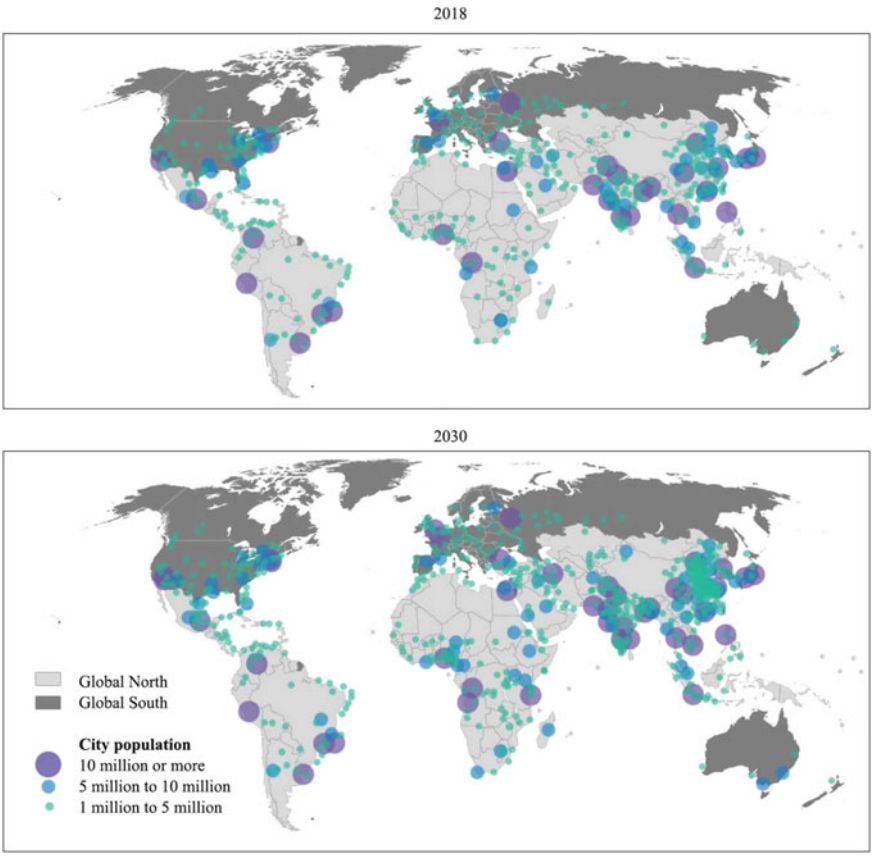

Fig. 3 Global urbanization in 2018 and projection for 2030, adapted from (UN 2018)

dose-response relationship between risk of mental illness and exposure to urban environments: the more time spent in an urban environment as a child—the higher risk of schizophrenia as an adult (Pedersen and Mortensen 2001; Van Os et al. 2010). An extensive, recent study comprising of over 900,000 participants pointed specifically to the degree of proximity to green spaces in the urban areas and development of psychiatric disorders from adolescence to adulthood (Engemann et al. 2019). The findings showed that the association between relative risk of developing *any* psychiatric disorder (borderline type, personality disorders, anorexia nervosa, other eating disorders, obsessive-compulsive disorder, neurotic and stress-related disorders, depressive disorders, bipolar disorders, mood disorders, schizophrenia and schizoaffective disorders, substance abuse) was higher among those who grew up further away from green spaces. Furthermore, rural living was found to be protective against the development of many psychiatric disorders.

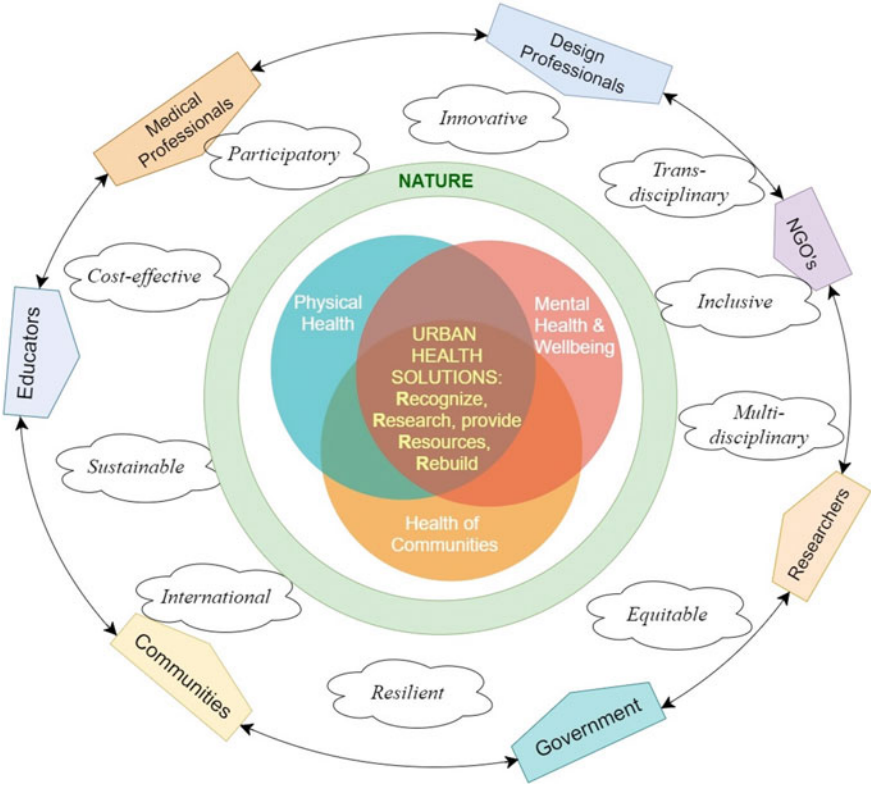

Fig. 4 Harmonious Ecosystem for Sustainable Solutions in Urban Health – a Conceptual Framework

The most commonly identified potential causes are attributed to social isolation, inequality, as well as poverty and ethnical segregation in certain neighborhoods. Therefore, the higher risk of mental illness is broadly correlated with lower socio-economic status (SES), which has a cascade effect on many environmental exposures. However, correlation is not causation, so it was problematic to prove that these issues were caused specifically by poverty. Clearly, mental health disorders in cities are not reserved only to the lower SES groups—depression and anxiety, substance abuse, schizophrenia, eating disorders and dementias are observed across all income brackets (contributing to a wide group of diseases of affluence or so called *affluenza*). This suggests that more complex mechanisms are driving these negative phenomena and a bulk of them point at the quality and specificity of the urban built environment.

There are several hypotheses and theories, but the exact mechanisms and their links with the built environment remain largely unexplored. Nevertheless, it seems plausible that the environmental factors may be effect modifiers between inborn predispositions and disease outcomes. This indicates that if suboptimal

environmental factors can speed up disease progression among those predisposed, they may also, if amended, protect against disease development. One of the potential mechanisms explaining the impact of city environments on mental health has to do with increased stress caused by pollutants and noise. For example, living close to road traffic can disturb sleeping patterns and cause more irritability and aggression, which fuel mood and anxiety disorders. Another sensory mechanism processing can be linked with the visual stimulation. A typical contemporary urban environment is filled with static and dynamic, mostly abstract built-up elements tied up with a complex web of infrastructure. Maximizing the density of information through a variety of forms, colors, textures can then lead to overload of sensory stimulation. Processing all of this information by the brain, for example in the process of wayfinding, may be challenging and in effect lead to depleted cognitive resources and mental fatigue, which can further promote mood and anxiety disorders. One key characteristic of urban space is the large-scale, high density of elements (e.g. buildings, pieces of infrastructure) all fitted onto limited plots of land. Smaller individual space, as well as shortened visual outreach, can create a sort of psychological strain. This is why landscape architects and environmental psychologists value long-distance views for giving a sense of comfort, relaxation for strained eyes, reorientation from the urban life and even contributing to a sense of personal freedom (Skalski 2007).

Another complementary hypothesis links the increased prevalence of mental diseases in the cities to a disconnection from nature. Contemporary urban spaces are comprised of forms based on Euclidean geometry, but these forms do not come from nature. In fact, it is very difficult, if not impossible, to find a perfect circle or a straight line in nature. Nature, on the other hand, is plentiful with amorphic and asymmetrical forms, with its own geometry (fractals, Fibonacci sequence). Some researchers and philosophers argue that the heavy exposure to abstract forms, multiplied in cities by modern architecture, may cause an additional strain on our nervous system (Skolimowski 1988). At the same time, the exposure to natural elements does not cause such a strain and can even mitigate the strain caused by the city structures.

For thousands of years, humans have been living and evolving in rural communities with a very close proximity to nature, and only for a few hundred years have we been adapting to urban spaces. Evolutionarily speaking, we are not used to the compact environments of big cities or crowds exceeding tribal dimensions of 150–200 people and, arguably, we may be still living through a phase of adaptation. Mental health is the likely cost of this adaptation to a relatively rapid environmental change. The idea behind Urban Health planning is that while properties of urban environments can cause mental health problems, they can also be used for the mental health promotion of well-being, or the prevention of psychological illness. Quite recently, scientists and professionals from various disciplines have started joining forces and expertise to uncover the mechanisms to mitigate the psychological strain or mental health promotion through urban space planning and design. In effect, many new disciplines have emerged such as *Neuroarchitecture, Environmental Neuroscience,* and *Evidence-based design*.

After years of eradicating the city greenery to allow for infrastructure development, it became clear that introducing nature into the city life is one of the most powerful tools to mitigate the negative mental health outcomes we experience from living in the cities, not only through the reduction of noise, pollution and urban heat, but also through the provision of contact with nature linked to sensory and attention restoration. Urban parks, forests and gardens, green roofs, pocket parks and restored riverbanks form the green infrastructure of the city, as opposed to the *grey* infrastructure of the built environment. Their contribution to humans was initially summarized within the ecosystem services approach, according to which, all green spaces directly or indirectly serve us through providing resources, supporting natural cycles, regulating the damage caused by human activity and providing aesthetic, educational and recreational values. For example, an important *Provisioning* ecosystem service is generating fresh produce for communities that can be grown in allotment gardens. An example of a *Supporting* service is allowing rainwater to infiltrate to the ground (instead of the sewage) and join the natural water cycling. An example of a *Regulating* ecosystem service is sequestration of carbon dioxide from polluted air, and an example of a *Cultural* ecosystem service is recreation—allowing people to bike in the urban forest. Nonetheless, in the light of recent developments, the provision of mental health and well-being by urban natural ecosystems has become a key aspect of health promotion in urban spaces.

UGS, with their specific types and forms, can be the main and most importantly sustainable tool for mental health and well-being promotion in urban areas. Promoting universal access to UGS, especially for persons with physical or mental disabilities, or non-clinical populations with high stress exposure is also strictly aligned with the Sustainable Development Goal 11.7 and 11.3.[1] Moreover, the newly emerging research and practice of investigation and incorporation of ecosystem and biodiversity values into the urban fabric acts as a medium to connect all stakeholders participating in urban planning and development processes. This transdisciplinary approach can balance the economic and social inequality (Sustainable Development Goal 15.9[2]) with the provision of high-quality salutogenic UGS.

2.2 Physical Health

The impact of urbanization on physical health is complex. On the one hand, the positive influence that rapid urbanization has had on the increase and ease of access

[1] SDG 11.7—Provide universal access to safe, inclusive and accessible, green and public spaces, in particular for women and children, older persons and persons with disabilities; SDG 11.3—enhance inclusive and sustainable urbanization and capacity for participatory, integrated and sustainable human settlement planning and management in all countries.

[2] SDG 15.9—Integrate ecosystems and biodiversity values into national and local planning, development processes and poverty reduction strategies, and accounts.

to healthcare, running water, better sanitation, and nutrition cannot be denied. Unfortunately, at the same time, we have observed a dramatic increase in the prevalence and severity of diseases attributable to urbanization, which disproportionately affect the lower SES groups and are predicted to further increase over the next decades in the absence of bold and dramatic urban planning changes.

Urbanization has most profoundly impacted the rise in chronic respiratory diseases, such as chronic obstructive pulmonary disease, asthma and pulmonary hypertension, which are responsible for three million deaths annually (6% of all deaths) and significantly reduce quality of life (Godfrey and Julien 2005). Urbanization has also caused an increase in other non-communicable diseases (i.e. diseases that are not transmittable from person to person) such as metabolic and cardio-vascular diseases (e.g. obesity, hypertension and type 2 diabetes (Cyril et al. 2013)), which are the most common causes of premature mortality worldwide, certain types of cancer (e.g. lung cancer, colorectal cancer (Monroe et al. 1992)), auto-immune and allergic diseases (e.g. eczema, asthma (Schram et al. 2010)), and the speed of spread and prevalence of infectious diseases (SARS, MERS or most recently Covid-19 (Alirol et al. 2011)). Importantly, urbanization has brought diseases typically associated with the Global North to the Global South. For example, the speed of progression of non-communicable diseases like obesity or diabetes in the Global South is currently very alarming (Goryakin et al. 2017) and is larger than in the Global North. This is thought to be mediated by the stages of economic development (Angkurawaranon et al. 2014). Similarly, while the Global North eradicated infectious diseases as one of the leading causes of death, infectious diseases, like respiratory infections and diarrheal diseases, are still a leading cause of death in the Global South (Neiderud 2015). Rapid urbanization in the Global South is considered to further increase this problem and is a serious cause for concern.

While we can clearly establish the negative effects that urbanization has had on health, it is more difficult to identify *why* that is. There are a few potential explanations of why urbanization contributes to the development of ill health, but most of them have a common root cause, which is the reduction of green spaces in the human living environment. Both in the Global North and the Global South, as our cities grew larger, the natural ecosystems in the cities were shrinking. This reduction had a cascade effect on the range of disease-promoting factors. UGS reduce temperature and noise, increase exposure to diverse vegetation, improve air quality, and promote mild and moderate-to-vigorous physical activity. Consequently, the loss of the UGS and biodiversity in cities leads to increased concentrations of air pollutant levels and allergens, and decreased exposure to diverse environmental microbiomes, causing the so-called 'dysbiotic drift' (Prescott et al. 2018). With higher concentrations of allergens and pollutants, we have observed the rise in the prevalence and severity of respiratory diseases and lung cancer (Hemminki and Pershagen 1994). This is more predominant in the Global South than the Global North, and developing Asia accounts for two-thirds of the global burden (Cohen et al. 2005). At the same time, lower exposure to diverse vegetation in the UGS is considered a strong risk factor for auto-immune disorders

and allergic disease, which are particularly prevalent in urban populations compared to rural ones. These disorders can be observed as early as in the first 12 months of life and track to adulthood (Botha et al. 2019).

As the cities grew bigger and the UGS reduced in size, we removed natural walking paths and increased reliance on public transportation systems, which inherently discourage walking and promote more sedentary lifestyles. The growth of road networks without walkable paths and lack of the UGS with recreational areas, as well as the long distances to reach the UGS, which are often un-walkable, are both a physical and psychological barrier to physical activity. On the one hand, we have little physical access to the UGS. On the other hand, the motivation to overcome those physical barriers decreases, not only because of the effort required, but also because of time limitations, particularly among the lower SES groups, who are more likely to have physically demanding jobs and less motivation for leisure physical exercise. Furthermore, due to lower pedestrian access to grocery shops, we have seen a rise in the so called 'food deserts', which are areas within city centers with poor access to healthy foods and fresh produce. Food deserts are predominantly present in the areas inhabited by low-income earners and are a causal factor contributing to both malnutrition and obesity. Historically, food deserts have mainly been associated with urban areas in the Global North and less is known about them in the Global South.

Low levels of everyday physical activity and reduced access to fresh produce are a major factor in the development of cardio-vascular and metabolic diseases like obesity and heart disease, sarcopenia and colorectal cancer, which were once considered diseases of advanced age, but in the modern world already demonstrate in early childhood. Loss of the natural environmental protection from heat and noise provided by the UGS is a further discouraging factor for spending time outdoors, particularly during the hot seasons in moderate climates, and throughout the year in tropical and subtropical climates. This is particularly prevalent in the so-called "heat islands", urban areas significantly warmer compared to their surroundings as a direct result of human activity, which impact the health of all animals including humans and have an active influence on meteorological conditions like rainfall, wind, and even season duration.

Furthermore, high noise pollution in urbanized areas has obvious detrimental effects on hearing and mental health, and some less obvious secondary effects on disease promoting factors. For example, excessive urban noise can lead to sleep problems, migraines, and physiological effects resulting from stress and hormonal changes that promote cardio-vascular disease. These problems may be worse in the Urban South, where there are often no laws and regulations on noise pollution that most, if not all, countries in the Global North have introduced.

Finally, urbanization increases rates of contact and the mobility of dwellers, both within and outside the cities, thus promoting the speed of the spread of pathogens. For this reason, infections have the potential to spread rapidly, which poses epidemiological risks. This has been particularly evident during the recent Covid-19 pandemic, where 90% of all infections were in urban areas (UN 2020a), or earlier examples of SARS and MERS in Asia, or frequent Ebola outbreaks in Africa,

which are quickly contained in rural areas and difficult to control in urban areas (Okware et al. 2015).

There are two important questions in the field of Urban Health that remain unanswered. First, *can* cities be made more healthy places? And second, *how* to sustainably improve Urban Health in both the resource-rich Urban North and the resource-poor Urban South countries? In recent years we have seen multiple longitudinal and epidemiological studies highlighting the positive impact of proximity to UGS on mental and physical health. For example, higher proximity to UGS predicts lower rates of cardio-vascular diseases (Seo et al. 2019), lower odds of occurrence and remission, better prognosis for the prevention of cancer (bladder, breast and lung (Porcherie et al. 2021)), and lower rates of respiratory diseases and allergies (Tischer et al. 2017). One of reasons for the lower prevalence of diseases close to UGS is increased physical activity that promotes better health and increased microbial colonization of one's microbiome, which improves immunity and hence mobilizes the body's fighting mechanisms against pathogens and mutations. Intuitively, we might therefore expect that creating more UGS, even if they are small, will improve the health of urban populations. Surprisingly, research evidence from clinical trials demonstrating this causal mechanism is still scarce (a PubMed search of the term "urban green spaces randomized clinical trial" returned 12 results), highlighting the need for methodologically-sound, randomized clinical trials showing clear evidence that creating more UGS will improve the health of urban populations. This direction is necessary to address the Sustainable Development Goals 3, 9, 11,[3] and importantly, it would also reduce health disparities between the rich and the poor, thus addressing goal 10. It is nevertheless encouraging that in recent years it has been recognized that cities *should* in fact be healthier, and there has been a concentrated effort to improve the healthfulness of cities. While we have evidence for sustainable solutions for Urban Health, their effectiveness is yet to be determined.

2.3 Health of Communities

While mental and physical health consider the individual, the idea of the health of communities considers inclusion and active contribution of the least advantaged populations in the formulation and design of the urban space. A collective vision of health and wellbeing promotes accessible UGS, which can be shaped and shared by all citizens and introduces a harmonious relationship between humans, the urban space, and nature. This relationship is forged through the exchange of ideas and actions of the communities to build and modify their own local urban environment.

[3] SGD 3—Ensure healthy lives and promote well-being for all at all ages; SDG 9—Industrial, innovation and infrastructure; SDG 11—Make cities and human settlements inclusive, safe, resilient, and sustainable.

In the process, the community structures are strengthened creating subjective feelings of territorial belonging, sense of place, social cohesion, and sense of community (Christens 2012b). In fact, these feelings of mutual support have been found to foster collective actions on a larger scale demonstrated in self-organizing social movements and manifestations through place-based strategies in their local UGS (Escobar 2004). In this case, communities begin to transform the UGS, introducing opportunities for bottom-up community gardening and farming.

The participation of communities in the making of cities is not a new concept (Jacobs 2016). In fact, important advances have been made to introduce new sustainable agendas, such as the SDG, which aim to tackle inequality and poverty through participatory governance and inclusive urban spaces (SDGs 1, 10, 11[4]). Nevertheless, a major threat to these initiatives in both the Global North and South, are the confounding political agendas introduced by neoliberal urbanism, which is an urbanism subordinated by capital that seeks for higher positions in the global urban network through the development of mega infrastructures (Vives Miró 2011). The problem with these developments is that communities are not included in the process and are often displaced as they settled in the areas destined for (re)development. In developing countries, there are extreme cases in which low-income communities are neglected participation and are dispossessed from their settlements to give place to urban development. One example can be found in the slums in Bangladesh, settlements that for the last decades have been consolidating due to rural to urban migration. It is estimated that nearly 90% of the slums are in government lands and 70% of them are tenants (Razzaque et al. 2019). Although the life conditions in the slums are scarce and extreme, they are often settled illegally in prime areas of the city, making them vulnerable to evictions as the occupied land is planned for new constructions (Fig. 5).

This phenomenon, also known as urban gentrification, has gained importance in the last decades among scholars and non-governmental organizations. For instance, in developed countries, disadvantaged or lower income communities are often exposed to urban gentrification when urban mega projects take place in their neighborhoods. In this case, the area(s) are destined for (re)development to attract higher income populations, which cause a form of exodus of the communities to remote areas in the cities. The place-connection, community ties, and local business are lost during this process. Additional negative impacts of neoliberal urbanization manifest in social problems such as social isolation, polarization, intolerance, and exclusion towards different sectors of society (i.e., religion, race) as commonly seen in developed countries. While these problems are intrinsically linked to the driving forces of development (i.e., globalization) and its political and financial structures, the most affected are urban residents caught in a continuum of rapid changes in their social patterns and cultural rhythms (Friedmann 2007). The frenetic lifestyles and

[4] SDG 1—End poverty in all its forms everywhere; SDG 10—Reduce inequality within and among countries; SDG 11- Make cities and human settlements inclusive, safe, resilient, and sustainable.

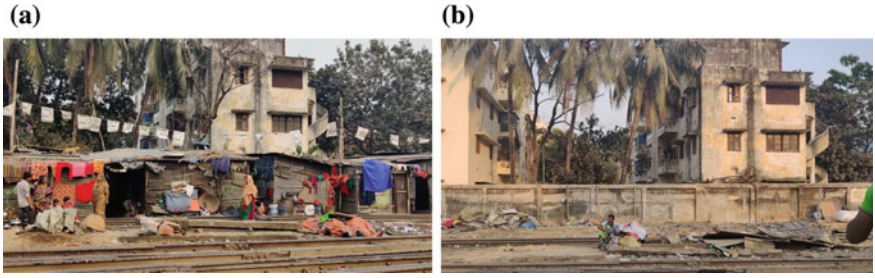

Fig. 5 Tjagon slum **a** before and **b** after eviction. Dhaka, December 2019 and March 2021 (Photos by Nazwa Tahsin, private archives)

lack of familiarity causes the detachment of people from the process of creating place, meaning, sense of belonging, and community bonding in the urban space, hence less tolerance, reciprocity, and social capital. This, according to scholars has created a sense of 'placelessness' altering the urban realm into a 'network of power and disempowerment' (Friedmann 2010), in which the participation of the collective in the transformations of the urban environment is negligible.

In the Global South, land dispossession is owed to gentrification and/or climate change. Thousands of low-income, land-dispossessed communities unable to secure land settle in high-risk areas prone to geological and anthropogenic disasters. The lack of adequate infrastructure, water, sanitation, overcrowding, environmental pollution, financial instability, and lack of access to UGS severely compromises the mental health and well-being of these populations, giving rise to dysfunctional social behaviors such as extreme violence. Under these extreme social and environmental conditions, the ill health and poor wellbeing of low-income communities is exacerbated. Nevertheless, although the physical and psychological burden that low-income communities face has been recognized, there has been little improvement in policy making that integrate mental health programs in low-income communities in the Global South (Patel et al. 2016).

Recent studies have reported the collective efforts taken by communities to prevent the negative impacts of neoliberal urbanization. These social movements have diversified from integrating discourses of social justice to expose cases of environmental injustices in both Global North and South countries. There are three types of environmental injustices as discussed by Schlosberg (2009): distributive (how goods are unevenly distributed), procedural (groups have equal access to decision-making), and lack of recognition (discrimination of groups due to race or identity). Clearly these typologies reveal the complexity of the multi-scalar relationships that create the venues for environmental injustice in a specific location (Debbané and Keil 2004). In the Global South, several cases have exposed the inequitable and unfair actions of the state that prioritize the interest of the higher socio-economic classes over vulnerable low-income communities. One example is the flood-control infrastructure (i.e., flood walls, dikes) built to increase infrastructural resilience in Thailand—the control systems were carefully developed to

protect urban centers and industrial states. Nevertheless, the location of these floodwalls created uneven exposure to floods imperiling the low-income communities located on the peripheries (Marks 2016). Interestingly, these injustices, also promoted civic mobilizations of low-income communities. In a way it can be said that when few sectors perpetrate injustices over the most vulnerable, in turn, these injustices create platforms of civic contestation against inequality. These contestations have been supported by international policies and regulations, especially in European countries dedicated to fund projects that help reduce the inequalities caused by industrial environmental degradation. Although, it is possible that the positive tangible effects of these policies will only be visible in several generations, as years of injustice cannot be wiped out in a single decade.

In the first type of environmental injustice (distributive) is also found the inequitable access to UGS and ecosystem services of marginalized social groups. This issue has been widely discussed by scholars, who have concluded that access to UGS is often stratified based on income, ethno-racial characteristic, gender, and age (Wolch et al. 2014). Similarly, it has been highly discussed how this form of environmental injustice can increase health disparities of low-income neighborhoods (Jennings et al. 2019). Although the clearest solution is to increase access to UGS in marginalized or low-income neighborhoods, the interventions should be carefully planned and designed to avoid introducing green or ecological gentrification when new UGS are built. Recent studies have found that UGS projects that have a political agenda of sustainability have a potential to be inequitable, as the land price speculation increases, as well as the property value and communities become dispossessed of their assets (Anguelovski 2016). One example is the representative mega green-infrastructure plan (Green Belt) developed in low-income neighborhoods in the city of Medellin, Colombia. The beautification of these neighborhoods through green infrastructure has resulted in the seizure of part of these territories to transform into touristic hubs for the more affluent (Anguelovski et al. 2019). This could affect the sense of ownership towards the green place, as well as the residents' social capital and activism (Fig. 6). Similar cases have been found in cities in developed countries (i.e., Portland, United States) (Anguelovski 2016).

Although increasing access to urban greening can have a significant positive effect on the individual's health and well-being as discussed previously, the questions of how, with who, and when to do it should be considered if green or ecological gentrification is to be avoided. To envision new forms of community health that promote agendas of inclusion, the communities should be collectively conscious and find the means for community organization and action to participate in the transformation of their local UGS. An example is found in the bottom-up nature community-based solutions created in existing UGS that integrate sustainable urban farming and gardening (Fig. 7). The participative character of these solutions fosters active engagement and direct contact with nature, which can directly benefit the mental health and well-being of the communities by preventing social isolation of the most vulnerable populations (i.e., elderly, disabled) and could provide social interaction and networks for migrants. Interestingly, after the outbreak of the Covid-19 pandemic, several of these community interventions were

Fig. 6 Jardin Circumvalar Campo Santo Park after the intervention of the government, Villatina Comuna 8, September 2017 (Photo by Diana Benjumea, private archives)

developed in existing UGS by communities in the Global North and South. Some scholars have argued that these interventions could become secondary support networks for the cities' UGS (Benjumea and Olszewska-Guizzo 2021; Krasny and Tidball 2012). However, the impact of community nature-based solutions expands beyond the physical improvement of the urban space. In fact, the biggest benefits have been recorded in the subjective psychological sense of wellbeing of the communities (Jennings and Bamkole 2019). These benefits are explained by the feelings of stewardship and control over their lives and proactive functions (Krasny and Tidball 2012) reinforced by community ties, economic opportunities (Hwang and Feng 2020; Michalski et al. 2020), generosity (Weinstein et al. 2009), community empowerment (Christens 2012a), and increased social capital (Jennings and Bamkole 2019). In short, community-based nature solutions provide evidence that mental health and equitable access to UGS is best achieved when the communities play an active role in the making and/or transformation of UGS.

3 Directions in Sustainable Urban Health

The issues of mental and physical health at the individual level, as well as the level of communities in the context of urbanicity, are being gradually recognized by institutions. Funders like the Rockefeller Foundation and the Wellcome Trust have oriented their programs towards systemic thinking, inherent in the idea of global health. The International Council for Science Programs, Future Earth, United Nations University's International Institute for Global Health have also embarked on the journey to establish systemic solutions to Urban Health issues (Siri 2016). Simultaneously, the European Commission with its *Green New Deal* agenda voices out the powerful message: "The solution is in nature" in its *Future Brief—Science for Environment* (EU 2021).

Fig. 7 Nature community-based solutions. Left: Ground-up Initiative, Singapore; Right: Medellin Comuna 4 Moravia (Photos by Diana Benjumea & Maleza, private archives)

Our *Harmonious Ecosystem for Sustainable Solutions in Urban Health* (Fig. 4) goes beyond conceptualization and provides directions for four specific actions to be taken in regards to the living environment to develop these solutions. We propose the directions for action to be focused on the 4Rs: Recognize, Research, provide Resources, and Rebuild. As long as all actors included in the conceptual frame can be involved in the process, we argue that the leaders of the positive change should be the researchers and policy makers. They shall be the mediums to convey the complex processes, building on the powerful driving forces of scientific curiosity and public service, or both. Below, we discuss the specific directions for researchers and policy-makers.

3.1 Researcher

The scientific community needs to formally recognize the impact of cities on physical, mental, and community health delivery as a new ecosystem service. This concept needs to be then addressed in **multidisciplinary** research initiatives (including epidemiologists, data scientists, bioinformaticians, architects, human geographers, among other specializations), which may well be a starting point for creating novel research areas. One of the potential causes of the slow adaptation of the Urban Health discipline to mainstream research could be methodological issues surrounding some of the earlier work in this field, and a lack of studies demonstrating causality. Namely, the majority of evidence is based on short-term observational studies. There is a profound lack of experimental evidence that would demonstrate causality, too few longitudinal population-based cohort studies that assess long-term impact, and too few translational randomized-control intervention trials in this field. Without such research, it is difficult to firstly convince policy-makers of the causal links between environmental factors and ecosystem health, and secondly, demonstrate with a strong probability that modifying certain environmental factors will have a measurable and clinically significant impact on

ecosystem health in the short and long term. It is also difficult to convince policy makers to direct, the often-limited, funds to (re)build the cities following the recommended advice.

Furthermore, the research needs to use sound methodologies with ample sample sizes and multi-disciplinary committees to ensure the highest scientific value and minimize the sources of bias to allow for replication in various contexts and across different climatic and social realms. At the same time, while widely replicable, the studies should also aim to establish the context and population-specific environmental determinants of health and well-being, for example, community gardens with specific features adapted to the local climates and area-specific populations. This may be challenging to achieve in resource-poor countries in the Global South, so to address this issue, research initiatives should foster **international** consortia to promote such context-specific adaptations for Urban Health solutions and should also provide funding for research and translational efforts in developing countries of the Global South, which have fewer resources for research efforts.

International, multi- and **transdisciplinary** collaboration is paramount to introducing Urban Health research as a mainstream solution for public health. Furthermore, improving the methodological quality and testing the efficacy of Urban Health solutions in intervention studies based in clinical settings will bring us closer to lobbying for Urban Health and self-care solutions to become complementary forms of treatment to classical and traditional pharmacological and lifestyle change solutions, recommended and prescribed by general practitioners. Based on the research to date, some of the most promising nature-based Urban Health solutions that require validation through intervention studies include passive and active exposure to certain types of landscapes (e.g. contemplative scenery, regular nature exposure for urban kids, park prescription programs, horticulture therapy sessions, among others). To this end, it is important for them to be **cost-effective** in the long term. To achieve this, we need to develop models to estimate the monetary public health value of these solutions to justify the return of investment and economical gains of protecting the natural environments in cities. While we might expect that the long-term public health value of sustainable Urban Health solutions will greatly outweigh the initial costs associated with (re)building our cities, there needs to be sufficient evidence from sources such as computational simulation studies to demonstrate feasibility. More financial support from the Global North and financial assistance from the international corporate structures, particularly those with prominent presence in the Global South (e.g. food and beverage companies, coffee traders) might be necessary to develop these solutions in the Global South.

3.2 Policy Makers

Policy making will mainly be informed by research efforts and approaching various SDGs in a synergistic manner, rather than each of the SDGs separately. Actions for

policy makers should focus on re-greening cities and promoting the **equitable** access to safe, green spaces in cities. This should focus on improving the proximity and walkability to UGS (e.g. less than 300 m walk to a green space from every household), as well as safety of the experience, such as lighting and maintenance, which are extremely important in poorer areas of the Global North and in the Global South. UGS should provide spaces for active and passive recreation (playgrounds, exercise areas, contemplative spaces (Olszewska et al. 2016)), additionally testing various **innovative** ideas, such as solutions to promote working in the UGS. These can include providing WiFi in the UGS, provisioning seating arrangements with tables and shelter from the atmospheric conditions. Importantly, we need policy makers to recognize the social inequalities in the delivery of ecosystem services and begin more rapid and dramatic transformation in the most vulnerable areas.

Inclusive and **participatory** approaches, such as engaging all age groups in the design and construction of the community garden, should be prioritized in order to enhance local community bonds and boost the sense of place stewardship. To this end, the idea of urban farming is by far the most promising through the provision of fresh produce (especially important when linked to food security issues), and the strengthening of community bonds and mental/physical health.

Besides working on the quality of the UGS, policy makers need to foster multi-stakeholder collaborations and invite experts and professionals, as well as communities, to the table. This **transdisciplinary** approach (e.g. consultations, social campaigns) may bring beneficial results in terms of more health awareness. Introducing Urban Health and sustainability concepts as integral components in basic school curriculum will additionally promote awareness from a young age. Again, the important caveat here is the need for stronger research evidence in order to introduce these concepts to the communities.

4 Conclusions

Environmental factors affect both mental and physical health and as such play an important role in the health of communities. On the one hand, poor access to the UGS in the cities has been linked to depression, anxiety, and a range of other psychiatric diseases, as well as poor respiratory, metabolic, and cardio-vascular outcomes. On the other hand, an emerging body of evidence suggests that we can use the built environment to build resilience against these diseases and potentially reverse them, thus improving the health of communities. Providing easy access to the UGS, especially designed to promote health and treat diseases across different contexts, may be a safe, cost-effective and, most importantly, sustainable solution to improve individual and community outcomes, while at the same time restoring the functional natural ecosystems in cities.

The goal is to design and implement innovative and sustainable Urban Health solutions to support the growth of resilient communities. In order to achieve this, there is a need for a concentrated and harmonious effort from multiple agents,

including researchers, NGOs, clinicians, educators, and, most importantly, policy makers. High quality, impactful translational intervention studies funded by local, national, and international institutions with involvement of private corporations will be required to develop and convince policy makers of the most optimal solutions for public health in both the Global North and South. This has to take into consideration the disparity between the Global North and South with the latter requiring greater initial funding.

The overarching directions that we propose for all the agents concerned with individual and community mental and physical health are summarized in Fig. 4, and center around the **4R**s:

- **R**ecognize that individual and community health is impacted by, and could potentially be improved by, the Sustainable Solutions in Urban Health
- Design methodologically sound translational **R**esearch studies that show evidence that individual and community health can be improved by the appropriate Sustainable Solutions in Urban Health
- Provide the **R**esources to implement Sustainable Solutions in Urban Health
- (**R**e)build the cities prioritizing the Sustainable Solutions in Urban Health, starting in the most vulnerable communities.

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Dr. Agnieszka Olszewska-Guizzo has a PhD in Landscape Architecture and Urban Ecology from the University of Porto (Portugal), and is a president and co-founder of NeuroLandscape NGO. She is interested in the relationship between the characteristics of the natural and built environment and the mental health and well-being of city dwellers and people suffering from mental disorders. She has applied psychophysiology tools, including neuroscience, to study changes in brain wave oscillations in people exposed to various types of landscapes. She introduced and operationalized the concept of Contemplative Landscapes and proposed a psychometric tool (Contemplative Landscape Model), which is a quantitative scale for assessing and classifying views, based on their potential mental health benefits through passive observation. In her work, she strives to implement scientific research into practical actions to promote mental health in cities.

Dr. Anna Fogel is an experienced clinical researcher with background in developmental psychology. Her research to date has largely focused on factors pertaining to healthy growth in childhood. She is examining how the environments in which children grow up and parental behaviours affect children's health and well-being. Dr Fogel is interested in designing and implementing intervention and prevention programmes aimed at improving parental and child mental and physical health to support healthy growth and help children achieve their full human potential.

Dr. Diana Benjumea is a Scientific Board member and Project leader in the research organization NeuroLandscape for the international research program titled: Planting Seeds of Empowerment: Actions to Promote Healthy Communities and teaches urban studies at the Singapore University of Social Sciences in Centre for University Core, College of Lifelong and Experiential Learning. She is an architect and holds a Ph.D. in Urban Studies and Social sciences from the University of Nottingham. For the last decade Diana has been engaged in practice and research projects in Asia and Latino America that aim to contribute to the health and well-being of communities. Her research integrate multi-disciplinary approaches that aim to create new models for promoting healthy urban environments and resilience through nature place-making. In her work Diana advocates to the implementation of participatory practices in urban and architectural design and planning that are supported by scientific research.

Nazwa Tahsin is a research fellow under the project "South Asian Water Leadership Program on Climate Change", a collaboration of IDRC and SaciWATERS, hosted by Institute of Water and Flood Management, Bangladesh University of Engineering and Technology in Dhaka. Besides that, she works with NeuroLandscape NGO under the program "Nature Connection & Mental Health of Communities". She is interested in climate refugees and environmental migrants, residential building codes and transportation behaviour. Both in professional and personal life, environment has always fascinated her. Besides research she loves to paint, read, and travel whenever possible!

We Know One Health, but We also Need One Communication

Teresa Letra Mateus, Paula Teixeira, and Rui Leandro Maia

1 Introduction

This chapter is structured as follows: introduction (1), review of concepts and state-of-the-art concerning One Health and Sustainable Development Goals (2), state-of-art, needs and gaps about Communication in One Health (3), the authors' own experiences and case studies that confirm the need of One Communication (4) in three different perspectives, food safety—the case of listeriosis (4.1), zoonoses—the case of hydatidosis (4.2) and environmental health—the case of vector-borne zoonoses and finally conclusions (5).

T. L. Mateus (✉)
CISAS—Centre for Research and Development in Agrifood Systems and Sustainability, Escola Superior Agrária, Instituto Politécnico de Viana do Castelo, Rua Escola Industrial e Comercial Nun'Álvares, 4900-347 Viana do Castelo, Portugal
e-mail: tlmateus@esa.ipvc.pt

T. L. Mateus
EpiUnit—Instituto de Saúde Pública da Universidade do Porto, Rua das Taipas, 135, 4050-091 Porto, Portugal

P. Teixeira
Universidade Católica Portuguesa, CBQF - Centro de Biotecnologia e Química Fina – Laboratório Associado, Escola Superior de Biotecnologia, Rua Diogo Botelho 1327, 4169-005 Porto, Portugal
e-mail: pcteixeira@porto.ucp.pt

R. L. Maia
UFP Energy, Environment and Health Research Unit (FP-ENAS), Universidade Fernando Pessoa, Praça 9 de Abril, 349, 4249-004 Porto, Portugal
e-mail: rlmaia@ufp.edu.pt

T. L. Mateus
Veterinary and Animal Research Centre (CECAV), UTAD, Quinta de Prados, 5000-801 Vila Real, Portugal

W. Leal Filho et al. (eds.), *Sustainable Policies and Practices in Energy, Environment and Health Research*, World Sustainability Series,
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The state-of-art has been made using PubMed to search for articles with keywords like "One Health", "Sustainable Development Goals", "Zoonosis" and "Health Communication". The cases presented and discussed were developed by the authors in the last ten years. The aim of the authors is to highlight some opportunities for One Communication in the context of food safety, zoonoses, and environmental health as well as the barriers perceived by them to the implementation of One Communication, taking into account the state-of-the-art and their own experience in recent projects and case studies.

2 One Health and Sustainable Development Goals

In the middle of the SARS-CoV2 pandemic, never in the twenty-first century has it been so relevant to talk about the importance of One Health, although its role has grown substantially in the last decade. That is evident when we look at the World Health Organization (WHO) disease outbreaks reported in the last two years, where the Middle East respiratory syndrome (MERS), Influenza virus (H5N1, H5N8, H3N2, H1N2), Rift Valley fever, Ebola virus, Dengue, and Yellow fever are constantly cited (WHO 2021). Humboldt-Dachroeden et al. (2020) noted that after 2016 the annual scientific production concerning One Health issues had increased notably in the aftermath of Ebola and Zika outbreaks, and hopefully, it also highlights the importance of the concept and the inevitability of One Health.

Recent global health initiatives of several organizations (WHO, World Organization for Animal Health [OIE], Global Health Security Agenda, among others) leverage this concept as well as the recent emergencies at the human-animal-environment interface (Behravesh 2019), triggered mainly by well-known phenomena such as the climate crisis, globalisation, urbanisation, deforestation, and intensification of agriculture. Yet, in 2018, the memorandum of understanding between the United Nations Food and Agriculture Organization (FAO), the OIE and the WHO described the rationale of the One Health approach as also achieving the Sustainable Development Goals (SDGs) (FAO, OIE, WHO 2018).

There are several concepts of One Health (AVMA [American Veterinary Medicine Association] 2021; CDC [Centers for Disease Control and Prevention] 2018; OHI [One Health Initiative] 2021; OIE 2021) designed in the specific context of each one of the organizations that has defined this concept. The definition adopted in this chapter is the one put forward by the One Health Commission (OHC) (OHC 2021): "*One Health is a collaborative, multisectoral and trans-disciplinary approach – working at local, regional, national and global levels – to achieve optimal health and well-being outcomes recognizing the interconnections between people, animals, plants and their shared environment*". The most important threats to be faced are zoonotic diseases, emerging infectious diseases, antimicrobial resistance, food safety, wildlife diseases, and social issues that also affect health, mostly poverty (Behravesh 2019). This fits into the SDGs, which include social development, the environment and economic improvement and are, therefore,

intrinsically linked to One Health—"healthy people living on a habitable planet". Thus, in both One Health and SDGs, the value of biodiversity and the sustainability of the planet ecosystems are taken into account for the survival of all living beings (Sleeman et al. 2019). In fact, the SDGs movements highlight the need to address the emerging threats in a multidisciplinary approach (Chatterjee et al. 2016).

It is important to ensure the existence of food, water, and a clean environment to achieve the desired global health (Gostin and Friedman 2015). The protein of animal sources like meat, dairy, eggs, and honey are important to feed the world (Behravesh 2019), but infectious diseases and mainly zoonoses represent critical threats to global health security (Salyer et al. 2017). In 2001, a highly cited publication (Taylor et al. 2001) estimated that 60% of all human pathogens are zoonotic and 75% of the emerging human infectious diseases are of animal origin. However, this is not such a new issue (Errecaborde et al. 2019). One Health is an approach that has been important for centuries (Behravesh 2019). Modern phylogenetic studies suggest the presence of rabies prior to the fifteenth century (Kuzmina et al. 2013). Moreover, some of the most important zoonoses around the world are also some of the oldest known to humans, like anthrax, brucellosis, echinococcosis, or leptospirosis (Salyer et al. 2017). Many of these diseases are neglected, however, they are also unpredictable and oftentimes underestimated. Most of them are also linked to poverty, as more impoverished communities usually face disease, low economic income, and loss of livelihood with environmental, animal, and human health consequences. The low- and middle-income countries, where poverty and disease have a symbiotic relationship, are the most affected by infectious diseases (Kakkar et al. 2019). Due to unplanned and unsustainable urban development in countries from the developing world, it is expected that these populations will be the most affected by the global burden of disease (WHO 2003). The correlation between the high burden of zoonotic diseases and poverty, especially when livestock is the most important source of income in a household, is strong (McDermott and Grace 2012). This link between poverty and emerging infectious diseases has also been evidenced by the 2014 outbreak of Ebola in Sierra Leone, which has one of the weakest health systems in the world (Shoman et al. 2017).

If we take into consideration that in 2020 only 68% and 39% of the world's population, respectively, had access to basic sanitation and safely managed sanitation (World Bank 2020), it becomes clear how a considerable part of the population is susceptible to disease. Kakkar et al. (2019) highlighted in their review with the same title, "the opportunities for One Health policies to reduce poverty" and this is due to be read. One Health goes beyond the biomedical approach and takes into account the eco-epidemiological as well as social, political and economic determinants (Kelly et al. 2017), and that is why it also provides a better understanding of solutions that fit locally, are feasible and realistic. With a One Health approach, the drivers of poverty in the human-animal-environmental interface would be better understood, thus enabling the development of targeted solutions to mitigate poverty (Kakkar et al. 2019). One Health synergies could be considered as 'shared responsibilities' in supporting global health security and the SDGs (Sinclair 2019), looking at SDGs not only as a vision but also as an inspiration for collaboration (Münter and Bojesen 2019).

3 Communication in One Health—Needs and Gaps

The sustainability of the One Health approach is achieved with good coordination, collaboration and communication across the sectors involved (Behravesh 2019; Kakkar et al. 2019; Sinclair 2019).

Coordination is essential for policy-making, strategic planning, resource allocation and the alignment across the different technical levels involved in One Health. Perhaps the biggest challenge is the political one. The political decisions concerning resource allocation for disease control priorities are influenced by economic arguments and evidence (Sinclair 2019). Nonetheless, Chatterjee et al. (2016) highlight a weakness: the unavailability of metrics to assess the impact of One Health policies in the field. Decision-makers need country-level data on One Health's impact to justify policy decisions and resource allocations (Sinclair 2019). Research published on multi-sectoral collaboration in health events rarely identifies the outcomes of the collaborative process (Errecaborde et al. 2019). Here lies an opportunity for academics to engage more with policy-makers in the context of One Health (Humboldt-Dachroeden et al. 2020).

There needs to be political will to support the robust engagement and sustainability of One Health as well as the SDGs (Behravesh 2019). But to achieve this, clarity and transparency are critical, because even if there are long-term improvements, implementation measures require a huge investment, coordination and collaboration among cross-cutting programmes and working groups (Sinclair 2019), which may be very challenging. Countries are not yet committed to providing the resources (structural, technical, human and others) needed as well as funding (Gostin and Friedman 2015). The United Nations have released an action plan to invest in the SDGs, expecting the private sector to help with funding (United Nations [UN] 2014), but Gostin and Friedman (2015) have made it clear that market incentives for private investment in global public goods are not common. To achieve global public goods, collective action is required. So, we face a clear lack of resources (Kakkar et al. 2019). With insufficient resources, it is too challenging to formalize multi-sectoral collaboration.

Indeed, there is a need to formalize collaboration and clearly outline the roles and responsibilities of all relevant sectors (Behravesh 2019). This is in line with Müntera and Bojesen (2019): One Health should not be only a concept for intellectual reflection, but instead needs to be formalized and co-created. This would allow mitigating the constraints in improving data sharing and channels for the exchange of information (Kakkar et al. 2019), namely between Ministries, which would improve surveillance and outbreak response capacity (Salyer et al. 2017). The One Health approach implies explicit collaboration (Errecaborde et al. 2019) and formal collaboration should foresee the creation of zoonotic-disease-specific working groups, improving the communication with the community and in turn reinforcing the One Health approach (Salyer et al. 2017). For this purpose, professional training programmes should be developed and implemented (Behravesh 2019).

One Health issues raise social, economic, ethical and legal issues that call for a holistic approach and systematic collaboration (Kakkar et al. 2019). There are several factors that support successful collaboration across three levels: individual, organizational and network factors. Global health requires multidisciplinary collaborative efforts (Errecaborde et al. 2019). However, historically studies have looked at human *or* animal disease, but not both (Chatterjee et al. 2016). An integrated study with humans and animals can decrease the time needed to obtain a correct diagnosis of zoonotic diseases, as in many cases, disease in animals precedes human infections (Kakkar et al. 2019). This was illustrated by Ebola (Rouquet et al. 2005), Rift Valley fever (Munyua et al. 2010) and the West Nile Virus (Eidson et al. 2005). The identification of animal cases of infection can be used to grow awareness, facilitate early diagnosis and prevent a zoonotic disease, saving lives and economic and social damage (Kakkar et al. 2019). In addition to saving more (animal and human) lives, an integrated approach reduces costs (Zinsstag et al. 2018). Enserink (2010) has stated that a human outbreak of Q-fever in The Netherlands could have been prevented if the veterinary and public health authorities had communicated with each other. This example highlights the need for real collaboration and communication across the human, animal and environmental health sectors (Sinclair 2019). The challenge is changing the mindset of healthcare providers since many lack awareness of the One Health concept (Kakkar et al. 2019). In any case, it is not just health professionals who need to shift the paradigm from biomedical and human health to a more holistic and integrated, multisectoral One Health approach (Kandel et al. 2017). Institutionalising One Health coordination, linking surveillance systems, sharing laboratory resources, including all the needed disciplines in epidemiology studies and conducting joint risk assessments (Sinclair 2019) may be a shift that will only take place throughout several generations.

Historically, One Health failed to include environmental health and wildlife stakeholders (Lebov et al. 2017; Khan et al. 2018; Sleeman et al. 2019; Humboldt-Dachroeden et al. 2020), but these are being seen as of increased importance and recognition partners and key players (Musoke et al. 2016; Behravesh 2019). Climate change leads to landscape changes and consequent modifications in vector, reservoir and pathogen lifecycles (Semenza and Suk 2017), so there is a need to look at health in social-ecological systems. Climate changes affect a large number of sectors, most obviously the natural environment and diseases (Zingsstag et al. 2018), but may also lead to an increase in social conflicts (Herrero et al. 2016). Moreover, natural disasters are more and more frequent and often lead people to have to leave their homes. Owners have to abandon their companion animals and livestock, thus affecting the owners' mental health and the animals' welfare. Solutions must be foreseen and these complex problems must be seen through a One Health approach (Behravesh 2019), as beyond medical support, there is a need for psychological and social support. This brings us to another neglected sector when a holistic approach is sought: the social and human sciences. The way people and animals live with each other is shaped by social norms, economic imperatives and human values (Kakkar et al. 2019), so a one-size-fits-all

approach does not work in every country/region (Behravesh 2019). For instance, antimicrobial resistance is a massive issue in developed countries, but antibiotics have saved and save millions of human and animal lives since they were first developed and are still essential in many parts of the world, namely the poorest (Behravesh 2019), so recommendations in this regard cannot be transversal and independent of the socio-economic circumstances and context of each country. In many communities, minor health problems in livestock strongly affect human food security and malnutrition (FAO 2011).

This also applies to health communication that should be more humanistic and give value to individual autonomy, since universally accepted best health practices do not exist (Werder 2019). Nonetheless, while medical/natural scientists often seem unaware of the need to collaborate with human/social scientists actively, the opposite also occurs. A bibliometric analysis performed by Humboldt-Dachroeden et al. (2020) found that One Health research is not present at all in monodisciplinary sciences like anthropological and political sciences, global governance, or public administration. Social and political science contributions can contribute to One Health institutionalisation, and combining quantitative and qualitative research with the aim of investigating in One Health is crucial. Thus, it is suggested that One Health initiatives should integrate mixed methods instead of only quantitative research due to the complexity of the issues at hand (Degeling and Rock 2020). An important finding in this regard relates to homophily, which occurs when individuals work in teams with other individuals similar to them (McPherson et al. 2001). Humboldt-Dachroeden et al. (2020) verified that there is an evident homophily among authors who published on One Health, even though homophily is in clear tension with the concept and transdisciplinary nature of One Health.

From the perspective of risk communication, there is also the urgent need to incorporate professionals from human, social and communication sciences. Risk is seen as being interrelated with the sociocultural context (Smith 2006), so risk management and communication have to include not just the threat itself but also how people perceive and respond to it (Abrams and Greenhawt 2020). Risk communication needs to explain the risk, reach the target group and lead to behavior change (Ueland 2019). Frewer et al. (2016) assert that this is remarkably difficult. Werder (2019) has stated that the effectiveness of health communication is related to the sharing of meaning between communicators. Werder cites George Bernard Shaw as saying: “The greatest problem in communication is the illusion that it has been accomplished”. It is more than the message and the channels that determine whether or not knowledge leads to behavior change. Resistance may be the result of a lack of motivation (Werder 2019).

In a study carried out in Madagascar on effective forms of communication to fight tuberculosis, it was found that there were differences in understanding according to the population profiles (such as rural-urban, male-female or modern-traditional) and, therefore, there was often the need to use additional channels, with little or no cost, such as indigenous healers (Bello-Bravo 2020). Cultural infrastructures are particularly important in the dissemination and transmission of messages with potential behavior modifiers, which, otherwise, would not

reach diffuse populations and users of their own dialects, demonstrating the importance of combining roles and functions between health professionals and actors with special needs and ability to promote social mediation (Osborn 2020). In another study, the messages about the risks of smoking produced positive effects concerning the cessation of smoking in the case of pregnant women in comparison with other participants: there seemed to be a greater awareness of the risks of smoking for mothers and babies (Klein et al. 2020).

The effectiveness of the message, in health or in any other area, is dependent on the profiles of the recipients and on mechanisms that, in specific situations, allow for the "internalization of externalities". For this reason, broadcasters must be concerned with transmitting content well, so that they reach all people in the same way, whatever their cultural, educational or socio-economic condition. As Bourdieu asserted, we need to be aware that language has to be accessible and appealing for everyone to reach their goals (Bourdieu 1998).

One should understand the kind of resistance strategies that people use to be able to improve the good delivery of health messages (Rains and Turner 2007). To obtain a behavior change, consumers need to perceive the risk information to be relevant for themselves (Ueland 2019). So, a bottom-up approach may be appropriate, that is, creating knowledge about citizen's concerns, risk perceptions, needs and motivations (Cope et al. 2010), instead of a one-direction message from experts to citizens.

Communication, whatever it may be, imposes a kind of informal contract in which, although the words are not innocuous, a "world" of possible interpretations is present. It always comprises a delimitation and structuring of reality: it is made of inclusions and exclusions and sometimes implies one among several possible categorizations of the object, the receiver being responsible for interpreting and capturing understandings and premonitions (explicit or implicit) of the messages. Communication can thus delimit or exclude understandings of reality that depend on the people targeted, on their profiles, which form disparate senses and emotions, impossible to fully control, much less when marked by specific, technical and scientific language.

Saussure (1978) has explained that what characterizes a sign, a word, is its value, which is not defined substantively, but through the web of possible relationships in a constellation of meanings. The word 'time' does not have the same value in different languages. The Portuguese word time encompasses the chronological and meteorological aspects, while the English word time only contemplates the former, the latter being the word weather. Saussure also maintains that language participates in the construction of reality. Therefore, different languages make up different world views. Polyphony and plurilingualism, in turn, are constitutive realities of any language, unless it is a dead language. One language hosts several languages, several sociolects, and a society is home to a "plurality of worlds" and worldviews (Bakhtine 1970).

The population that communicates through a particular language is not, in most cases, homogeneous, from a social and linguistic point of view, which implies that not everyone can understand messages in the same way (Ghiglione

and Matalon 1978). However, the linguistic heterogeneity in the population may make this purpose difficult. When a health message, for example, a prescription, is not interpreted in the same way by the recipient, its effectiveness collapses, forcing the way in which people communicated to be rethought. This is the biggest challenge in public health communication.

This is consistent with the need for more community-based means of health education, as suggested by Musoke et al. (2016). Health communication should thus involve multiple disciplines, including medical, human, social and communication sciences, to redefine human health according to a humanistic understanding of human motivation (Werder 2019). Nevertheless, there is little cross-fertilization of research across disciplines (Errecaborde et al. 2019). As there is a lack of collaboration among sectors, this can lead to conflicting messages or message overload (Müntera and Bojesen 2019). This is especially worrying when the information of the message is not fully credible, as there is a lack of regulation about who informs what, which may result in the provision of misinformation (Maia et al. 2019). The One Health approach and the need for One Communication is very evident when we think about personal hygiene from all perspectives. Hand washing is the most important means to prevent infection transmission, whatever the origin of the infection may be (Mbakaya et al. 2017; Guo et al. 2018): food-borne (Ejemot-Nwadiaro et al. 2021), nosocomial (Allegranzi and Pittet 2009) or even MERS-CoV (Yang et al. 2019) and COVID-19 (Zhou et al. 2020). In the sense of adopting the same and single message even from different sources. One Communication is more effective in health promotion and communication.

One Health issues are complex and interdisciplinary collaboration as well as knowledge sharing must be promoted, with a view to creating an innovative implementation, management and strategy to face diseases (Humboldt-Dachroeden et al. 2020). Ueland (2019) has shown that risk communication requires in-depth knowledge about the receivers of information, who may be as diverse as each country, culture and person.

In summary, there is a lack of communication between involved sectors and stakeholders considered relevant from a One Health perspective, but also an insufficiently effective communication by experts to citizens. It is known that experts' perceptions of risks are not consistent with community perceptions (Bearth and Sigrist 2016). Citizens ask for "less statistics and more stories". One must also be aware that the internet is becoming the most important information channel (Ueland 2019). There is a huge gap in the communication between researchers and policy-makers. There are population groups characterized by functional illiteracy, a problem widespread in less developed countries, but is invisibly present in developed countries as well. Illiteracy patterns are associated with cultural, educational and socioeconomic factors of the common citizen and also lack of specialized knowledge, namely of journalists (Jayaram 2015).

Scientific research is crucial for an innovative and sustainable health system, but it should also be communicated to policy-makers, who in turn have to analyse multiple determinants of disease like individual, social, economic, cultural and environmental conditions (Sinclair 2019; Kakkar et al. 2019). There is a need for

demonstrable and understandable data for decision-makers to persuade them for this call to adopt a One Health approach in their national or regional context (Sinclair 2019). Even editors of scientific journals seem to give only modest attention to One Health when compared to the relevance given to it by health practitioners or international organizations (Humboldt-Dachroeden et al. 2020). Finally, there is also a need to improve communication with citizens (Kakkar et al. 2019).

The barriers to implementing One Health can seem endless, but the results would be impressive and effective. As stated by Deem and Brenn-White (2020), One Health is the key to prevent COVID-19 from becoming the new normal. Besides One Health, we also need One Communication.

4 One Communication—Our Experience

4.1 Food Safety—The Case of Listeriosis

Listeriosis is a disease caused by the consumption of foods contaminated with *Listeria monocytogenes.* Clinical manifestations of invasive listeriosis include septicaemia, meningitis and abortion, and have a high mortality rate (Mateus et al. 2013). The most recent report from the European Food Safety Authority (EFSA) stated that cases of listeriosis remained stable in 2015–2019 after a long period of an increasing trend; the number of listeriosis outbreaks in 2019 was 50% higher compared with 2018. The case fatality was high (17.6%) (EFSA and European Centre for Disease Prevention and Control [ECDC] 2021), which makes listeriosis a very important foodborne disease to follow closely. Pregnant women have an infection risk twenty times higher than healthy adults (Ogunmodede et al. 2005) and, since listeriosis is transmitted mostly through the consumption of contaminated food, we wondered whether Portuguese pregnant women were aware of this infection risk. To answer this question, a questionnaire was designed and applied in person to 956 Portuguese pregnant women with the main aim to identify their knowledge about food safety in general and listeriosis in particular (Mateus et al. 2014). We stated that about half of the respondents believed they had received enough information, but they did not recognize the name listeriosis, they did not change eating habits since having become pregnant and they did not avoid high-risk foods. Doctors were their most mentioned and requested source of information. In the face of these responses, we concluded that there is a lack of information and, above all, there is a lack of communication.

The word communication comes from the Latin word *communicare*, which means to put in common and to communicate understanding. This is not an easy issue at all, especially for health professionals who are usually overwhelmed with tasks. So, this may be an excellent opportunity to work on multidisciplinary approaches with food safety experts, other healthcare professionals, communication/marketing professionals, among others. Citizens reveal different

dimensions of personality in different contexts—so the more diverse the professionals working in health communication, the more likely they are to communicate effectively.

In this survey, we also concluded that barriers preventing health care providers from educating pregnant women on food safety should be further investigated. So, a subsequent questionnaire about listeriosis knowledge was directed to health care providers (Mateus et al. 2018). We collected 671 answers and 77% of the respondents admitted that they do not inform pregnant women about preventive measures against listeriosis. Yet, 87% would like to receive information about the disease and preventive measures. There is thus a clear space once again for collaboration between sectors.

Following these two surveys, a review of risk communication strategies on listeriosis for high-risk groups (Maia et al. 2019) was performed. We realized that educational sciences should also be involved, as well as children's education. The channels should be diverse. Professionals' perceptions are quite different from the citizens', and this can create a genuine moral conflict. To avoid or mitigate these conflicts, it would be very important to involve the media in two ways: scientists/researchers/experts need to be trained to learn how to communicate with media professionals, and media professionals need to be trained about science communication.

4.2 Zoonoses—The Case of Hydatidosis

Hydatidosis, also known as cystic echinococcosis, causes severe symptoms and possible death in humans, and results in huge economic livestock-associated production losses, being considered a neglected and re-emerging disease (Moro and Schantz 2009). This disease is hyperendemic in the Mediterranean region and sine-endemic in Portugal (McManus et al. 2003; Morais 2013). Communities involved in livestock production are a vulnerable population, however little is known about their awareness about this disease. So, once again, we developed a questionnaire to be administered in-person with the aim to assess sheep and goat farmers' awareness of, perceptions of, and attitudes towards parasitic zoonoses and hydatidosis (Mateus et al. 2016). We collected 279 answers and 97% of these farmers had never heard about hydatidosis. Those who claimed to know about it adopted high-risk behaviors. We realized that culture and traditions play an important role in the perception of diseases and that is why regional studies are so important (and often neglected by scientific journals). To be able to communicate with this target population, we learned that we need "more experience, less science". That is coherent with the most frequently referred source of information—veterinarian—even if we were asking about a zoonotic disease.

The truth is that doctors delegate to veterinarians the responsibility of health education regarding zoonoses, but there is no communication among both these professionals. We know from existing literature that collaboration and

communication should occur between the human and animal health sectors, involving working groups of multidisciplinary individuals at a national level. This should happen mostly at a regional and local level.

Following this quantitative study, we carried out a qualitative study based on interviews. Although the findings of this study have not yet been published, this has been a unique research experience, as we found the most unlikely stakeholders to help us with the health education of farmers: mayors and priests. This may be because, as psychologists say, we agree more with those we like than with those who are right. A mixed methods approach seems to be more adequate for community-based studies, especially when their aim is health education through a One Health approach. One should not forget that some farmers are not used to reading—or do not know how to read—so visual messages are more appropriate for this target population.

4.3 Environmental Health—The Case of Vector-Borne Zoonoses

Vector-borne diseases—infections transmitted by the bite of infected arthropod species—are widespread in Europe. These diseases are spreading dangerously due to climate change, urbanisation and globalisation (Tomassone et al. 2018). Among them, *Dirofilaria immitis* is one of the most frequently detected mosquito-borne zoonotic nematodes in mammals in Europe and dirofilariasis is considered an emerging zoonosis (Reddy 2013). Leishmaniasis is transmitted through the bite of phlebotomine insects, and in Portugal, its incidence in animals and humans is increasing. Ehrlichiosis and anaplasmosis are diseases transmitted by ticks that are in expansion, highlighting the risk of exposure and transmission of diseases.

We carried out a study to assess the awareness of pet owners and other citizens about these vector-borne diseases in two different regions from Portugal: Minho and Alentejo (Mateus et al. 2019). For this purpose, three different questionnaires were designed and administered. Concerning dirofilariasis, 53% of the 316 respondents lived in a high-risk exposure area for the disease, and yet only 34% recognized the term dirofilariasis, and among these, only 13% confirmed it was a zoonosis. The majority of the persons only considered the tick as being a vector and the most dangerous one, mosquitos and others being neglected. However, from the 239 respondents to the tick-borne diseases' questionnaire, only 7.9% recognised the name of these diseases. These respondents wanted to receive information firstly from a veterinarian, but immediately followed by the family doctor/nurse. In relation to leishmaniosis, 291 persons completed the questionnaire, and 182 (62.5%) had heard about the disease, even if most of them (n = 163, 56.0%) were unaware about its zoonotic potential.

Veterinarians may have an essential role in public health education, but they are generally unaware of this. Citizens still prefer to receive information from a health

(human or animal) professional, especially face-to-face, even if in the most recent survey there was a greater percentage of persons who referred to web channels.

5 Conclusions

WHO stated that to be able to communicate risk, one should identify target groups and, above all, understand their risk perceptions and communication needs. That was what this team set out to do, through a bottom-up approach. We intended to become familiar with citizens' knowledge and risk perceptions and awareness, because in our experience this is the most appropriate way to identify the different population targets and to adapt the message and the channels to each one of these targets, so that communication can be effective.

In this chapter, we aimed to highlight the One Health concept as a crucial opportunity for communication between different silos, as we have been doing for several years. Our team incorporates a microbiologist expert in food safety, a sociologist expert in environment and health, and a veterinarian with a special interest in zoonoses. WHO considers health communication as essential in controlling an outbreak as epidemiological assessments or laboratory analyses. Our personal experience with the COVID-19 pandemic allows us to test this. We already know One Health, but we really need to leverage One Communication.

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Positive Ecological Psychology: Contributes to the Promotion of Healthy Lives and Well-Being

Isabel Silva, Glória Jólluskin, and Paulo Cardoso

1 Introduction

We currently live in a consumer society, where more and more products are produced, purchased, discarded and replaced by others, whose production is likely to imply, to a greater or lesser extent, natural resources, in a cyclical consumption process, which can be extremely harmful to the environment. In this scenario, it is not possible to ignore the limitations of the Earth's natural capacity to absorb all these environmental impacts. Therefore, it is important to develop forms or models of production with less impact of human activities on the environment and which imply the use of less and less natural resources, optimizing their use, looking for solutions that enable new models of thinking and using these natural resources, using raw materials, thinking about energy consumption, emissions, waste, environmental impacts, in order to minimize them or even reduce them to zero. It is also essential that this simultaneously enables the satisfaction of basic needs of citizens, but also ensures their quality of life, without jeopardizing the quality of life for future generations (Mella and Gazzola 2015). So, it is essential to develop clean technologies, in order to supply, in a conscious and sustainable way, the needs of services, goods and products of the current society, while enhancing economic development and sustainable development. Ensuring an acceptable social quality of life implies finding a balance between the positive and negative impacts of the global energy strategy and clean technologies in societies, globally considered (Nadimi et al. 2017), and on their individuals.

I. Silva (✉) · G. Jólluskin · P. Cardoso
Universidade Fernando Pessoa, Praça 9 de Abril, 349, 4249-004 Porto, Portugal
e-mail: isabels@ufp.edu.pt

G. Jólluskin
e-mail: gloria@ufp.edu.pt

P. Cardoso
e-mail: pcardoso@ufp.edu.pt

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Assuming that access to clean energy has a positive impact on societies, while excessive fossil fuel extraction, together with population growth, increases the risks of climate change and environmental degradation, Nadimi et al. (2017) argue that energy policy is a way to find an equilibrium between the energy positive and negative impacts on society. In spite that it does not assure a fair distribution of quality of life around the world, they believe that a proper energy policy provides a sustainable use of energy that coincides with an acceptable social quality of life.

Research has exploited this impact at country level, revealing that in countries with different levels of development there may be different impacts of measures to reduce energy consumption.

According to Pasten and Santamarina (2012), the implementation of policies appropriately directed to developed and developing economies could optimally guide future energy demands in order to capitalize on quality of life worldwide. These authors argued that short-term policies should recognize the present dependence on fossil fuels, their decreasing reserves and climate consequences. In this context, the highlight must be given to increasing quality of life in the developing world and to limiting excessive consumption in developing countries.

Some countries that have achieved the highest levels of objectively defined quality of life have the potential to reduce energy consumption without compromising their quality of life (Nadimi et al. 2017). Nonetheless, the same does not happen in all countries. Nadimi et al. (2017) studied 112 countries over 9 years, controlling some indicators of economic, health and education dimensions of quality of life (e.g., gross domestic product, exports, population growth, urbanization, climate and population). These authors concluded that, considering the impacts on countries' quality of life, it should be taken into account three energy policies: (1) eco-sufficiency for developed countries; (2) eco-efficiency for developing countries; and (3) poverty reduction for developing countries. That is, countries that have achieved the highest quality of life standards have the potential to reduce energy consumption without compromising this quality of life. Developing countries have an extraordinary capacity to promote their efficiency in production systems and energy consumption, managing to increase their quality of life by concentrating their efforts on energy efficiency, the creation of goods and services with less energy and lower CO_2 emissions, less waste production and less pollution, which will allow them to reduce the environmental risks and diseases associated with them, improving the health of their populations.

On the other hand, we find developing countries, with the lowest quality of life and lack of access to clean and safe energy, as well as with the highest levels of poverty. These are the ones that can benefit most from the spread of renewable energy systems, which not only save natural energy sources, but also relieve environmental degradation and CO_2 emissions. For them, these systems are also a way of creating jobs for the populations, helping to reduce the level of poverty.

Energy policies are therefore important to promote quality of life and well-being levels acceptable to the population. This acceptable social quality of life is often defined as the Welfare Index. This index aims to provide regular results to screen the evolution of well-being and social progress in what concerns to families'

material conditions of life and their quality of life (Instituto Nacional de Estatística [INE] n.d.). This is an index that is subdivided in ten areas: economic well-being; economic vulnerability; work and income; health; work-life balance and education; knowledge and skills; social interactions and subjective well-being; civic participation and governance; personal security; and environment (INE n.d.).

In this perspective, well-being is defined as the best standards of quality of life in general, covering material living conditions, but also other factors that are believed to contribute to quality of life. These factors include those related to the environment, good health, adequate educational levels, use of time, the value of living in society, a good level of democratic participation, as well as access and involvement in cultural and leisure activities (INE n.d.). It is important to recognize that this index has the merit of fostering dialogue between the different stakeholders who promote economic and social progress and among citizens in general, and can be a useful tool for opinion-makers, for public and private decision-makers, but the way in which the concept of well-being is understood is not coincident to subjective well-being or psychological well-being, although subjective well-being obviously influences this social well-being (INE n.d.). This way of assessing quality of life focuses mainly on objective socio-economic conditions, on the physical environments in which people live, on the goods and services to which they can access individually or collectively, assuming that people with these conditions will have a high quality of life and will feel happy, which may not be true in a subjective perspective (Liu and Matsushima 2019). In addition, the well-being defined by this index is also an indicator that allows characterizing the country in a national scale, but not to other geographical scales, as well as does not allow characterizing specific populations (INE n.d.).

The assessment of quality of life through objective indicators (such as the Welfare Index) and subjective indicators (directly asking people how they feel and if they are happy) (Liu and Matsushima 2019) can offer a broader and complementary vision when we think about the impacts of clean technologies on well-being.

But why is the subjective view of well-being important when we think about environmental protection and sustainability? Why is it that individuals' subjective happiness, well-being and perceived quality of life are important? Aren't we valuing a selfish approach in which we simply do not think about the others? (Smith 2018).

This chapter presents a narrative literature review in which we intend to promote the reflection on the need of incorporating objective and subjective quality of life indicators when assessing the impacts of pro-environmental policies and behaviours. Additionally, we present arguments that intend to show that the factors that promote individual well-being can be aligned with the factors that facilitate well-being at collective or global levels, namely in what concerns to conservation efforts' results. Finally, it is argued that the promotion of pro-environmental competences can coincide with de development of individual competences for having well-being and being happy, as well as that environmental campaigns shall endeavour to simultaneously promote both, in order to facilitate their long-term integration in individuals' lives, sustainably changing their attitudes and behaviours concerning nature protection.

2 Subjective Well-Being and Environment

From a subjective perspective, well-being has been understood according to different perspectives—that of a pleasurable life, what we call a good life, but also a life lived according to our true self, which happens when activities are more congruent with our values and we feel truly involved in them. In this subjective approach, well-being refers to circumstances in which people feel intensely alive and authentic, existing as they really are; circumstances that allow their flourishing, the development of their potential, and a meaningful life.

Ryff (1989) argues that psychological well-being comes from accomplishing a sense of dominance over the environment, developing meaningful and lasting relationships, achieving personal growth, acting in an autonomous way, finding a purpose and living according to our true nature. This author presents us with a eudaimonic conception of well-being, which aligns with the idea that well-being arises from living well or realizing our potential, of becoming better people, living a virtuous life and achieving important goals.

On the other hand, Schueller and Seligman (2010) present us three distinct paths to well-being—pleasure, involvement and meaning-, considering that the search for all three paths is important to live the "full life". They thus combine eudaimonic and hedonic approaches, believing that it is from the assessment that we make of our satisfaction with life (cognitive assessment), but also of our affective states (emotional assessment) that that an individualized view of the well-being is developed (Schueller and Seligman 2010).

Are these visions of individual well-being associated with environmental protection and preservation measures? At least they should… if we take into account that development must be compatible with the needs and expectations of citizens (Mella and Gazzola 2015) and most people expect to have a happy life.

Many of the studies on environment focus on the notion of quality of life, which is distinct from the notion of subjective well-being, but which also should also refer us to the vision of each person individually considered. For example, World Health Organization (1997, p. 1) defines quality of life "as individuals' perception of their position in life in the context of the culture and value systems in which they live and in relation to their goals, expectations, standards and concerns". Quality of life is, thus, assumed as "a broad (…) concept affected in a complex way by the person's physical health, psychological state, level of independence, social relationships, personal beliefs and their relationship to salient features of their environment" (WHO 1997, p. 1). It is a subjective assessment, clearly associated with our individual expectations and priorities, with our goals, aspirations, values, patterns, desires, needs, wills, associated with what gives meaning to our life, with what makes our life worth living. It is a concept that stems from who I am, how I relate to others and to the world around me. In this subjective perspective, quality of life is something that no one but the person himself/herself can say what it consists of, because what is quality of life for me will hardly be what is quality of life for each of the others. But it is also something that is not static—what was important to

ensure an individual quality of life as a child, in adolescence, in adulthood… has not remained unchanged over time.

It is in this perspective, of a well-being and a quality of life understood as subjective, multidimensional and dynamic concepts, that it urges to think the environment.

Well, the objectively defined well-being may have little to do with what we understand to be a life that is worth living, even though research reveals that feeling involved and the search for meaning are positively related to objective well-being (Schueller and Seligman 2010). But the real question that is important to ask is: To what extent can the factors that promote individual well-being be aligned or become congruent with the factors that facilitate well-being at collective or global levels? (Ryan and Deci 2001).

Very recently, Kushlev et al. (2020) published data from a longitudinal study conducted on subjective well-being. These authors evaluated, over 11 years (between 2006 and 2017), 1.7 million people in 161 countries, demonstrating that, around the world, satisfaction with life and positive emotions (feeling happy, enthusiastic, satisfied with life)—not the lack of negative emotions (not feeling sad, anxious, bored)—is associated with being pro-social. That is, people with greater subjective well-being (those who are more satisfied with their life and who experience positive affect more frequently) are more available to help a stranger, give time to another person, to be volunteers, to give money to someone in need. This association is found in the richest countries, but also in the poorest ones, and income doesn't seem to affect that willingness to help others by donating money, time, volunteering, or willingness to help a stranger. In fact, previous studies had demonstrated this association, even when controlling variables such as income and social support (Aknin et al. 2013), having also shown that this relationship between being pro-social and subjective well-being is both causal and reciprocal—because we are happy, we have more prosocial behaviours and these behaviours also make us feel happy (Aknin et al. 2012), and this association is observed both in men and in women (Kushlev et al. 2020).

Kushlev et al. (2019) had verified that positive affect (although not negative affect) is associated with being more socially active, but also more active from a political and environmental point of view. Subjective well-being, after all, has an impact on our involvement with others and with the world around us.

Research has been trying to understand the development of the connection with nature, that is, how people identify themselves with the natural environment and the relationships they establish with nature. Results have been revealing that this connection is very important for well-being. Direct experiences with natural environments seem to have very profound emotional effects on people. Contact with nature and feelings of connection with nature are associated with greater meaningful life (Cervinka et al. 2012; Howell and Passmore 2013); happiness (Zelenski and Nisbet 2014); satisfaction with life (Mayer and Frantz 2004); eudaimonic well-being, health (Martin et al. 2020); psychological, social and emotional well-being (Cervinka et al. 2012; Howell et al. 2011); higher positive affect (Herzog and Strevey 2008; Nisbet et al. 2011); higher mindfulness (Howell et al. 2011) and

higher vitality (Nisbet et al. 2011; Zelenski and Nisbet 2014). Results also showed that this exposure to nature can happen through involvement in simple and everyday activities in nature, close to home, not having to imply drastic changes in the lives of the generality of people (Passmore and Howell 2014b).

Some researchers advocate an approach to the relationship between the individual and nature from an Eco-Existential Positive Psychology, which assumes that the relationship with nature is essential to our well-being and that experiences with the natural environment play an important role in answering to "existential anxieties of our identity—happiness, isolation, meaning of life, identity, freedom and death" (Passmore and Howell 2014a, p. 370), but also that these experiences enable us to fully flourish as human beings (to live a life in which we experience involvement, interest, meaning and purpose). According to this perspective, it is in this relationship with the environment that we can answer "Who am I as a human in a natural world greater than me?" (Passmore and Howell 2014a). This relationship with the natural world is perceived as mutually beneficial—exposure to nature and an increased sense of connection with nature are associated with greater individual well-being, but also with greater "environmental well-being", which stems from an increase in responsible behaviours from human beings (Passmore and Howell 2014b).

Most research on the effects of nature on health has focused mainly on disease or on the reduction of dysfunction (reparative effect)—on reducing stress, anxiety, anger, depression, substance abuse, attention deficits, recovery after surgical treatments, etc. For example, in the 1980s, Ulrich (1984) demonstrated that patients undergoing a cholecystectomy (surgery to remove the gallbladder) who were placed in rooms overlooking trees or brick walls had different recovery processes. Patients who had tree views had fewer days of hospitalization, in their clinical records there were fewer patient complaints registered by nurses, they took fewer analgesics with moderate or strong effect and had a slightly lower number of minor complications after surgery. Obviously, this is not a study that allows us to extrapolate these results to other realities, but it makes us question the importance of exposure to nature in disease recovery processes (Ulrich 1984). In 2001, Taylor et al. demonstrated that children with attention deficits had fewer symptoms after playing in a park with a green area when compared to children who played indoors. Although the green of the residential children's environment was not related to the severity of attention deficit symptoms, the green of the environment in which they played was related to those. In addition, the children that played in internal environments without windows had significantly more severe symptoms than children who played in outdoor lawns with or without trees (Taylor et al. 2001).

Interaction among community members can be more frequent in outdoor gathering spaces, which can also increase familiarity, mutual investment in well-being and social cohesion. As a result, green spaces can normalize healthy behaviour by promoting the interest in acting for the common good (Shepley et al. 2019).

But health is not merely absence of disease or dysfunction. The World Health Organization (WHO) defines mental health as a "a state of well-being in which the individual realizes his or her own abilities, can cope with the normal stresses of life,

can work productively and fruitfully, and is able to make a contribution to his or her community" (WHO 2004, p. 23), considering that mental health is the basis for well-being and effective functioning of the individuals and of the community. Mental health is not just the simple absence of mental illness, but also implies the presence of a positive functioning at an individual and at a social level (Keyes 2002).

It has been keeping this conception of mental health in mind that research, more recently, has been expanding its attention to analyse not only the restorative role, but also to the additive role that nature can play in our lives (Howell and Passmore 2013), on our well-being, happiness (whether understood from a hedonic or eudaimonic perspective) and meaning.

Research shows that people that contacted with nature during 120 min or more, in the previous week, were more likely to have better health perception or high well-being in comparison to those without contact with nature in the same period of time and this pattern remains in older adults and among those with chronic health problems. Furthermore, it does not matter how this time of contact is achieved—for example, whether it was during a long visit over the weekend or on several shorter visits during the week (White et al. 2019).

Contact with nature seems to have many benefits, even when such contact is limited, and proves to be a path to happiness and environmental sustainability (Zelenski and Nisbet 2014). The connection with nature independently predicts happiness (and, in particular, positive affect), even after controlling for other connections (family, friend, etc.). It is also a greater predictor of well-being indicators than of malaise, suggesting that this relationship may play a more beneficial role in happiness than of mere buffer (Zelenski and Nisbet 2014).

The connection to nature is positively associated with positive affect, vitality, autonomy, personal growth, meaning or purpose of life, and with satisfaction with life (Nisbet et al. 2011). Nisbet et al. (2011) argue that if individuals feel good about their natural environment and if they appreciate and care for it, they are more likely to engage in behaviours that respect and protect that environment. Furthermore, this relationship is bidirectional—when people feel more connected to nature and try to protect it, they feel greater well-being, but also when people feel happier, they are more likely to engage in environmentally protective behaviours, and, in doing so, it is created what can be called a positive feedback loop, which reinforces their positive affect and individual well-being (Nisbet et al. 2011).

But, do the gains from exposure to nature are limited to the affective domain? Berman et al. (2009) demonstrated the restorative value of nature in improving cognitive functioning. They found that performance on a backwards digit-span task (task that imply people having to retain the correct order of a sequence of digits while elaborating the reverse reproduction) improved significantly when participants walked in nature, but not when they walked in the city centre. Berman et al. demonstrated that these results were not motivated by changes in mood, nor were affected by different weather conditions. They also demonstrated that the executive function of attention improves when individuals are exposed to images of nature, but not when they are exposed to images of urban environments.

Research also shows that there is also an impact of the contact with nature on higher-level tasks, for instance on creative problem solving. Atchley et al. (2012) showed that four days of immersion in nature (with disconnection of multimedia and technology) increase performance in creative and problem-solving tasks. These studies may leave us in doubt about the underlying mechanisms: these will be due to increased exposure to nature, to a lower exposure to technology or to other factors related to being immersed in nature? Nevertheless, these investigations open new paths to explore and to sharpen curiosity about the potential of including approaches that imply connection with nature in the rehabilitation of individuals, but also in initiatives aimed at nurturing talent, aimed at creating conditions for flourishing in a psychological point of view.

Research also demonstrates that there is a moderate positive association between the perception of natural beauty and pro-sociality. Individuals with a higher degree of perception of natural beauty report greater pleasantness, greater empathy and greater perspective taking and this association is maintained even after controlling age, sex, religious frequency and connection with nature (Zhang et al. 2014). The perception of the beauty of nature also has an effect on generosity. This association is mediated by positive emotions, suggesting that exposure to beautiful images of nature induces positive affect, which, in turn, stimulates a prosocial response (Zhang et al. 2014). There also seems to be an effect on trust in others and on behaviours to help others (Zhang et al. 2014).

In a literature review, Capaldi et al. (2015) concluded that, after exposure to images of nature, people feel more connected to others, more caring, more spiritual, and even when this experience with nature is only evoked, it can induce feelings of connection to it, as well as of being part of something greater than ourselves. This connection with nature is associated with a greater probability of helping strangers, giving money to others, acting gregariously, feeling attracted to someone we have just met. It is also associated with humanitarianism (the defence of love for others and the promotion of the humanity well-being as a duty of the human-beings), social well-being, kindness, altruistic concern and perspective taking (Capaldi et al. 2015).

Weinstein et al. (2009) explored how immersion in nature might influence our life aspirations, which influence important life decisions, define our values, and affect the direction and quality of our life experiences by shaping our perceptions, judgments, and behaviours. These authors concluded that individuals who have been immersed in nature (even if through the visualization of images of nature, guided imaginations or the presence of plants in the laboratory) began to value intrinsic aspirations more than extrinsic ones, that is, they began to value the search for goals that, in themselves, satisfied their basic psychological needs of personal growth, intimacy and community (Weinstein et al. 2009). In addition, they began to feel more autonomous, which means that they began to feel that they were more in contact with themselves, that there is a sense of internal congruence and self-authorship, that they have freedom from external and internal pressures, and began to have a greater connection to nature. They also had more pro-social aspirations, namely more generous decision-making (Weinstein et al. 2009). On the contrary, individuals immersed in unnatural environments seem to value extrinsic

aspirations more (which focus on goods of external value that are not inherently rewarding; aspirations that seek to obtain consideration or positive rewards from others—for example, money, image, fame) and to make more greedy decisions or at least seem to occur inhibition at the level of generous decision-making (Weinstein et al. 2009). Having prosocial aspirations is particularly important—let's not forget that people with a prosocial predisposition generally tend to display greener behaviour (Hilbig et al. 2013).

The connection with nature is associated with our affect, cognitive functioning, to the way we relate to others and to our character (Merino et al. 2020). VIA Institute on Character (https://www.viacharacter.org) has been dedicated to identify, evaluate and promote human character strengths and virtues, i.e., the positive parts of our personality that affect the way we think, feel and behave. This organization identified 24 forces of character, organized in six major domains—wisdom, courage, humanity, justice, temperance and transcendence. Research has suggested that connection with nature potentiates the several character strengths and human virtues, in particular the appreciation of beauty, love for learning and curiosity (Merino et al. 2020). These particular strengths—that belong to the domains of wisdom and transcendence—are strongly associated with the connection with nature (Merino et al. 2020).

The connection to nature not only has a stress-absorbing effect, but is also enhances our happiness, whether providing us with pleasurable experiences and positive affect, or contributing to our happiness from a eudaimonic perspective, contributing to find a meaning in life, flourishing and becoming better people. To flourish we need positive emotions, engagement, relationships, meaning and achievement. These are the building blocks from which happiness is built (Seligman 2018). These are precisely the same building blocks enhanced by the connection with nature—feeling good, using our strengths, establishing meaningful relationships, feeling motivated to move forward and more capable of achieving our goals.

3 Relatedness to Nature and Environmental Protection

Despite these positive effects of people's contact with nature, there is growing evidence that direct contact between people and nature is decreasing, because of the growing urbanization rates, the more frequent use of new technologies for entertainment and the perception of unsafeness of nearby natural sites (Rosa and Collado 2019).

The association between experiences in nature and environmental attitudes and behaviours is complex, and there are no specific guidelines for people's daily contact with nature (Rosa and Collado 2019). However, there is clear empirical evidence that suggests that direct experiences in nature are positively associated to individual's environmental attitudes and behaviours. This led researchers who want to increase pro-environmentalism to defend a more frequent contact with nature, particularly during childhood.

Nevertheless, we know that a stronger commitment to nature seems to drive to a greater human interest in environmental protection (Perkins 2010). Restall and Conrad (2015) argue that understanding how people's relationship with nature is formed, how it influences their personal values and attitudes, and how it influences their behaviours can contribute to a greater understanding of how connecting with nature can contribute to environmental management goals. Restall and Conrad (2015) conducted a systematic review of a decade of scientific literature (produced between 2002 and 2011), and concluded, in their analysis, that research supports the need and relevance of applying more social and affective strategies to promote nature conservation behaviour.

Research shows that childhood experiences in nature are very significative for creating a bond with nature that lasts into adulthood and that these positive childhood experiences are the main predictor of pro-environmentalism later in life (see review by Rosa and Collado 2019). However, when looking at the association between nature connection and nature protection attitudes and behaviours, the results appear to be ambiguous, and there is still much to be explored (see review by Rosa and Collado 2019). In any case, the gains in the domain of psychological, emotional, social well-being seem solid.

And, yet, today many of us experience significantly lower levels of daily contact with nature compared to preceding generations. Starting from the hypothesis of biophilia, that assumes that human beings have an innate connection with nature and that, just as they feel the need to connect with others, they feel the need to connect to the natural environment (Bratman et al. 2012; Lumber et al. 2018), and questioning the assumption that human beings have an unlimited capacity to adapt to the environment (Gullone 2000), it is necessary to answer several questions: Do we really have an unlimited capacity to adapt (Gullone 2000)? What happens to our cognitive abilities, emotional states, and mental health if we are deprived of experiences in nature? Does it make us suffer? If so, a considerable portion of the human population will be experiencing the impacts of this removal of nature from their lives (Bratman et al. 2012).

It is important to understand how subjective disconnection from the natural environment can influence our health from a physical and psychological standpoint (Nisbet et al. 2011). Louv (2005), in his book entitled *Last Child in the Woods*, warned about a disorder that he believed could affect individuals, families, and communities, a disorder he named "nature deficit disorder" and which, even today, is not an official diagnosis. But, already 15 years ago, it was a way of drawing attention to the human costs of the alienation from nature: diminished use of the senses, attention difficulties, and higher rates of physical and emotional illness. And we can add, the negative impact on levels of happiness for each of us individually considered and for our communities (not forgetting that the Well-Being Index is not exhausted in, but includes, subjective well-being). We are all called to recognize our contribution, small or large, as individuals, in the destruction and conservation of the natural environment. We are part of it. The solutions to the environmental problems we face will not be found only in science and technology, but also in changes in our behaviour.

4 Conclusion

Many efforts to find solutions to environmental problems may be frustrated by our disinterest, indifference or resignation. And, given the complexity of the environmental crisis, it will be difficult to find a solution in a single point of view of this reality.

All branches of sciences, including Psychology, can make a relevant contribution, assuming the responsibility of contributing to a greater knowledge about the relationship between the connection with nature and individual well-being. Sciences can focus on explaining how to promote ecological commitment and influence the predisposition to preserve the natural environment in individuals and communities, how to promote positive environments that promote individual and collective benefits, and influence the predisposition to preserve the natural environment. It is urgent to answer the question "How can policy and environmental managers operationalize approaches that include deeper psychological values for a more effective and inclusive environmental management?".

Chapin et al. (2011) advocate that it is critical to understand the psychology of communication about Earth Stewardship, otherwise it would be difficult to be effective. Several negative messages have effectively improved consciousness about the threats of environmental degradation and about negative emotions (such as fear, anger, and shame) that stimulate the change of behaviours at short-term. However, those negative messages also result in avoidance behaviours that do not favour the integration of long-term resolutions into lifestyle choices. These authors also draw our attention to the fact that messages that promote positive emotions stimulate ways of thinking and acting that incorporate the individuals' creative abilities and allow them to develop coherent long-term strategies. They consider that there are incredible opportunities to integrate positive messages into communication procedures in what concerns to environmental issues, improving their effectiveness.

In the same perspective, Corral-Verdugo (2012) believes that sustainable behaviour is addressed as having what he calls "negative antecedent-instigators" (negative emotions as fear, guilt, shame), which are stimulated to avoid unwanted outcomes from environmental degradation, and draws our attention to the fact that research identifies several negative psychological consequences (as discomfort, annoyance, inconvenience and sacrifice) associated to sustainable behaviour. However, he also underlines the importance of not forgetting the countless studies which prove that sustainable behaviours are predeterminate by "positive psychological antecedents" (as capacities, emotions, virtues and strengths) and "positive psychological consequences" (as satisfaction, psychological well-being, and happiness). Corral-Verdugo believes that sustainable behaviours can be initiated by positive dispositional factors, and maintained by psychological benefits.

Environmental approaches must undergo a transformation, opening themselves to a paradigm change when thinking human behaviour. It urges to adopt a positive psychology point of view on the ecological investigation of human behaviour (Valera and Vidal, 2017). We argue in the defence of a Positive Ecological

Psychology that contributes to the definition and implementation of environmental policies and behaviour change that simultaneously protect and preserve the environment, and simultaneously allow individuals to develop and growth their potential, flourishing.

The positive approach in environmental awareness campaigns has been the subject of study and discussion among researchers and experts. In this sense, positive representations of nature can have a positive influence on individuals when used in environmental awareness campaigns presenting, for example, a part of the environment that is (still) intact and should be preserved (Hartmann and Apaolaza-Ibáñez 2012). In fact, Wonneberger (2018) empirically demonstrated that a campaign with a positive emotional appeal can be evaluated more positively, being considered more beneficial and more important. Also, Chadwick (2015) found that in climate change campaigns, appeals to hope can be a more effective approach than appeals to fear.

It is essential to make consumers understand the need for and benefits of green products to maintain a cleaner and greener environment (indirect benefits). Nevertheless, is equally important to help them to understand that to connect to nature and to protect it, also have individual direct benefits—improving their capabilities to flourish and stimulating their well-being.

Thus, these two perspectives should converge in the campaigns to change behaviour in order to preserve the environment. It is not enough to develop campaigns focused in raising a sense of shame related to our behaviours and on identifying and remedying our weaknesses. It urges to combine these approaches with new ones, focused in promoting positive character strengths and human virtues —appreciation of beauty and excellence, creativity, curiosity, gratitude, hope, humility, kindness, love, love of learning, perseverance, perspective, teamwork, social intelligence, spirituality, zest, social virtues, responsibility, civic pride, self-efficacy, psychological well-being, optimism, and pro-social behaviours. The development of pro-environmental capabilities can co-occur with de development of skills for having well-being, being happy, having a meaningful and "full life", purpose which all human beings are probably more prone to integrate in their lives in a long-term perspective.

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Isabel Silva PhD in Psychology from University of Porto. Associated Professor at Fernando Pessoa University (UFP), where she is responsible for the Behavioural and Social Sciences Research Centre (FP-B2S) and where she coordinates the Psychometry Laboratory. She is a clinical psychologist in practice at the School-Hospital UFP. She holds a specialist title in Clinical and Health Psychology and in Community Psychology awarded by the Portuguese Psychology Order.

Glória Jólluskin PhD in Psychology from University of Santiago de Compostela. Assistant Professor at Fernando Pessoa University (UFP). Integrated Researcher of the Behavioural and Social Sciences Research Centre (FP-B2S). Member of the Psychometrics Laboratory at UFP. Holds a specialist title in Social Psychology and in Psychology of Justice awarded by the Portuguese Psychology Order.

Paulo Cardoso PhD in Advertising and Public Relations from Autonomous University of Barcelona. Professor at Lusíada University of Porto and at Fernando Pessoa University, in the fields of Marketing and Communication. As a researcher, he has published and disseminated his work in scientific journals and national and international conferences. As a consultant he has worked in the field of consumer behaviour, brand identity and communication planning.

Social Responsibility and Bioethics in Higher Education: Transversal Dialogues

Ivaní Nadir Carlotto, Justice Kofi Debrah, and Maria Alzira Pimenta Dinis

1 Introduction

The concepts that define Social Responsibility (SR) derive from a large arsenal of pre-existing theories whose scope includes, in the great majority, organizational and process concepts, thus allowing to give answers to social and public policy issues, in which their reflexes are evident when applied to society (Martínez et al. 2016). Based on this assumption, the institutions' responsibilities cover the ethical, philosophical, economic and legal foundations, and not only the purely organizational and business aspects. Thus, when the institution reinforces its investment seeking the best social performance, it also invests in people and society's behaviour as a whole, since such conduct is less harmful to individuals and contributes to achieving more results beneficial to society (Lozano 1999). Some authors highlight several theories related to SR, exposing their respective approaches regarding the diversity of aspects that make up the social panorama: economic, political, social and ethical aspects. Table 1 shows a timeline for the theoretical frameworks and their guiding ideas.

Based on these concepts, and to determine specific responsibilities for each situation presented in relation to SR, it is possible to relate SR simultaneously to the theories involving health and sustainability, education and ethics (Schmidt 2009). Among other arguments for assuming the concept of SR, it is highlighted that all actions require responsibility at all levels of performance. This responsibility pro-

I. N. Carlotto (✉) · M. A. P. Dinis
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: 33163@ufp.edu.pt

M. A. P. Dinis
e-mail: madinis@ufp.edu.pt

J. K. Debrah
University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal

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Table 1 Timeline for theoretical framework about the concepts of social responsibility

Reference	Social responsibility concepts
Weber (1922)	The theory of social and economic organization
Clark (1939)	Social control of business
Bowen (1953)	Social responsibility of the businessman
Davis (1960)	Can business afford to ignore social responsibilities?
McGuire (1963)	Interrelates the company's responsibilities to society
Davis (1967)	Understanding the social responsibility puzzle: What does the businessman owe to society?
Walton (1967)	Uses the theory of social responsibility as a necessary element to reinforce company/society relations
Friedman (1970)	The social responsibility of business is to increase its profits
Committee for economic development (USA) (1971)	Social responsibilities of business corporations
Davis (1973)	It addresses social responsibility as a necessary element for solving problems related to social development. In a way, this approach minimizes the detrimental effects on individuals' well-being from a social perspective
Drucker (1984)	The practice of management
Lozano (1999)	Ética y Empresa (Ethics and company)
Araque-Padilla and Montero-Simó (2006)	La responsabilidad social de la empresa a debate [The social responsibility of the company under debate]

Adapted from Gomes (2015) and Martínez (2016)

duces economic, social and ethical consequences (Schwartz and Carroll 2003), i.e., to act with responsibility is to do the right thing.

This chapter seeks to address the existing interfaces between SR theory, and its close relationship with the concepts involving health, sustainability, higher education (HE) and bioethical principles to demonstrate a perspective built from a unified cooperative discourse and through sharing shared responsibilities.

2 Social Responsibility and Health: Interfaces with Health Promotion and Sustainability

Health and health promotion (HP) are a fundamental dimension of the SR approach, expanding the recognition and the need for a worldwide discussion on the role of cooperation in society and the definition of social activity parameters. These concepts recommend that, in the context of health, there is an immense potential to create, through SR, new strategies and forms of intervention to achieve the objectives of the HP (Monachino and Moreira 2014). In this logic, it is possible to list fundamental values of human health, which are linked to the concepts of SR and

HP, such as the commitment to the search for scientific knowledge in health, contributing to the achievement of a better quality of life and better individual and social health conditions, trust and ethics. Taking this line, a step further, it becomes possible to fit into this debate, the concepts of sustainability and sustainability in health, since these concepts highlight the importance of responsibility in health in general, and in the environmental sphere, and its influence on health and the well-being of communities (Weed and McKeown 2003). The movement-related to sustainable health development has made significant progress in the past decade to provide elements for understanding and advance research involving environmental relationships in individuals' health. It is important to note that this advance was much favoured by the 17 Sustainable Development Goals (SDG), in which health as a priority intervention policy (UN 2015) and its interface with the SR and the environment is listed in SDG 3.

Although the responsibility for the debate on health and sustainability has intensified in several ways in recent years, it is of fundamental importance to bring the concept of responsibility for health to public knowledge as an element of mutual and shared co-responsibility between subjects and objects necessary for health (Schmidt 2009). This approach allows the concept of health to be put on hold (*momentary suspension*) and observed from a clear and plausible perspective of the accessibility and universality of the right to health. It also allows granting and sharing responsibilities, giving meaning to health decision-making, be it managerial or assistance, the right to treatment or status in prioritization decisions. It is also useful in the formulation of health policies and coordinated health management (Carlotto and Dinis 2019).

Actions involving the various social segments, e.g., working conditions, human rights, health, environment, innovation, and education, have significant impacts on citizens' lives. Implementing the United Nations guiding principles on business and human rights (UNGPs) and the United Nations (UN) 2030 Agenda for sustainable development is a challenge imposed today to implement actions responsibly worldwide (UN 2007).

Becoming socially responsible implies integrating social, environmental, ethical and human rights issues into intervention strategies, in a legal and regulatory manner.

The SR and health provide essential benefits in risk management, cost savings, accessibility, partnership, SR management, the sustainability of interventions and innovation, and sustainable economics.

The reflexes of this approach to society offer a set of ethical and moral values on which it is possible to build a more cohesive society and aim to transition to a sustainable life system, as a whole.

In this area, it is essential to emphasize the importance of human rights as an increasingly influential SR. The UN guiding principles on human rights define the existing social actions to have no negative impacts on human rights. The UN Human Rights Council endorsed these guiding principles in 2011 (UN 2017).

3 Social Responsibility and Higher Education

As educational organizations, universities are essential for adopting HP's actions, not only characterized as scenarios aimed at obtaining and improving well-being but also acting as indispensable partners in conjunction with the health area, thus contributing to responsible citizenship in the social context. From this approach, the concept of salutogenesis derives, whose scope is perfectly suited in the context of HE given the specific characteristics of Higher Education Institutions (HEIs). The multiplicity of roles played by HEIs ensures that this healthy perspective fits in with educational institutions' mission and vision since they act as specialized learning centres, stimulating creativity and innovation, developing responsible citizenship, and mobilizing resources if investments (Dooris et al. 2012). Such commitment related to SR is increasingly incorporated in HEIs, reinforcing the vision of health and well-being in HE and strengthening the operationalization of academic activities, focusing on sustainable development that encompasses environmental, social and economic policies (Carlotto and Dinis 2020; HEFCE 2014). Thus, the salutogenic paradigm advocated by HP is expanded in the context of HE. These measures are related to health insofar as they support and stimulate the pursuit of quality of life and individuals' well-being. Such an approach promotes a growing commitment by HEIs to sustainable development and HP, encouraging health actions based on evidence and guided by a salutogenic approach (Dooris et al. 2017). The scope of the approach to the concept of health from the perspective of HP and salutogenesis allows foreseeing situations and healthily redesigning courses of action in all fields of activity in HEIs (Li 2017).

The SR of HE is a contemporary theme that reflects the complexity of global challenges in this area. HE activities' focus encompasses the SR of this sector in understanding the social, political, cultural and economic dimensions and the adequate capacity to answer these questions. HEIs have the leadership in generating knowledge and facing global problems imposed on society, e.g., public health, climate change, renewable energies, interculturality or gender equality (UNESCO 2009).

The UNESCO Chair in Community Based Research and Social Responsibility in Higher Education (2012) acts as a guide for resolutive and qualitative actions involving SR in HEIs and sustainability. SR is characterized as the main responsibility of HEIs, through reflection and dialogue established between HEIs and society, considering the needs of both (Parsons 2014). Therefore, the return of HEIs to its cultural bases and engagement with its history is urgent to be able to rescue its essence as a HEIs and, in this way, relate it to teaching-learning and scientific research activities. Reflection on these academic structures allows HEIs to visualize and understand their internal organization and how governance in society operates.

Vallaeys (2007) proposes that the definitions of SR in HE cannot be interpreted as being merely philanthropic, but as guiding actions for the management of HEI. From this perspective, SR should not be understood apart from the HEIs strategic planning, nor should it be characterized by individual philanthropic attitudes that

may mask the organization's internal challenges. The SR presents itself as an element inherent to the management of the HEI and demonstrates its relationship with the internal and external organization of the Institution.

Parallel to the concept of SR, it is reasonable to highlight the emerging concept of University Social Responsibility which is guided by the philosophical paradigms related to ethics in HEIs, allowing such ethical and SR principles to be incorporated into the management of HE and in their relationships with society (Vasilescu et al. 2010). This approach involves the commitment of HEIs to direct their actions towards socio-environmental issues, promoting social awareness and sustainability.

The exercise of SR in the educational context assumed by the HEIs in their institutional project, considering the ethical assumptions undertaken in their political, pedagogical project, is undoubtedly an asset in implementing actions aimed at achieving SR in HE. By manifesting their commitment to SR, HEIs broaden their social function beyond instruction, taking on the commitment to direct teachers and students in their academic trajectories and using their knowledge to act in an edified way (Barrozo et al. 2019).

4 Social Responsibility and Bioethical Approach

Wikler (1997), from the University of Wisconsin Medical School, when questioning what it is to be a bioethicist, lucidly listed the three stages through which the study of bioethics manifests:

I. The first stage of bioethical studies consisted basically of formulating professional codes of conduct. Bioethics (more precisely, medical ethics, at this stage) was reduced, in the meantime, summarily to the rules against the commercialization of advertisements or bad relations between professionals, as well as the evidence of financial values that guided medical practice.
II. The second stage was named 'The Birth of Bioethics', as it called for a renewal of the relationship between doctor and patient.
III. The third stage covers the bioethicist Daniel Callahan as a framework for the approach involving the health system's ethical foundations as a unified whole.

Along with these considerations and evidence of this pioneering social vision of health, bioethics has reinvented itself to seek answers to these questions. However, this was not an easy path since bioethicists themselves needed such knowledge but, in turn, did not have a theoretical-practical arsenal related to issues of economics and health policies necessary to understand the current social approach. In the meantime, there was a need to explore new philosophical resources. However, this need was not centred on the moral values arising from individual actions or traditional deontological and ethical codes. It was necessary to deepen the concepts derived from social and political philosophy, namely from theories related to

equality and equity, i.e., distributive justice. The term "bioethics" emerged in the 1970s to highlight the study of the moral relationship between human beings and the social and physical world (Potter 1970). However, given its controversial character for certain global and national policies, bioethics led to dilemmas that emphasised a community *ethos* favouring individuals' autonomy. Thus, the great philosophical questions originated in the initial bioethical studies and considered futuristic by the majority of pioneering bioethicists, e.g., genetic engineering, epidemiologically and ethically, demanded intense ethical scrutiny and that could lead bioethics towards social ethics (Jonsen 2001).

Such reflections on the role of bioethics require a long examination of research ethics. Furthermore, in this way, a question on this topic can be raised in social terms: How is it possible to achieve improved health and well-being without putting some people at risk? This question can guide the purpose of the study of bioethics towards social ethics. This question is of fundamental importance to understand the interface between SR and Bioethics. Many new issues attract bioethics to these cross-cutting paths: the renewed concern with the ethics of genetic engineering, the organization and financing of health, and public health promotion cannot be pursued without a more pertinent appreciation of social ethics (Carlotto and Dinis 2020).

However, the understanding of bioethics' social issues emerges when new issues are put on hold, highlighting the relationship between individuals and their social environment. The theory of social ethics is constructed through the formulation of questions and answers, and, in this set, bioethics responds positively since it has social responsibilities (Carlotto and Dinis 2021).

When publishing the Report of the International Bioethics Committee on Social Responsibility and Health, the United Nations Educational, Scientific, and Cultural Organization (UNESCO 2010) proposes a vision aimed at reformulating the conceptual framework about the right to health and its practical implications, viewing health as a fundamental human right, which should be fully guaranteed to every human being. The call that the report advocates and everyone is called to respond to is the commitment to non-exclusion and ensuring accessibility to the "excellence" of scientific and medical progress. Thus, it can be evidenced, in this sense, the socially responsible character of bioethics, since the recipients of this 'responsibility' are not just governments and states within the limits of their 'jurisdiction' and public policy makers (Semplici 2011). The bioethical challenge existing in SR's scope is to plan and operationalize, simultaneously, health actions that consider the social and global determinants of health and current public policies.

5 Cross-Cutting Dialogues

The bioethical paradigm's characteristic is to guarantee individuals' autonomy concerning the understanding of their own health and that of global health. Bioethics' involvement in the scope of HE is fundamental since it refers to moral

principles and values, configuring itself in a new bioethical vision directed towards responsibility that projects beyond the limits of its discipline (Turoldo 2009).

HEIs are closely linked to the economic, social and environmental landscape of the modern world. This global involvement of HEIs comes from a diverse and active society: stakeholders, students, families, non-governmental organizations, government agencies.

The complexity of the contemporary world exponentially increases the ethical challenges and dilemmas to be faced in society. Such challenges require collective responses and increasingly complex solutions that make it possible to establish individual and global connections with everyone involved in this process. An example of these connections is the already mentioned 17 SDGs formulated by the UN (UN 2015) that clearly defined an agenda to deal with these complexities.

Faced with this scenario, there is a clear need for HEIs to respond to these challenges through innovative curricula and study programs and creative and collaborative research agendas in ways that will allow them to cross-institutional and disciplinary and regional and international boundaries. Scientific research that addresses measures to incorporate SR in education encourages education for global citizenship, educating individuals to assume personal responsibilities through collective actions and global development. Such actions involve areas of knowledge that communicate, for example, entrepreneurship, health, education at all levels, environment, economy (Wells 2017).

Promoting SR in HE is a multidisciplinary task, so there is a need to cross dialogues with various areas of knowledge. This orientation can be seen by elaborating a knowledge network that proposes addressing social challenges under a unified view instead of aiming for scientific advancement in isolated disciplines. The joining of these efforts shows remarkable results in the highlighted areas, e.g., health, migration, culture, environment, governance and politics (Malone 2017).

The mission and purpose of HEIs occupy a unique and differentiated position in the SR concept itself. This vision is manifested in the construction of more inclusive and equitable academic communities, which act as catalysts and propellers for creative and innovative thinking in SR issues.

6 Conclusions

HEIs have contributed significantly to the development of actions aimed at a globally recognized concept about SR. More specifically, the combination of SR in HE with the bioethical paradigm provides universities with the knowledge they need to design a more sustainable future. For responsible development to be generated, countries must invest in education, science, and technology to focus on SR. Such a view allows universities to be located at the centre of national and global strategies.

As future intervention strategies related to this theme, HEIs can align their interests with the needs of society, working in collaboration with other HEIs in order to maximize their impact of actions, collectively, seeking the inclusion of the SR and bioethics theme in local curricula and programs, in order to conduct research aimed at communities that contribute to responsible development. They should also work in reinforcing the transversal links between the different areas of knowledge, in order to guarantee the integration of SR issues in the curriculum and in the strategic planning of the HEI, thus including new values and practices for responsible development in HE. The articulation of SR competences and skills aimed at professors and students, in order to allow them to be efficient and effective in the communities to be worked on is also important.

The involvement and integration of stakeholders that can assist both in the planning and execution of educational activities and in the evaluation processes, as well as further investment in multidisciplinary research, stimulating talents and promoting international mobility and collaboration, will all contribute to enlighten the society towards the role of SR in HEIs.

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A Review on the Cultural Ecosystem Services Provision of Urban Green Spaces: Perception, Use and Health Benefits

Diogo Guedes Vidal, Ricardo Cunha Dias, Gisela Marta Oliveira, Maria Alzira Pimenta Dinis, Walter Leal Filho, Cláudia Oliveira Fernandes, Nelson Barros, and Rui Leandro Maia

1 Introduction

Due to the increase of the world population and its concentration in cities, a balance between humans and nature is necessary more than ever. Within the framework of sustainable urban planning, the health of the ecosystem is essential for all life on Earth, comprising both human and non-humans (Dinis 2016; IUCN 2020). The governance of ecosystem services (ES) by committed local authorities plays a

D. G. Vidal (✉) · G. M. Oliveira · M. A. P. Dinis · N. Barros · R. L. Maia
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: gisela@ufp.edu.pt

M. A. P. Dinis
e-mail: madinis@ufp.edu.pt

N. Barros
e-mail: nelson@ufp.edu.pt

R. L. Maia
e-mail: rlmaia@ufp.edu.pt

R. C. Dias
Centre for Public Administration and Public Policies (CAPP), Institute of Social and Political Sciences (ISCSP), University of Lisboa (UL), Campus Universitário do Alto da Ajuda, Rua Almerindo Lessa, 1300-663 Lisboa, Portugal
e-mail: rdias@iscsp.ulisboa.pt

C. O. Fernandes
Research Centre in Biodiversity and Genetic Resources (Cibio-inBIO), Faculty of Sciences, University of Porto (FCUP), Rua do Campo Alegre s/n, 4169-007 Porto, Portugal
e-mail: cofernandes@fc.up.pt

W. L. Filho
European School of Sustainability Science and Research (ESSSR), Hamburg University of Applied Sciences (HAW), Ulmenliet 20, 21033 Hamburg, Germany
e-mail: walter.leal2@haw-hamburg.de

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decisive role in local changes. This has the potential to initiate movements and support adequate institutions and laws that may be applied at the regional or national level (IUCN 2011).

A socio-ecological approach is needed to maintain and restore biodiversity and ES, mainly in a time where global changes are threatening all species. In this current scenario, ecosystems are expected to be resilient and supportive of all life (Farinha-Marques et al. 2011). In addition to this effort, some studies reveal an absence of political awareness regarding this issue, which could thus undermine sustainability efforts (Rodrigues et al. 2004; Rands et al. 2010). To reverse this trend, the scientific community and decision-makers are trying to develop a holistic approach to safeguarding the ecosystem. This approach recognises humans as important beneficiaries and guardians of nature, aiming to constitute the basis for policy design and to integrate multilevel governance (Cardinale et al. 2012; Turnpenny et al. 2014; Haines-Young and Potschin 2018; Russo and Cirella 2018a).

The scientific recognition of ES offered by UGS was an important step for integrating ES services in sustainable urban planning. The ES can act as relevant elements, connecting urban and nature dimensions (nature connectedness) (Mayer et al. 2008; Howell et al. 2011). ES provided by UGS are far from being fully known. The Common International Classification of Ecosystem Services (CICES) recognises the main services provided by ecosystems (Haines-Young and Potschin 2018; Russo and Cirella 2018b; Food and Agriculture Organization of the United Nations 2019): provision of material and energy needs, environmental regulation and maintenance for humans, and the non-material characteristics of ecosystems that affect physical and mental health states of people, i.e., their cultural significance. A significant number of studies have contributed to describing the relevant impacts of the main provision, regulation, and maintenance services offered by UGS (World Health Organization 2017; Graça et al. 2018; Vargas-Hernández et al. 2018; Charoenkit and Piyathamrongchai 2019; Matos et al. 2019).

However, little is still known about cultural ecosystem services (CES). CES and their multiple dimensions have been studied in a fragmented way, thus compromising its integration in the ES framework. Alongside, the perception that CES are the most difficult services to classify and measure (Fish et al. 2016) and the fact that CES are primarily driven by human experience (The Urbes Project 2015) also play a role in this gap. This is mainly related to CES' connections to human emotions through a deep sense of meaning, fulfilment and motivation—dimensions that cannot be measured in a laboratory or through the use of technology. This can be a barrier in the decision-making process since the emphasis is on quantitative data and empirical measurement. Additionally, recent evidence (Gould et al. 2019) shows that people are not consciously aware of CES, which results in the difficulty to articulate and to study them. On the other hand, CES integrate the identity dimension, and people may not

W. L. Filho
School of Science and the Environment, Manchester Metropolitan University, Manchester M15 6BH, UK

want to share such meaningful personal and cultural insights with researchers. All these reasons contribute to setting CES aside from the decision-making process.

A common definition of CES consists in the non-material benefits that people obtain from ecosystems, such as an aesthetic inspiration, a cultural identity, a sense of home, and a spiritual experience related to the natural environment (Food and Agriculture Organization of the United Nations 2019). Other definitions have been proposed by some authors, such as Fish et al. (2016, p. 212) that defines CES as the 'contributions ecosystems make to human wellbeing in terms of the identities they help frame, the experiences they help enable and the capabilities they help equip'.

There are mainly four types of recognised CES (Food and Agriculture Organization of the United Nations 2019): (1) recreation, mental and physical health related to nature-based opportunities; (2) tourism; (3) aesthetic appreciation and inspiration for culture, art and design; (4) and spiritual experience and sense of place. The greatest strength of CES is probably the fact that they are central to well-being (Millennium Ecosystem Assessment 2005). Previous studies (Schmidt et al. 2016; Dickinson and Hobbs 2017; Vidal et al. 2020) link CES and well-being in various dimensions, i.e., physical, mental and social health. These strengths should be considered in spatial planning and by decision-makers, as their mission is to promote resilient, healthy, and sustainable cities.

In addition to CES' importance on the ES framework, the need for an inter-disciplinary approach also brought other essential concepts to this discussion. These concepts aimed to contribute to the wide ranges of values between the values of nature that go beyond the intrinsic ones, i.e., the value of ecosystems as ends to themselves, and the instrumental values, i.e., the value of ecosystems as merely means to an end and measured in monetary terms (Arias-Arévalo et al. 2017).

The concept of relational values (RV) includes the preferences, principles and virtues about human-nature relationships that enable change in the decision-making process (Chan et al. 2018; Himes and Muraca 2018). RV differ from CES in the fact that it is not about the values of nature but the values *about* nature (Chan et al. 2016). These values are representations of what different people find meaningful about nature, which are the feelings of attachment, commitment and responsibility towards nature. The recognition of RV in the field has resulted in its inclusion, as a category, in the conceptual framework provided by the Intergovernmental Platform on Biodiversity and Ecosystem Services (IPBES) (Duraiappah and Rogers 2011; Díaz et al. 2015).

Accordingly, this review aims to contribute to a better understanding of CES provided by UGS in a more comprehensive way. A previous systematic review (Hegetschweiler et al. 2017) analysed studies that relied only on European cases that focused on the CES' supply and demand factors and how they are combined in urban green infrastructures. Nevertheless, studies on how CES are perceived are still lacking in the literature, alongside an international overview of the published studies analysing UGS uses and health benefits in a systematic way. In this presented review, the focus is different, since the attention is focused on UGS, a component of the urban green infrastructure. UGS are designed to be parks and other green spaces, including plant life, water features and other kinds of natural spaces that play an important role in public open spaces. This is a key point for

public policies and landscape urban planning, since designing and improving UGS contributes to making cities healthier places to live. A comprehensive approach is needed to provide reliable and accurate information on this topic. Accordingly, the present approach aims to identify how CES are being measured and which CES are being identified and studied in order to understand the reliability of the analysed studies' outcomes. CES perceptions, main uses and impacts on human health constitute necessary knowledge for designing future intervention in UGS that match current and potential users' preferences and motivations to contribute to making cities healthier places to live in.

Thus, five research questions were designed in this review to understand:

(i) the main data collection methods and analysis techniques to study CES;
(ii) which types of CES are identified in the literature;
(iii) how CES are recognised and perceived by UGS users;
(iv) the main uses of UGS and their relation to CES;
(v) the major impacts of CES on the physical and mental health of UGS users.

It is expected that this review systematises the last twenty years of scientific knowledge in this topic, identifying future research paths.

2 Material and Methods

The PRISMA guidelines (Moher et al. 2009) were adopted to conduct this review. PRISMA is a validated reference for literature review, which comprises an evidence-based, minimum set of twenty-seven items for reporting in systematic reviews and meta-analyses and a four-phase flow diagram (Tricco et al. 2018). The PRISMA flow diagram (Fig. 1) and the checklist were followed for reporting the findings of the presented systematic review. Due to the exploratory nature of this review and to some limitations related to the keywords used to search the studies, no predefined protocol was registered.

2.1 Search Strategy and Eligibility Criteria

The literature search was conducted to collect studies that focus on the CES offered by UGS. The combined keywords used in all searches included only 'urban green space' OR 'parks' AND 'cultural ecosystem service' OR 'cultural services', following the example of previous systematic reviews (Hegetschweiler et al. 2017; Boulton et al. 2018; Rajoo et al. 2020). These three reviews considered two to four search terms, which allowed one to extract a significant number of records and examine their pertinence to this review. If one of these keywords was not present in

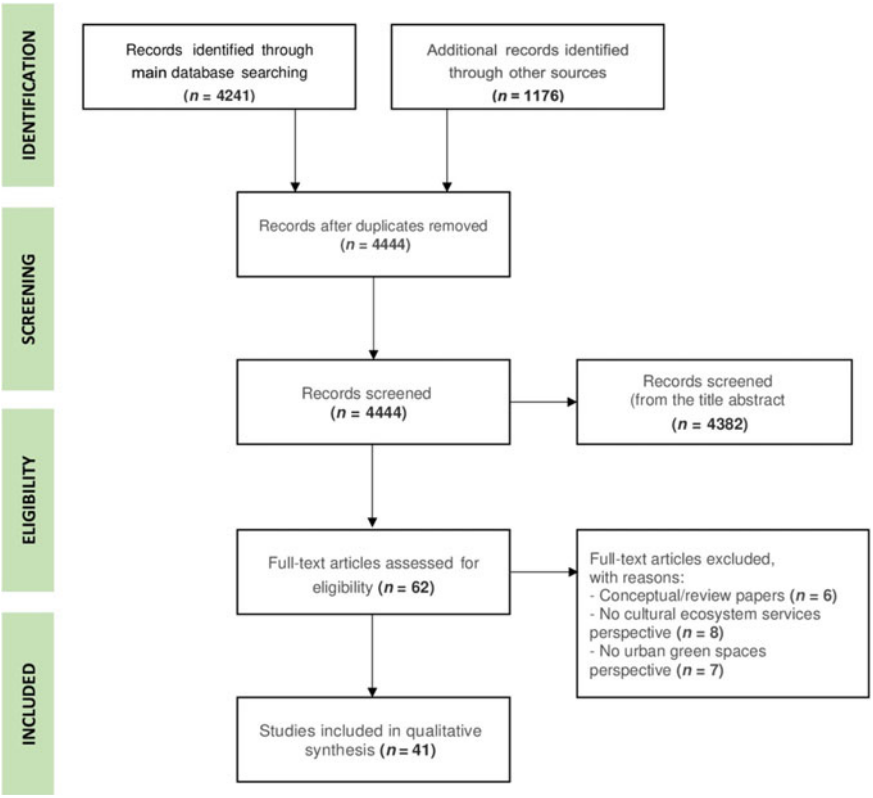

Fig. 1 Flow diagram showing the number of studies screened, assessed for eligibility, and included in the review, adapted by Moher et al. (2009)

the records titles, keywords or abstracts, the article could not be included (inclusion criteria). The timeline, equal for all searches in all databases, focused on the last twenty years, from January 1, 2000 to March 30, 2020. The selection of the time frame for this period is explained by the entry into the new millennium, which has coincided with a greater attention to urban sustainability (Agenda 21; Millennium Development Goals; Millennium Ecosystem Assessment; ES framework development; and SDGs). The search was carried out in ScienceDirect (Article type = Research articles, years = 2000–2020), PubMed (Article type = journal article, text availability = Full text, year = 2000–2020) and Google Scholar (year = 2000–2020) databases. No hand search or reviewing references that were reported in previous reviews or relevant publications was performed.

The literature search was conducted to collect studies that focused on the CES provided by UGS. The inclusion criteria adopted were: (i) field studies in UGS,

such as surveys administration, participatory approaches, interviews, geographic information system (GIS) application, and other methodologies to study the assessment, perception, preference, and impact of CES in green space users, (ii) full-text availability, (iii) peer-reviewed articles only and (iv) articles published in the English language. The following exclusion criteria were adopted: (i) conceptual or review articles and (ii) articles published in languages other than English.

2.2 Data Extraction

Aiming to obtain an overview of the selected studies, the following information was extracted, based on the research questions: (i) country of the study, (ii) research objectives, (iii) study sample characteristics, when available, (iv) study design (i.e., cross-sectional or longitudinal), (v) data collection method and (vi) main findings. The title, abstract and full-text were screened to assess any discrepancy. The data entry in the Endnote was confirmed for analysis of completeness and accuracy, namely the relevance of the extracted literature.

3 Results

ScienceDirect returned 4241 results, Google Scholar returned 1160 results and PubMed returned 16 results. Duplicate articles that were indexed in more than one database, mainly from Google Scholar, doubling some of the extracted records, were excluded (n = 1173). 4444 results remained and were screened for relevance. Considering the present review's purpose and research questions, a search in the Endnotes was conducted to identify whether the selected keywords were present on the articles' title, abstract and keywords, removing another 4382 papers. The full-texts of the remaining 62 articles were assessed, and 21 articles were excluded, as they did not meet the previously defined eligibility criteria.

Forty-one papers were included in the review. Based on the data extraction elements, a summary of the included studies is presented in Table 1, organised according to their chronological order of publication. In the next subsection, the selected studies are analysed, according to the formulated research questions.

Table 1 List of the 41 studies included in the systematic review in chronological order of publication (2006–2020)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Guite et al. (2006)	United Kingdom	To examine the strength of association between physical and social factors in the built environment and mental well-being	*n* = 830 Females (63%) 45–54 yrs (25.4%)	Cross-sectional	Survey	Scores of the lowest quartile of the SF36 for Mental Health and Vitality are associated with dissatisfaction in access to UGS
Home et al. (2012)	Switzerland	Psychosocial outcomes that motivate people to seek urban green spaces Preferred activities	*n* = 902 Mean age 49.5	Cross-sectional	Survey	Motivations: restoration, with social bonding as a desirable side benefit. Older people are motivated to visit nearby green spaces by the wish to seek social contact while younger people are motivated by the wish to seek escape and to reflect
Ambrey and Fleming (2013)	Australia	To examine the influence of public greenspace on life satisfaction	Residents of Australia capital cities	Cross-sectional	Survey	A positive relationship between the percentage of public greenspace in a resident's local area and their self-reported life satisfaction, on average corresponding to an implicit willingness-to-pay of $1172 in annual household income for a 1 per cent (143 m^2) increase in public greenspace

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Nutsford et al. (2013)	New Zealand	To study whether proximity to UGS is associated with human mental health	n = 3149 small area units in Auckland	Cross-sectional	GIS	Decreased distance (up to 3 km) and an increased proportion of green space are associated with a lower incidence of anxiety/mood disorder treatment
White et al. (2013)	United Kingdom	To explore the relation between UGS, well-being and mental distress	n = 12,818 26–35 yrs (19.2%)	Longitudinal; GHQ (mean observations per person = 6.83) Life satisfaction (mean observations per person = 5.56) 17 yrs of follow up	Survey	Individuals have less mental suffering and greater well-being when living in urban areas with more green space
Song et al. (2014)	Japan	To explore if contact with the natural environment can improve physical and mental health	n = 17 Males (100%) Mean age 21.2 yrs	Cross-sectional	Field experience	After walking in the urban park: greater parasympathetic nervous activity and less sympathetic nervous activity; heart rate was significantly lower when walking in the urban park; negative feelings such as 'tension-anxiety' and 'fatigue' were significantly lower; anxiety dimension score was also significantly lower after walking in the urban park

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Krekel et al. (2016)	Germany	To investigate the effect of urban land use on residential well-being	*n* = 22,*000* Females (53%) Mean age 48.7 yrs	Cross-sectional	Survey	The access to green urban areas is positively associated with, whereas access to abandoned areas, such as waste or left over land, is negatively associated with life satisfaction. The effects are strongest for older residents, accounting for up to a third of the size of the effect of being unemployed on life satisfaction
Melis et al. (2015)	Italy	To study the association between UGS and the consumption of antidepressants	*n* = 547,263 Females (52.2%) 35–49 yrs (37.4%)	Longitudinal 2 Observations 2 yrs of follow up	Survey	Indicators of green spaces are associated with mental health levels (protective factors)
Voigt and Wurster (2015)	Austria	Perception and valuation of species and structural diversity of an urban green space	*n* = 76	Cross-sectional	Interviews	People use 'diversity' to express their feeling of well-being during their stay at a given site rather than an objective assessment of the number of species or elements
Langemeyer et al. (2015)	Spain	Assess monetary values associated with CES; to assess non-monetary values	*n* = 198	Cross-sectional	Survey	CES values change across different green infrastructure and management regimes. Environmental learning'

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						generates low monetary values but high non-monetary values. Stronger place values were related to low management intensity, while values for tourism increase with land-uses embedding cultural facilities
Bertram and Rehdanz (2015)	Germany, Sweden, The Netherlands and Austria	Compare attitudes towards ecosystem services provision, perception, and use of urban parks	n = 1527 Females (58.7%) Mean age 44.2 yrs	Cross-sectional	Survey	Similarities between cities regarding attitudes towards ecosystem services provision and the importance of different park characteristics for visitors
Zhang et al. (2015)	Netherlands	To examine the links between self-reported health, attachment to green space and the availability of accessible and usable green spaces	n = 223 Males (57.8%) Mean age 45.4 yrs	Cross-sectional	Survey	Greater attachment to the local green space and better self-reported mental health in the neighbourhood with greater availability of accessible and usable green spaces
de la Barrera (2016)	Chile	Preferences for green spaces and perceptions of safety in three socioeconomically differentiated neighbourhoods	n = 78	Cross-sectional	Interviews	The neighbourhoods showed differing patterns, uses and users of the green spaces explained primarily by differences of perception regarding community

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						attachment, image, and preference over other spaces. Socioeconomic status is associated with the intensity and diversity of use, community attachment, and the image of the parks
Gubbels et al. (2016)	Netherlands	To assess the impact of perceived and objective changes in greenery on physical activity and mental health of adolescents and adults living in severely deprived neighbourhoods	n = 454 adults Females (55.7%) Mean age 46.3 yrs n = 401 adolescents Females (57.6%) Mean age 13.2 yrs	Longitudinal 2 Observations 1 yrs of follow up	Survey	Improvements in perceived vegetation are related to a decrease in depressive symptoms in adults
Maraja et al. (2016)	Germany	Perceptions of CES in the urban context and which focus areas were emphasized	n = 41	Cross-sectional	Interviews	A variety of intricate cultural ecosystem service perceptions was found. Hence, selecting and emphasizing only a few services without prior studies could misinform decision-makers and lead to biased policy outcome. Regionally specific

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						perceptions of cultural benefits from urban green are important information for planning processes
Ode Sang et al. (2016)	Sweden	Investigate the importance of neighbourhood UGS to local people's use, perception, and self-reported well-being, and any links to CES. Explore the influence of demography (gender and age) and the green spaces' naturalness for people's use, perception, and well-being	n = 1347 Females (56.8%) 26–35 yrs (24.0%)	Cross-sectional	Survey	High perceived naturalness generated more activities, higher aesthetic values and well-being for residents in the vicinity of urban green spaces. Women are more active, see greater aesthetic value and have higher well-being associated with green spaces. Older residents participate in a greater number of nature-related activities than younger residents. Older residents see greater aesthetic values and have higher well-being associated with urban green spaces than younger people
Baur et al. (2016)	USA	Explore human dimensions of forest ecosystems, focusing on urban forests	n = 734 Females (53.0%)	Cross-sectional	Survey	Respondents rated watershed health, ecological health and habitat preservation, and sustainability as the most important management goals. Respondents felt most

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						strongly that more UGS, habitat, and safety were indicators of successful urban forest management. Renters generally hold stronger attitudes about management than homeowners, though practical differences are small
Larson et al. (2016)	USA	To explore public perceptions of urban ecosystem services by examining the benefits associated with greenways	n = 460	Cross-sectional	Survey	Several types of ecosystem services were recognized by the respondents: environmental benefits (e.g., air and water quality regulation; acknowledged by 74% of respondents), but were less widely recognized than cultural benefits (e.g., economic impacts, social connectivity; 90%) or experiential benefits (e.g., attractive scenery, recreation; 98%)
Chan (2017)	Hong Kong	To study how urban green spaces can become a green brand that encompasses health-related elements	n = 301 Females (52.0%) 21–60 yrs (70.0%)	Cross-sectional	Survey	Moderate association between the health-related elements and other green brand elements was found. An extension of the health promotion value of the green

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						spaces to the brand elements, focusing on the quality and the landscape aesthetic function of UGS was identified
Chen and Hua (2017)	Hong Kong	To assess resident perceptions of ecosystem services provided by, urban heritage trees	n = 1075 Males (53.4%) 18–29 yrs (32.6%)	Cross-sectional	Survey	Biological and cultural benefits of urban heritage trees were perceived to be important. Nevertheless, six classes were identified based on different levels of two latent class factors, which differed markedly concerning individual's perceived importance of ecosystem services provided by urban heritage trees, from fairly balanced to very divergent perceptions of biological services and CES
Southon et al. (2017)	United Kingdom	To assess green-space visitors' responses to urban meadow	n = 420	Cross-sectional	Photo-elicitation studies and a controlled perennial meadow creation experiment; Survey	Meadows were generally preferred to herbaceous borders and formal bedding planting. Meadows that contained more plant species and some structural diversity (i.e. were tall or of medium height) were most preferred.

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						The magnitude of these preferences was lower amongst people that used the sites the most, probably due to a strong attachment to the site, i.e. sense of place. People with greater eco-centricity (i.e. those who used the countryside more frequently, had greater ability to identify plant species and exhibited more support for conservation) responded more positively to meadow vegetation. Crucially a wide range of respondents was willing to tolerate the appearance of meadows outside the flowering season, especially when provided with information on their biodiversity and aesthetic benefits and potential cost savings (from reduced cutting frequencies)
Chang et al. (2017)	China	To assess the CES	N.A	Cross-sectional	Land rent method	Results showed that the same area of green spaces near the centre provided much higher

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						cultural services than that near the urban edge; along the centre-edge gradient, there was a threshold out which the ecosystem services were lower than the maintenance cost of green spaces
Wood et al. (2017)	Australia	To investigate the association between the presence, amount and attributes of UGS in new greenfield neighbourhood developments and the mental health of residents	n = 492 Females (62.0%) Mean age 47.8 yrs	Cross-sectional	Survey	Number and total area of UGS are significantly associated with greater mental well-being. Positive mental health has been associated with parks focused on nature and green spaces characterized by recreational and sports activities
Massoni et al. (2018)	Norway	To assess and classify the recreational services in UGS	n = 85	Cross-sectional	Index application and survey	The size is a weak and non-linear determinant of structural diversity. On the other hand, stated preferences are correlated with structural elements. Respondents indicated public transport as the most preferred element, followed by dominance of grass, balance between forest and grass and lake/pond

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Fischer et al. (2018)	Italy, Germany, United Kingdom, Slovenia and Sweden	To assess how people use urban parks and how recreational patterns relate to respondents' sociocultural and geographical contexts	n = 3814 Females (58.0%) Mean age 39.0 yrs	Cross-sectional	Survey	Across Europe respondents share a general pattern in their recreational activities with prevalence for the physical uses of parks, especially taking a walk; the geographic context matters, demonstrating a high variety of uses across the cities; The sociocultural context matters for physical park uses and is associated to a lesser extent with nature-related uses
Pope et al. (2018)	United Kingdom	To investigate the access to green space about Psychological distress in a deprived urban population	n = 578 Females (54.0%) > 60 yrs (65.9%)	Cross-sectional	Survey	In addition to accessibility to the sufficiency of green spaces, the ability to use them for relaxation and recreation was significantly associated with reduced psychological suffering and. A dose–response relationship was identified between the number of positive attributes of the green space and psychological suffering
Zwierzchowska et al. (2018)	Austria, Poland and Romania	To assess cultural urban ecosystem services demand and flows of parks as reflected in visitor perception and behaviours	n = 373 Females (52.0%) 19–60 yrs (64.0%)	Cross-sectional	Survey	Respondents visit parks mainly to relax and rest as well as for pleasure and social activities. While parks tend to meet these demands well, the

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						most pronounced mismatches are in the field of educational potential. The ecosystem service capacities of parks have different strengths in attracting visitors and in some cases, this effect can be stronger than a simple inconvenience inaccessibility and distance
Łaszkiewicz et al. (2018)	Poland	To evaluate the impact of urban green space availability on residential duration, relating with socioeconomic groups	n = 466	Cross-sectional	Econometric model	The length of residential duration of the wealthier residents is not affected by the availability of nearby green space, while the length of residential duration of the less socioeconomically privileged residents is affected negatively by the availability of nearby green space
Sarkar et al. (2018)	United Kingdom	To investigate the association between residential green exposure and the prevalence of major depressive disorders	n = 94,879 Females (52.0%) Mean age 56.9 yrs	Cross-sectional	Survey	Protective effect of green spaces on depression was observed. Interaction analyses indicated that the beneficial effects of UGS were more pronounced among women, participants under 60 years of age and residents in areas with low socioeconomic status

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Southon et al. (2018)	United Kingdom	To investigate the impact of creating biodiverse habitats on green-space users' physical and mental health, and psychological well-being	n = 360	Cross-sectional	Survey	Significant associations between perceived site-level biodiversity per se and site satisfaction and feeling connected to nature were founded. A positive association between nature dose and self-estimated mental health was observed. Perceived richness was positively associated with vegetation height, evenness, and colourfulness suggesting that these are cues for estimating species richness. Respondents with higher levels of eco-centricity were more accurate than people who were less connected to nature
Riechers et al. (2018)	Germany	To understand inhabitant perceptions of CES provided by UGS	n = 558 Females (51.0%) Mean age 43.0 yrs	Cross-sectional	Survey	The perceived importance of CES was influenced by spatial and social factors: Older inhabitants living in periurban areas preferred CES related to nature experiences. Younger inner-city dwellers tended to prefer CES facilitating social interactions

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Scholte et al. (2018)	Netherlands	To spatially analyse the recreational potential of land, which physical attributes contribute to the recreational potential of land, at both a regional and a national scale and how preferences for such attributes differ between respondents from distinct geographical regions	n = 3293	Cross-sectional	Online mapping survey	Interregional differences, whereas prominent at the regional scale, are small at the national scale, suggesting there is a shared understanding of what places are 'hotspots' for recreation within the country studied
Ko and Son (2018)	South Korea	To analyse perceptions of CES in the urban context	n = 240 Females (79.6%) 20–40 yrs (45.8%)	Cross-sectional	Survey	Since forests and large parks are easily accessible from the downtown area, they play major roles in providing CES. This study suggests that people find diverse cultural value in their everyday surroundings, not just in spaces with excellent ecosystems
Rudl et al. (2019)	Czech Republic	To study how young urban trees as important structures in the cultural heritage of cities	n = 40 trees	Cross-sectional	Field mapping	Young trees (not just very large and old trees) can be very important structures for the provision of CES in cities, and that they can be viewed as living cultural symbols, which is a new aspect in the awareness of the environmental and social roles of urban trees

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Dai et al. (2019)	China	To analyse how online comment data match the various categories of CES	n = 7257	Longitudinal 7 yrs of follow up	Content analysis (online comments)	Cultural services of urban parks could be divided into seven types: aesthetics, recreation, sports, inspiration, education, cultural heritage, and spiritual satisfaction). Differences exist in the perception of cultural service in urban parks, the park's scale, and characteristics determine the visitor's CES perception level. The aesthetic and recreation types were the most easily perceived, and 68% and 63% of parks have the above two perceptual records, respectively
Hong et al. (2019)	South Korea	To examine how the frequency of visits and time spent in UGS affect urban dwellers' subjective well-being To investigate respondents' primary motivation, and constraints on their ability to visit	n = 400 Males (50.0%) 40–49 yrs (27.5%)	Cross-sectional	Survey	No significant interactions between visit frequency and time spent in UGS were identified. Respondents who had visited UGS within the past two weeks expressed higher positive and lower negative emotions than did non-visitors, regardless of visit frequency, and regular visitors showed higher general life satisfaction levels. Time spent in UGS did not affect

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						emotions or life satisfaction in general. Heavy users mostly visited urban green spaces to walk, and light/non-users cited the lack of UGS their home as the major constraint on visiting UGS
Liu et al. (2019)	China	To explore biopsychosocial pathways linking residential greenness exposure to depression	n = 20,533 Males (52.5%) Mean age 44.8 yrs	Cross-sectional	Survey	Exposure to UGS in a residential context is negatively associated with depression, and that physical activity, stress and social cohesion of the neighbourhood have a complete effect of mediation in this association
Ramer et al. (2019)	United States	To examine how park visitors' perceptions of flowering lawns	n = 537 25–34 yrs (33.9%)	Cross-sectional	Survey	97.2% of respondents supported implementing flowering lawns in public parks. Positive perceptions of bees and flowering lawn appearance were the only two significant factors associated with support for flowering lawns in both pre- and post-informational intervention logistic regression models. Aesthetics and benefits to bees were the

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
						most frequently stated perceived benefits
Ngulani and Shackleton (2019)	Zimbabwe	To determine urban green spaces use as sites for religious gatherings	n = 385 Males (56%) 19–40 yrs (60.5%)	Cross-sectional	Survey	Religious gatherings were observed in all sampled green spaces and 7% of a random sample of visitors to the urban green spaces said that they participated in such. Amongst the worshippers, 71% said worshipping outdoors was part of their religious practices and 29% said they did so because they had no building in which to worship. Most (79%) worshipped in public green spaces 1–4 times per week. Many felt that it would be easier if the city council designated specific and quiet areas in public green spaces for their religious observances, which they could then help maintain. The mean value of spiritual services was determined to be US$93 ± 79/ha/yr, and tended to be highest in the high density, poorer suburbs

(continued)

Table 1 (continued)

Source	Country	Objectives	Sample characteristics	Study design	Data collection method	Outcome
Olsen et al. (2019)	66 European cities	To explore associations between cities' land cover/use, residents' reported life satisfaction and within-city socio-economic inequalities in life satisfaction	n = 63,554 Females (52.8%) 55 yrs or more (33.2%)	Cross-sectional	Survey	Pastures and herbaceous vegetation are associated with life satisfaction. A more even distribution of land cover/use was associated with lower inequality in life satisfaction. More equal distribution of land cover/use is associated with lower levels of socio-economic inequality in life satisfaction
Kuldna et al. (2020)	Estonia and Finland	To analyse the perceived importance of and satisfaction with nature observation activities and their influencing factors	n = 802 Females (55%) Mean age 39.5 yrs	Cross-sectional	Survey	Age, gender and nationality influenced how important visitors considered nature observation. Two factors had an effect on the satisfaction with all nature observation activities (watching, listening and learning): age group and the site's natural appearance. Visitors who had read the information boards were more satisfied with learning about the site's nature. Visiting nature trails or boardwalks and visiting the birdwatching tower did not influence visitor satisfaction with nature observation

3.1 Overview of the Studies

This section concerns the first research question, providing information related to the main data collection methods used to study CES, the geographical location of where the studies were developed, preferred journals and representative years. The timeline previously defined for this review was the last twenty years, specifically since 2000. In Fig. 2, it is shown that the majority of the analysed studies were published in 2018 (24.4%), which highlights the timeliness of this topic. This concentration of papers coincides with the publication of the CICES.

The geographic location where the studies were developed is presented in Fig. 3.

The majority of the analysed studies were developed in Europe (68.6%), namely in the United Kingdom (15.7%) (Fig. 3). Asia is the region that follows in terms of numbers of studies (15.7%), with 5.9% developed in China.

Concerning the journals chosen by the researchers to publish their studies (Table 2), the impact factor (IF) ranges, overall, from 1.131 to 10.70, a significant difference. These data reveal that this topic is well received by high IF journals, providing a basis to researchers for disseminating their works in this area. The Ecosystem Services journal (5.572 IF) represents 22.0% of the analysed studies, followed by the Urban Forestry and Urban Greening journal (3.043 IF; 14.6%) and the Landscape and Urban Planning journal (5.144 IF; 12.2%). In total, these three journals represent more than half (48.8%) of the studies analysed in this review.

Aiming to analyse the authors' keywords, Fig. 4 presents the map frequency of use and the interconnection between them. The 41 records resulted in 176 keywords.

Through the records, it can be verified that the most referred keywords were 'cultural ecosystem service', 'ecosystem services', 'urban green spaces', 'urban parks', 'cities' and 'green infrastructure'. According to the cluster keywords, some are rather interesting and reveal the connection between CES, wellbeing, landscape planning and recreation. The dark green cluster joins 'cities', 'biodiversity', 'nature connectedness', 'wellbeing' and 'benefits'. The red cluster joins 'public health', 'city branding', 'nature', 'green space' and 'cultural recreational ecos'.

Another important characteristic of the studies is the study design, which is of utmost importance because it partially translates the robustness and reliability of the results. 89.5% of the analysed studies have a cross-sectional design. Of the 38 analysed studies, only 4 have a longitudinal design, 3 in Europe and 1 in Asia,

Concerning the data collection methods (Fig. 5), the survey application is the method most used in this field of study, representing 73.2% of the analysed studies. The remaining methods are face-to-face interviews conducted in green spaces (7.3%), field experience with participants exposed to nature (7.3%), economic model application (7.3%), GIS application (2.4%) and content analysis of online comments (2.4%).

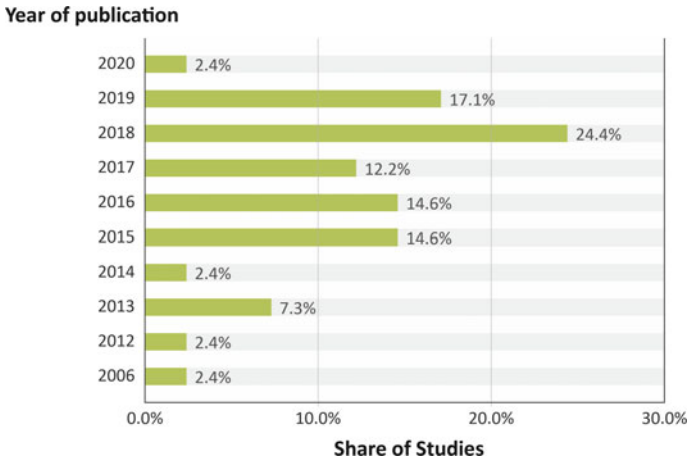

Fig. 2 Share of studies (%) by year of publication (2006–2020). Years that are represented in the figure, returned analysed studies

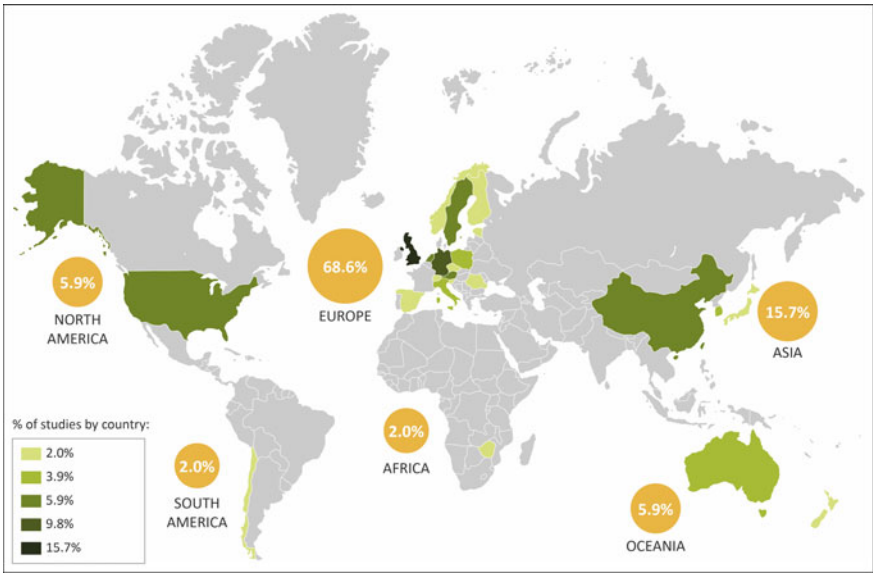

Fig. 3 Distribution of analysed studies (%) by continent and country (2006–2020)

CES are more studied in Europe by researchers from social sciences, mainly in the areas of psychology and landscape management, who opt to use essentially cross-sectional design. Most of the analysed studies used surveys to collect data and were published in specialised journals in the field of ES and linked with human wellbeing, urban landscape management and planning.

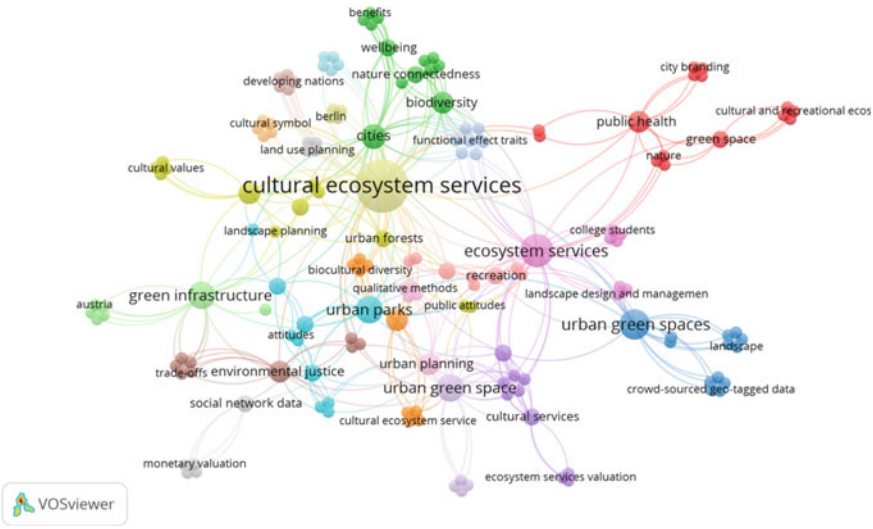

Fig. 4 Co-occurrence network of author/keyword map, generated using the software VOSviewer 1.6.11 (van Eck and Waltman 2010). Each circle represents a keyword and the size of the circle varies according to the frequency of the keyword (i.e., the larger the circle, the higher the frequency). The distance between circles and the established networking represented by lines characterises the relation between keywords (i.e., keywords that are closer and have stronger links are more closely related). Colours are determined by the cluster to which the keyword belongs, which was automatically originated by the VOSviewer software based on the previous input information (2006–2020)

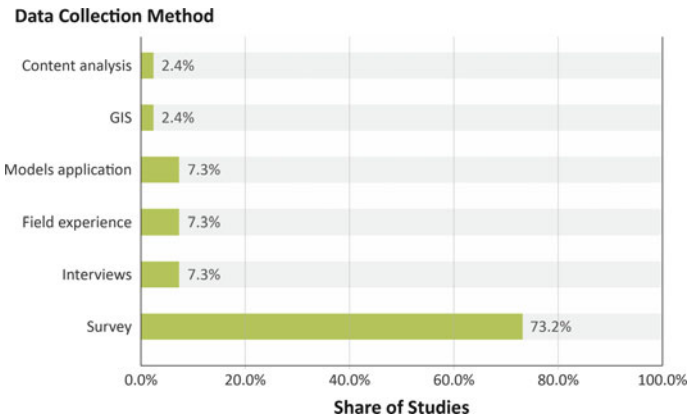

Fig. 5 Share of 41 analysed studies (%) by data collection method (2006–2020)

Table 2 Distribution of the analysed studies by publishing journal

Journal	Impact factor*	*N*	%
Ecosystem Services	5.572	9	22.0
Urban Forestry and Urban Greening	3.043	6	14.6
Landscape and Urban Planning	5.144	5	12.2
Health and Place	3.202	3	7.3
Public Health	1.696	2	4.9
International Journal of Environmental Research and Public Health	2.468	2	4.9
Sustainability	2.592	2	4.9
Leisure Sciences	1.969	1	2.4
Psychological Science	4.902	1	2.4
Journal of Physiological Anthropology	1.131	1	2.4
Scientific Reports	4.122	1	2.4
Social Sciences and Medicine	3.616	1	2.4
European Journal of Public Health	2.459	1	2.4
The Lancet. Planetary Health	10.70	1	2.4
Ecological Indicators	4.490	1	2.4
Environmental and Socio-economic Studies	–	1	2.4
Ecological Economics	3.895	1	2.4
Total		41	100.0

3.2 Qualitative Syntheses of the Reviewed Literature

Aiming to respond to the second research question, Table 3 presents the types of CES explored in the analysed studies, categorised according to CICES (Haines-Young and Potschin 2018). This gives a general overview of the most analysed dimensions, which will demand further attention in future research.

Two main studied dimensions were identified: 'Perception and assessment' (n = 18) and 'Recreation and mental and physical health' (n = 20). On the other hand, 'Tourism', associated with monetary issues, is the least analysed CES dimension (n = 4). Both 'Aesthetic appreciation and inspiration for culture, art and design' (n = 7) and 'Spiritual experience and sense of place' (n = 6) also have the potential to capture the attention of researchers.

The literature review allowed for the aggregation of the 41 studies, integrating three major emphases on the qualitative analysis. The first group (n = 17) identified in this review is a set of studies whose main topics are related to understanding how CES are recognised and perceived by UGS users. The second group (n = 6) aggregates a set of studies that analysed the uses of CES provided by UGS, that is, residents' motivations to use or benefit from these services. Finally, the third group (n = 18) brings together a set of studies that investigated the impact of CES in UGS on physical and mental health, namely increasing wellbeing. The studies presented

Table 3 Distribution of analysed studies by the CICES classification of CES

Study	Perception and assessment	Ecosystem services and biodiversity			
		Recreation and mental and physical health	Tourism	Aesthetic appreciation/ inspiration for culture, art, and design	Spiritual experience and sense of place
Guite et al. (2006)		X			
Home et al. (2012)		X			
Ambrey and Fleming (2013)		X			
Nutsford et al. (2013)		X			
White et al. (2013)		X			
Song et al. (2014)		X			
Krekel et al. (2016)		X			
Melis et al. (2015)		X			
Voigt and Wurster (2015)		X			
Langemeyer et al. (2015)			X		
Bertram and Rehdanz (2015)	X				
Zhang et al. (2015)		X			
de la Barrera et al. (2016)	X				X
Gubbels et al. (2016)		X		X	X
Maraja et al. (2016)	X				
Ode Sang et al. (2016)		X		X	
Baur et al. (2016)	X				
Larson et al. (2016)	X		X		
Chan (2017)			X		
Chen and Hua (2017)	X			X	
Southon et al. (2017)	X			X	

(continued)

Table 3 (continued)

Study	Perception and assessment	Ecosystem services and biodiversity			
		Recreation and mental and physical health	Tourism	Aesthetic appreciation/ inspiration for culture, art, and design	Spiritual experience and sense of place
Chang et al. (2017)	X				
Wood et al. (2017)		X			
Massoni et al. (2018)	X				
Fischer et al. (2018)	X				
Pope et al. (2018)		X			X
Zwierzchowska et al. (2018)	X				
Łaszkiewicz et al. (2018)	X				X
Sarkar et al. (2018)		X			
Southon et al. (2018)		X			
Riechers et al. (2018)	X				
Scholte et al. (2018)	X				
Ko and Son (2018)	X				
Rudl et al. (2019)				X	
Dai et al. (2019)	X	X	X	X	X
Hong et al. (2019)		X			
Liu et al. (2019)		X			
Ramer et al. (2019)	X			X	
Ngulani and Shackleton (2019)					X
Olsen et al. (2019)		X			
Kuldna et al. (2020)	X				
Frequencies	18	20	4	7	6

in the next section are site/location specific and the results should not be generalised.

3.2.1 CES Recognition and Social Perception by UGS Users

The third research question aims to understand how CES are recognised and perceived. As stated by Fish et al. (2016), CES have been the target of many research approaches in the last years. The recognition process of CES has not been easy. They are understood as the most difficult ES to characterise and measure (Fish et al. 2016; Gould et al. 2019). In this review, special attention was given to the recognition and social perception of CES in the analysed works.

CES recognition given by UGS users has been identified in the literature. These perceptions can be organised into three major relations: our relationship with nature; nature as a mediator of the relationship with ourselves; and the planning of these relationships (Fig. 6).

Aesthetics and recreation are the most easily perceived CES (Maraja et al. 2016; Dai et al. 2019). In what relates to recreational services of UGS, the literature reveals that the size of the park is a weak determinant according to the users' point of view, contrasting with access to public transports, the dominance of grass, and the presence of a lake/pond, which are the most preferred elements (Massoni et al. 2018). Also, if green spaces are easily accessible and close to urban centres, they can play major roles in offering CES (Chang et al. 2017; Ko and Son 2018).

It was also identified that cultural benefits (such as economic impacts and social connectivity) and experimental benefits (such as attractive scenery and recreation activities) of UGS are more widely recognised than environmental benefits, such as air and water quality regulation (Larson et al. 2016). This recognition has been found in similar manners at different geographical scales, but is more intensively on a national scale than on a regional scale, suggesting a shared understanding of CES (Bertram and Rehdanz 2015; Scholte et al. 2018). Other important elements that were recognised as the most relevant by the UGS users included the space's cleanliness, low crime, ecological health and habitat preservation (Bertram and Rehdanz 2015; Baur et al. 2016). In addition to these similarities among cities, CES perception could be influenced by social factors, such as age and gender: older inhabitants living in periurban areas preferred CES related to nature experiences; younger inner-city inhabitants tended to prefer CES that facilitated social interactions (Riechers et al. 2018; Kuldna et al. 2020).

Regarding the monetary values of CES (instrumental values), they change across different green infrastructure assets and management regimes. As an example, environmental learning practices generate low monetary values but high non-monetary values. On the other hand, a place has a higher monetary value according to the required management intensity (Langemeyer et al. 2015). Another aspect relates to the fact that the CES' monetary dimension could be valuable for health-related elements, namely acting as a green brand (Chan 2017).

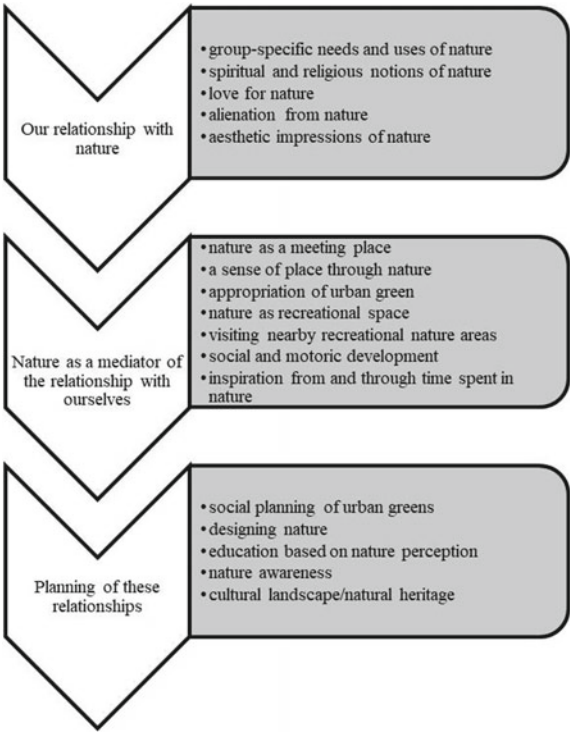

Fig. 6 Relations of CES perceptions by UGS users

UGS users with greater eco-centricity, i.e., value system centred on nature, as opposed to anthropocentrism, preferred vegetation elements in the site quality and appreciation improvements (Southon et al. 2017; Ramer et al. 2019). Meadows, containing more plant species of tall/medium height, were generally preferred to herbaceous borders and formal bed planting. This preference is related to aesthetic and monetary CES dimensions. Users are willing to tolerate the appearance of meadows outside the flowering season, particularly when provided with information on their biodiversity and aesthetic benefits and the potential cost savings derived from reduced cutting/pruning frequency (Ramer et al. 2019). Urban heritage trees were also perceived as important structures in the cultural heritage of cities, namely in CES functions, acting as living cultural symbols and contributing to increasing the awareness of nature (Chen and Hua 2017; Rudl et al. 2019).

3.2.2 Motivations and Uses Related to CES by UGS Users

The fourth research question of this review concerns the uses and functions of UGS. This section shows that, globally, an effort to study how people use UGS, what they look for, and what their motivations are, has been continuously made for the last twenty years.

Concerning UGS users' motivations to use or benefit from CES, several have been identified: restoration, with social bonding as a desirable side benefit, but mainly relaxation and rest, as well as pleasure and social activities (Home et al. 2012; Zwierzchowska et al. 2018). These motivations differ according to the users' age: the elderly are more motivated to visit nearby green spaces in a desire for social contact; on the other hand, younger people seek to escape and to reflect (Home et al. 2012).

How UGS users use and benefit from CES are important guidelines for policymakers. Globally, a higher prevalence for the active use of parks, specifically taking a walk, is identified. Nevertheless, the uses change according to the park's physical characteristics, the surrounding area, community attachment, its image, the users' socioeconomic status, and the preference over other spaces (de la Barrera et al. 2016; Fischer et al. 2018). In contrast, spiritual experiences provided by CES in UGS are not widely studied or analysed. The Ngulani and Shackleton (2019) study focused on this dimension, namely the use of UGS for religious purpose. The same study also calls attention to the need for local authorities' commitment to creating quiet areas in public green spaces for religious observances, which could become helpful to the space's maintenance. Table 4 provides an overview of the main motivations and uses identified in the analysed studies and their corresponding determinants.

3.2.3 Wellbeing: Impacts on Physical and Mental Health

The majority of the studies reviewed relates to the impacts of CES provided by UGS on physical and mental health, namely in wellbeing, which answers the fifth research question. Fish et al. (2016) refer that CES is traditionally a subject studied by social sciences. However, social scientists have been left out of urban planning and this possibly explains what seems to have been a certain invisibility of CES in UGS at that level. Only recently has cultural planning been asserting itself before

Table 4 Motivations and uses identified in the analysed studies (n = 6) and corresponding determinants

Motivations	Determinants
To create social bonding	Age
To do social activities	
To restore	
To have pleasure	
To relax	
Uses	**Determinants**
To have a walk	UGS physical characteristics
To bike	Community attachment
	UGS perceived image
To have religious gatherings	Surrounding area
	Users socioeconomic status

the traditional technical planning, and this evolution has been very slow (Seixas 2017).

Studies have assessed the association between visiting and enjoying UGS and mental wellbeing, suggesting that green space availability and satisfaction are associated with self-reported wellbeing (Guite et al. 2006; Ambrey and Fleming 2013). As the distance from the residential area decreased (up to 3 km) and the proportion of green space increased, an association was identified with a lower incidence of anxiety/mood disorder treatments in an urban environment (White et al. 2013; Nutsford et al. 2013; Krekel et al. 2016; Wood et al. 2017; Olsen et al. 2019; Liu et al. 2019). This association is also observed in relation to the increase of physical activity in areas with a higher incidence of green spaces, which contributes to reducing stress and improving social cohesion (Zhang et al. 2015; Liu et al. 2019). Concerning park characteristics, those that offer recreational and sports activities are more associated with mental wellbeing (Pope et al. 2018; Gao et al. 2019). These impacts on mental wellbeing (namely acting as a protective factor Melis et al. 2015) are noticeable among women, those under 60 years of age, and residents in areas with low socioeconomic status (Sarkar et al. 2018). According to Hong et al. (2019), regular visitors or periodic users, i.e., those that visit green spaces fortnightly, express higher general life satisfaction levels.

As stated before, vegetation plays an important part in CES. The impacts of perceived vegetation on the mental and physical health of UGS users show that greenery is related to a decrease in depressive symptoms and is associated with activity generation, higher aesthetic values, and the wellbeing of UGS users (Ode Sang et al. 2016; Gubbels et al. 2016; Southon et al. 2018). The elders are those who perceive greater aesthetic values and have a higher associated wellbeing (Ode Sang et al. 2016). Another aspect is that the length of residential duration of the wealthier residents is not affected by the availability of nearby green space, while the length of residential duration of the less socioeconomically privileged residents is negatively affected by the lack of a nearby green space (Łaszkiewicz et al. 2018).

In addition to the factors related to the identified association between UGS availability/use and self-reported wellbeing, the study of Song et al. (2014) contributes to a physiological understanding of human contact with the natural environment, resulting in the participants' lower heart rate, anxiety and fatigue.

4 Discussion

Aiming to understand CES provided by UGS and its multiple dimensions, this study intended to review what has been done in the last twenty years (2000–2020). Three major dimensions were analysed: (i) recognition and social perception, (ii) uses, and (iii) impacts on physical and mental health. A discussion of the main findings is presented, considering their relevance to key groups (policymakers and urban planners) regarding the framework provided by CICES (Haines-Young and Potschin 2018) and the relevant literature on CES provided by UGS.

CES as a thematic interest is in an ascending trend. Since 2015, a substantial increase in scientific production on this topic has been observed. This could be related to the global agenda focusing on the development of nature-based solutions. That focus is more evident since the publication of the 2030 Agenda (United Nations 2015; Nunes et al. 2016), which offers an integrated framework to pursue sustainability. The topic is commonly studied in Europe, as a previous review on ES confirms (Brzoska and Spāģe 2020), namely in Germany and the United Kingdom. A possible explanation could be the European Union's policies (Ling et al. 2018), which have supported the assessment of the values of ecosystems and the services they provide. However, a growing concern about CES has been observed globally, mainly in Asia.

Focusing on the strength of evidence for each main outcome, only a few of the analysed studies have a longitudinal design. Although both longitudinal and cross-sectional studies are observational studies, cross-sectional studies allow researchers to compare many different variables at the same time. However, it is more difficult to differentiate cause and effect from the simple association, which can be more rigorously studied using a cohort study or randomised controlled study (Mann 2003). Moreover, cross-sectional studies have a lower budget and can be carried out more quickly, thus the results are more easily obtained. Instead, in a longitudinal study several observations of the same subjects over time are conducted, lasting many years in some cases, allowing for the identification of possible cause-effect relationships among variables. Additionally, it is also important to remark that longitudinal studies with few observations are not necessarily more costly than large cross-sectional studies. Within the framework of cultural planning (Seixas 2017) and citizen science (Irwin 1995), enabling the easy and direct participation of users in the decision-making process of these spaces through action research projects should also be considered. This has not been the case yet, at least in a representative way.

Cluster keywords can be useful to identify the strength of the association between CES dimensions and their impacts on the residents' wellbeing. The close connection between 'biodiversity', 'nature connectedness' and 'wellbeing' is a clear example of the positive impact of the contact with nature between residents and biodiversity, being the most expressive cluster and emphasising the importance given to this CES dimension.

One of the most important topics analysed in this review relates to the recognition of the CES of UGS. According to Fish et al. (2016), CES are difficult to classify and define due to their nature. Therefore, contributions to this subject are valuable and of particular relevance. Among the identified CES, aesthetic values and recreation are the most recognised dimensions by UGS users. This may be due to the fact that CES are part of people's experiences when they contact with UGS (Gould et al. 2019). Moreover, integrating such personal and cultural insights into the decision-making process is not easy when one considers that urban planning has been supported by evidence that is more easily perceived and replicable. Consequently, efforts should be made to identify CES perceptions to better inform policy-makers and urban planners.

As mentioned before, CES are somewhat related to the concept of RV in two main ways: first, the recognition of UGS as a way to develop a sense of place (Tuan 1990) through nature; and second, the development of education based on nature perception or nature awareness is part of the collective RV. That includes cultural identity, social cohesion and social responsibility (Chan et al. 2016). This is directly related to the fact that UGS with recreational opportunities and a pleasant appearance are those that contribute more to the decrease of stress and depression symptoms of their users (Pope et al. 2018; Gao et al. 2019). Those findings are extremely important, because in contemporary societies people are facing stress disorders that are triggered by their lifestyles, which are more intensely felt in urban areas (Hartig and Kahn 2016; Oliveira et al. 2020). As urban spaces are dealing with these socioenvironmental challenges, this review has shown that CES provided by UGS can contribute to enhancing the residents' wellbeing.

Although some studies have pointed out that nature is closely connected to spirituality and traditional customs that contribute to a sense of place, social cohesion and belonging (The Urbes Project 2015; Schmidt et al. 2016), the spiritual or religious experiences are less explored. Also, tourism (Veras et al. 2020) and the monetary dimension of CES are still rather unexplored. In fact, a recent study from Zin et al. (2019) argues that the assessment of CES has been based on modelling approaches that can be limited by the coarse resolution of the data input. This weakness contributes in some way to the recognised difficulty in incorporating the CES in local sustainable urban planning. Given that each region has its own specific characteristics, data should be produced locally and be accessible to policy-makers, planners, and land managers (TEEB 2010; Peh et al. 2013). This data is of extreme importance for city leaders in CES recognition and in its integration process in sustainable urban planning.

CES are also translated into many uses and functions related to what users expect from UGS. In general, the analysed studies that focused on UGS' use, motivations and functions concluded that users go to these spaces mainly to relax and to restore (Home et al. 2012), findings that are preceded by other studies (Fonseca et al. 2010; Goméz et al. 2014; Madureira et al. 2018). These spaces are considered an escape from urban lifestyles, like a spot of nature, improving mental health outcomes (Tendais and Ribeiro 2020). The same study explains the salutogenic effects of UGS on the population's mental health based on two theoretical models: the Attention Restoration Theory (Kaplan 1995), which states that the use and contemplation of natural spaces significantly reduce mental fatigue that results from the stimulus of urban lifestyles, such as road traffic, agglomeration and noise, improving the concentration and attention levels; and the Stress Recovery Theory (Ulrich 1983), which argues that the contact with natural spaces reduces the psychophysiological responses to stress. These two models are useful for understanding this important dimension of CES, providing theoretical tools to incorporate these services in the urban planning.

Another rather unexplored result that emerged from this review is the impact of available green spaces on the surrounding residential areas, such as in neighbourhood social cohesion, residential duration, and social health. Only the study of

Łaszkiewicz and collaborators (2018) concluded that the length of residential duration of the less socioeconomically privileged residents is negatively affected by the lack of nearby green space. Although not directly analysed in this review, the same study mentioned the concept of environmental justice (Schlosberg 2007), referring to a fair distribution of environmental benefits and burdens. Several studies around the globe have focused on the uneven distribution of UGS. In deprived communities, UGS tend to be lesser in quantity and poorer in quality (Dadvand et al. 2012; Hoffimann et al. 2017; Graça et al. 2018). This situation undermines the efforts of good environmental and public health outcomes for all, reducing the possibility to have a flourishing life and contributing to exacerbating the inequality cycle of these communities. Furthermore, providing universal access to urban green spaces with quality for all is a target of the UN 2030 Agenda for sustainable development (United Nations 2015).

All these results express a key fact that should be considered and discussed: the powerful relationship between people and nature. This relationship, expressed by the RV that people have in regards to nature, should be used as a path to reduce the negative impacts of human lifestyles on the environment. The awareness of the need to safeguard and protect nature is stronger when the attachment level to nature is greater, as the RV can play a part in the definition process of people's existence (Schröter et al. 2020). The motivation to care for and to value nature needs to be developed according to relational approaches and by looking to nature beyond its instrumental values. Relational approaches could also be important in the integration of CES in environmental assessments and policies (Chan et al. 2016). RV approaches could be more productive and more precise in the translations of people values. These approaches are useful for local public policy design initiatives that are important for simultaneously safeguarding the environment and encouraging the community's commitment to its implementation. Furthermore, RV approaches are also fairer and more integrative when dealing with disparities in nature or ES distribution. A way to promote an integrated framework that combines different perspectives, namely those that are usually excluded from the decision-making process, is to understand their values towards nature.

The lack of relational approaches could be addressed if more qualitative studies on CES are performed in the future. Despite the usefulness of survey applications in extensive and exploratory studies, the qualitative analysis is appropriate to give meaningfulness to the RV. It will be interesting to analyse if, in the post-coronavirus (COVID-19) pandemic crisis and after a long period of confinement, new CES will emerge in UGS.

5 Conclusions

This paper reviews the multiple dimensions of CES provided by UGS, namely its perception, use and health benefits. The results show a set of the main CES dimensions studied: (1) perception and assessment, (2) recreation and mental and

physical health, (3) aesthetic appreciation/inspiration for culture, art and design, (4) tourism, and (5) spiritual experience and sense of place. This review highlights the interdependent connections among such dimensions, aiming to contribute to a more integrated ES framework.

CES perceptions were organised through a relational approach, which emphasises the need to incorporate nature awareness into the municipal studies, master plans and public policy designs to promote sustainable and healthier cities. This issue plays a major role in human health and wellbeing. However, this review points out a lack of relational approaches that focus on RV, which could undermine the effectiveness of public policies. Accordingly, CES should not be understood in an isolated way and considered only in its instrumental dimension. When the focus relies only on instrumental values of nature, it cannot truthfully translate the views on human wellbeing and their values and attitudes towards nature, and the result could be a set of disconnected policy outcomes.

Some limitations need to be addressed. After a search for the term 'green spaces', a very significant number of results were found, but the majority did not match the scope of this review. Thus, it was decided to narrow the search with more explicit terms, i.e., 'urban green spaces' and 'cultural ecosystem services'. These specific keywords allowed the authors to obtain results that fit the particular scope of the present review. In future studies, it would be interesting to explore both CES and RV concepts in further reviews.

Finally, this review also indicates new possible research directions. On one hand, it would be interesting to know how different cultures perceive CES. Different values probably translate into different uses, motivations, expectations and perceptions about UGS. On the other hand, it is necessary to resolve the duality between CES' aesthetic component and functionalities. It is also necessary to develop participatory approaches to create innovation in UGS planning that addresses cross-cutting issues. This is probably the most significant challenge for greater CES recognition.

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Diogo Guedes Vidal is graduated in Sociology (2014) and MSc in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability. He is currently a Ph. D research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Ricardo Cunha Dias is graduated (2015) and has a master's degree (2017) in Sociology and is currently a Ph.D student in Public Administration, specialization and Public Policy. He is Invited Assistant Professor at the Institute of Social and Political Sciences (ISCSP) at the University of Lisbon and a collaborating researcher at the Center for Administration and Public Policy (CAPP). His main areas of research are transformational governance and sustainable development.

Gisela Marta Oliveira is Chemical Engineer (specialized in Bioengineering), post-graduate in Food Technology, Master in Biomedical Engineering—Biomaterials and Ph.D in Earth Sciences (specialized in Geohazards, Gaseous Emissions and Geological Sequestration of CO_2). She started working as a young researcher in plant biotechnology, for seven years, at the Portuguese Catholic University and since has held several positions as teacher and instructor of mathematics subjects and engineering technologies courses as well as research manager at University Fernando Pessoa. Since 2013, she is member of the Coordinating Council of FP-ENAS Research Unit where she researches on energy, environmental engineering and crosscutting subjects.

Maria Alzira Pimenta Dinis is graduated in Metallurgical Engineering (1992), MSc in Materials Engineering (1995) and Ph.D in Earth Sciences (2010). She is currently Associate Professor in the University Fernando Pessoa, Porto, Portugal, researching in FP-ENAS, UFP Energy, Environment and Health Research Unit. Her main research domains include Reservoir Modelling and Environmental Engineering, with scientific outputs translated by numerous publications.

Cláudia Oliveira Fernandes is graduated in Agricultural Engineering (1997) and in Landscape Architecture (2010), MSc in Natural Resources Management (2001) and Landscape Architecture (2011), and Ph.D in Environmental Sciences (2009). She is currently Assistant Professor in the School of Sciences, University of Porto, Portugal, and researcher at the Research Centre in Biodiversity and Genetic Resources (CIBIO—InBio Associate Laboratory) leading the Landscape Planning, Design and Management research group (LPDM). Her main research interest includes the assessment, planning, design, and management of a wide-ranging of habitats and ecosystems, especially in urban environments.

Nelson Barros is graduated in Environmental Engineering, MSc in Thermal Engineering an Ph.D. in Environmental Sciences. Member of the Editorial Board of the Journal of Ecological Engineering. Currently, is Associate Professor at University Fernando Pessoa, coordinator of the Ph.D program in Ecology and Environmental Health and coordinator of the Laboratory of Research in Energy, Environment and Environmental Health (3ERL), a Research Group of the Fernando Pessoa Research Unit in Energy, Environment and Health (FP-ENAS).

Rui Leandro Maia is Ph.D in Sociology (2002), MSc in History of Populations (1995) and graduated in History (1988). He is currently Invited Associate Professor at Fernando Pessoa University, Porto, Portugal, and researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit. His main research domains include demography, sociology, food safety, environment and treatment, analysis and criticism of sources, with scientific production translated into several publications.

Land for Life in Brazil: Conservation and People

Carlos A. M. Gonzaga, Patrícia Denkewicz, Alison Laurie Neilson, and Rui Pedro Julião

1 Introduction

This paper presents a case of social-environmental conflicts resulting from the establishment of two Environmental Protected Areas in Brazil. The case refers to the displaced community of Ponta Oeste, at the West point of Honey Island. A top down spatial planning disrupted the community and changed its surrounding socioeconomic activities. Government officials justified the restrictive planning as a tradeoff to prevent gentrification and environmental risk of luxury tourism. A communitarian collective action resisted the changes, arguing that public administration breached constitutional provisions and human rights. After decades of resistance, the state's lawmakers recognised the territorial rights of the defendants.

The searched data for this study included an analysis of legal documents and participatory observation. The purpose of the participatory procedure was the searching of implicit meaning in the observed facts. It would allow discerning the reasoning of community solutions to identified problems. There was no intention of quantifying values or making symbolic exchanges. The processing of results con-

C. A. M. Gonzaga (✉)
Midwest State University (Unicentro), Rua Manoel V. Souza # 179, Irati, PR, Brazil
e-mail: gonzaga@unicentro.br

P. Denkewicz
Parana State University (Unespar), Campo Mourão, PR, Brazil

A. L. Neilson
Centre for Social Studies (CES), University of Coimbra, Coimbra, Portugal
e-mail: aln@fcsh.unl.pt

R. P. Julião
Interdisciplinary Centre of Social Science (CICS.NOVA), NOVA University Lisbon, Lisbon, Portugal
e-mail: rpj@fcsh.unl.pt

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sidered description of the pertinent legal documents and a theoretical approach to reviewed literature.

The Honey Island (Fig. 1) is at the following geographical coordinates: North 25°29′ S; South 25°34′32″ S; East 48°17′15″; West 48°23′16″ W (SEMA and IAP 1996). It is at the entrance to Paranagua Bay, next to the channel that access one of the largest seaports in Latin America. The island has a total area of 2762 hectares, with 93% designated for conservation. It has no roads and terrain motorized vehicles are forbidden in its lands. The spatial planning imposed by public administration restricted housing, commercial buildings, and subsistence cultivation or fishing.

Fig. 1 Honey Island Map (Adapted from Denkewicz 2020, and IAP 2012)

The creation of the first conservation area on Honey Island, an Ecological Station, occurred in 1982. It has an area of 2.2 thousand hectares, aiming to preserve mangroves, coastal vegetation and swamps on the west side. The primary reason to establish the area was the fulfilment of a condition imposed by the Brazilian Navy who controlled it. The condition was part of the agreement to transfer the island management for the State of Parana government (Sema and IAP 1996). Twenty years later, the government implanted a state park to prevent depletion of a rare remaining of an Atlantic Forest and its freshwater springs (Parana 2002). None of this initiative considered prior consultation with any of the five local communities of *Caa-Icara* people.

The first nation people there were the *Guarany-Mbya* indigenous ethnic group (Ladeira 1990). Currently, most of the native population is *Caa-Icaras*, an ethnic group resulted from the interbreeding of *Guarany-Mbya* and Portuguese colonialist. In 2010, the local population was 1094 inhabitants (IBGE 2010). However, in 2014, there was a population estimate of three thousand inhabitants (Gonzaga et al. 2014). The number's discrepancy may result from large tourist flow, lack of control on visitors' entry and exit, and irregular or short-term residency.

Government agency recognised that there was a fleeting period of disorderly settlements by outsiders, both tourists and tourism entrepreneurs. From 1970 to 2010 the resident population increased 90.6%, while the constructed buildings increased 650% (IAP 2012). This was so, despite the enforced displacement of native population from the community of Ponta Oeste, in the 80s.

This research provided the basis for insights about interactions (or lack thereof) between social stakeholders and public agents related to environmental conflicts. It analyses the convenience of participatory environmental governance to promptness communitarian collaboration for sustainable management. The structure of the paper contains this introduction, followed by a theoretical framework on environmental conflicts, in the Sect. 2. The Sect. 3 presents the characterisation of the case and analyses the evolution and motivations of the collective action. In the Sect. 4, there are last remarks and suggestion for future research on the addressed theme.

2 Methodology

This research had a qualitative and descriptive approach. Data collection occurred through document analysis and participatory observation. The qualitative analysis sought to understand the meaning implicit in the facts observed, to glimpse potential solutions to the identified problems. There was no intention to quantify values or to make symbolic exchanges.

A systematic literature review was conducted with the help of the *Methodi Ordinatio* method (Pagani et al. 2015). This is a tool for searching and identifying the relevant scientific literature to discuss a subject. Its mechanism focuses on the number of citations, the age of publication, and the journal's impact factor. The databases searched were Web of Science, Scopus, Science Direct, and Scielo. The

search terms, combined with Boolean operators, were ((“territor* plan*” OR “land use plan*”) AND “environment* conflict”). The keywords’ operation required compliance adaptation for each specific database interface. However, besides the automated literature search to ground the theoretical discussion, the starting point for the references was the literature on local social-environmental policies and practices.

To execute the participatory observation technique, one author established residence on the island for one semester in 2015. Intermittent visits were made in the subsequent years to monitor the case until the completion of the research project in 2019. Such an initiative allowed for a transparent research relationship with the native communities of Caa-Icara, the designated public managers, and the tourism entrepreneurs coming from the mainland.

3 Theoretical Framework

The connection of environmental problems with the outcomes of human activities became clear (Crutzen 2002; Ostrom 2010; Biermann 2014; Song et al. 2018; Buscher and Fletcher 2019, 2020). Reckless exploitation, high entropy processes in natural resources transformation and acceleration of CO_2 emissions aggravated environmental problems (Hosokawa and Hosokawa 2001; Crutzen 2002, 2016; Steffen et al. 2011). Excesses at industrial manufacturing, human consumption, and waste production exacerbated ecosystems depletion to some irreversible disruption (Altvater 1993; Pierri 2001; Costa 2016). These symptoms of environmental crisis are experienced and perceived through asymmetric wealth and power conditions of global population (Martinez-Alier 2004; Lira and Witkoski 2016; Buscher and Fletcher 2019, 2020).

The rupture between humanity and nature characterises ecological crisis (Ost 1995; Marques 2013). It is a consequence of untouched nature hegemonic model where prevail the idea of human disconnection from his environment (Martinez-Alier 2004; Lira and Witkoski 2016; Buscher and Fletcher 2019, 2020). This metabolic rift distances human beings from natural processes and leads to random unpredictability and uncertainty (Foster 1999; Salleh 2010; Neilson and São Marcos 2019).

The idea of an Anthropocene age (Crutzen 2002) drives the discussion about what is nature and whether it ever has been autonomous or untouched by humans. It reflects the impact of the anthropogenic predominance in human behaviour and ethics in relation to other species and nature (Foster 1999; Kopnina 2016; Buscher and Fletcher 2019, 2020). Current debate on human-nature relations cover a wide range of technical and ideological positions, such as the new wilderness (Pearce 2015), the anthropogenic biodiversity (Thomas 2017), the urban wildlife (Schilthuizen 2018), the half earth for people (Kopnina 2016), or post-capitalist convivial conservation (Buscher and Fletcher 2019).

The growing need for agricultural land, pastures, urban and industrial became ground to justify aquaculture growth, offshore energy facilities, maritime transportation increase, and tourism expansion on coastal land. Marine exploitations are moving towards deeper waters, further from the coast (Foley et al. 2005; Douvere 2008). This mentioned trend receives political support by initiatives such as the EU Blue Growth Strategy (European Commission 2020), World Bank's PROBLUE Program (World Bank 2020), and American Blue Economy strategic plan (NOAA 2021). The primary focus is on expanding the frontiers of ocean exploration and intensifying the harvesting of preserved maritime resources.

For Berkes et al. (2006), the expansion of extraction frontiers masks the resources depletion at the regional level, and the scarcity of global supply. This features a common result from continuous overexploitation. Based on economic logic, the trend is to articulate different world's territories into globalised market, naming environmental elements as natural capital (Altvater 1993; Chiarella Quinhoes 2011). In addition, developed economies expand their market hegemony in financial transactions based on creation of new immaterial commodities, such as carbon credits and patents, deepening social, gender and ethnic inequalities (Neilson and Castro 2016).

The growing appropriation of the planet's resources reduces the sustainability of ecosystems for food production, drinking water supply, air purification, climate mitigation, waste absorption and resilience in face of infectious diseases (Foley et al. 2005; Potdar et al. 2016; Letcher and Vallero 2019). Meanwhile, the socioeconomic inequalities of the world populations proliferate. Poverty with food and nutritional insecurity stands out as paradoxical inconveniences for an economic system pretending to match growth. The negative effects from this engender environmental injustices related to the social burden uneven distribution. The perception of unfairness and threats of compulsory changes in material subsistence triggers several social-environmental conflicts related to land use and change (Gonzaga 2018).

The expression of social-environmental conflicts may appear as simple discussions, or violent acts, or yet as collective actions of civil disobedience (Romero Renau 2015). These conflicts origins are in the perception of inequality related to rights, benefits and risks among social groups sharing a common-pool of resources. The outbreak of conflicts gives visibility to inequalities in access to financial and political capital (Martinez-Alier 2004; Acselrad 2004, 2010; Martinez-Alier and Walter 2016).

In view of this scenario, the concepts of sustainability and sustainable development received widespread use for unspecific purposes, as umbrellas for apolitical and environmentally correct speeches. In this way, it merges a globalised pattern of uncritical environmental education and cultural homogenisation (Neilson and Castro 2016). This directs and legitimises social-economic reproduction of inequalities by public administration agency (Martinez-Alier 2004; Lima et al. 2018).

Social-environmental confrontations arise from non-negotiated appropriations of a territory and its elements. The conflicts can result from economic changes that

imply benefits for some groups to the detriment of others. This is the sequel to 'socialisation' costs from hostile land use and land cover change. It binds the greatest burden of environmental costs to impoverished populations, vulnerable and marginalised social minorities. Therefore, promptly legitimises the demand for environmental justice (Martinez-Alier 2004; Acselrad et al. 2009; Anguelovski 2015). There is aggravation of conflicts when the resources in dispute are the material and symbolic basis for a group of individuals, including their social reproduction (Zhouri and Laschefski 2010).

The power of decision-making over environmental costs distribution derives from social-economic relations structure. The places and action boundaries of each social group define the structure of power relations and the social-environmental impact of its activities. Poor communities that depend on the resources present in their living territory have locally observable weight. Otherwise, social groups who concentrate capital and power have globally diffuse influence mediated by international trade. That is so because consumption patterns in the global market depend on resources from all over the planet (Gonzaga 2018).

The political intervention and influence capacities of each social group depend on the predominant language interpreting the reality and the issues under evaluation. Languages are specific to cultural environments (Berger and Luckmann 1966). They name what is and what is not important to discuss, which creates an advantage for those who set the topics on the agenda of conflict negotiation. Whoever defines the predominant language of negotiations has more power to determine the results and the redistribution of environmental costs (Martinez-Alier 2004).

The institutionalisation of terms as development, sustained growth, and competitive advantage justify the void questioning on consumption pattern, land grabbing and resources over extraction. The equalitarian political division of environmental burden reproduces existing power structure, social-economic inequalities, and environmental injustices (Martinez-Alier 2004; Monteiro et al. 2012).

In the second half of the twentieth century, environmental protected areas have become predominant environmental policies initiatives. It was the national government response to noticeable extinction of several species at global level (MEA 2005; Hutton et al. 2005; Adams and Hutton 2007). Their creation was political decisions aiming to benefit both biodiversity and people. Theoretically, the benefits of ecosystem conservation should be available to the communities that preserved those (Santos and Schiavetti 2014). However, several studies show that decisions to create conservation areas arise multiple environmental conflicts (Adams and Hutton 2007; Castro Júnior et al. 2009; Spinola 2013; Buscher and Fletcher 2020). The predominant conception of human-nature dichotomy is at the centre of most conflicts. It identifies humans as the major obstacle to conservation.

In the twenty first Century, there was social and political pressure for the creation of coastal and marine conservation areas (Santos and Schiavetti 2014; Maestro et al. 2019). Not only because of the sped up deterioration of marine ecosystems but also because of the international mobilisation to carry out oceans' spatial planning. The primary references were the concepts of 'blue economy' and

'blue growth' (Barbesgaard 2018). Human occupation and land use in coastal ecosystems pressure landscape dynamics (Diniz et al. 2019). The complexity and fragility of coastal ecosystems requires dialogue and commitment among confronting stakeholders.

Participatory decision-making encourages new organisational configurations, knowledge production, and sustainable management practices (Bezerra Franca 2019). However, participation often occurs merely as bureaucratic formality. Its formal practice aims to legitimise decisions unconnected to the interests of local communities. The lack of political capital causes depreciation and denial for locals' knowledge and aspirations (Neilson and São Marcos 2016; Menon and Gonzaga 2017). Thus, the analysis of interactions between indigenous and conservation areas includes ethical, sociological, and legal dimensions. It is so because there is a contesting not only on their permanence, but on their own community existence (Spinola 2006).

4 Results and Discussion

A large portion of land conflicts in Brazil could be avoided, or negotiated in less frightens conditions. The country lacks a national policy of spatial planning. Rather, there are fragmented references to spatial planning embedded in several sectoral policies for agriculture, security, environment, energy and others (Kohlhepp 2002; Miragaya and Signori 2011; Peres and Chiquito 2012; Foleto 2013; Sancho 2017; Bezerra Franca 2019). The institutional void results in a blurring framework for land use and land change management.

The conservation areas in Brazil present a series of governance problems. The difficulty articulation among institutions and the scarcity of political, financial, structural and human support stress the management fragility (Bezerra Franca 2019). Even though there is legitimacy for territorial planning efforts to preserve biodiversity, there is not always transparency of the real motivations involved in creating such areas (Barros 2010). Despite public interest in protecting ecological commons, sometimes there are economic private reasons interfering. This includes interests in maintaining reserves of natural capital and genetic banks waiting for the development of new biotechnologies.

Although many institutional changes have occurred since the first Brazilian National Park, in 1930, the dichotomy of human-nature prevails. There is an assumption that all societies are equally depleters of natural ecosystems. Thus, definition of environmental public policies and conservation areas result from shallow levelling between unequally instrumented stakeholders. Differences are in material conditions and in cultural background. But, from the urban hedonists to the riverside wild fishers or *quilombolas* (slaves descendants), all fit in the hegemonic fictional cultural amalgamation of undifferentiated dudes (Castro Júnior et al. 2009; Spinola 2013).

The dichotomous principle prevents human presence in conservation territories (Souza and Milanez 2015). There are those who consider environmental conservationism as an obstacle to economic development, local or global (Laschefski and Zhouri 2019). Meanwhile, the Brazilian government has allowed mining, highways and hydropower dams in conservation areas and in legally protected territories of indigenous people of Amazon (Chiarella Quinhoes 2011; Costa 2012; Moreira and Herrera 2015; Magno 2015).

In the community of Ponta Oeste, at the Honey Island, the Brazilian constitutional and institutional rights are being violated. The public agent's actions in relation to the local community confront constitutional precepts. Also, they do not observe the National Conservation System (Brazil, Law 9985/2000), nor the land's rights of indigenous people and cultural minority communities (Brazil, Law 6040/2007). In addition, regulating Honey Island spatial planning (Parana, Decree 4242/2009) contradicts a previous agreement between community and government, expressed in 1981's Zoning Plan.

The Ponta Oeste used to be the largest residential community on the island, housing 211 inhabitants, one third of its entire population (Sema and IAP 1996). There was the island's first school, from 1985, to attend the community's large number of children (40% of residents). Until the 90s, there was the only electoral office on the island and the public health centre. By the time of this research, in 2017, there were only 25 inhabitants, averaging 60 years of age.

After the Ecological Station settlement, public officials coerced the residents to leave the village, threatened by imprisonment. The restrictions included limitations on the use of maritime space and artisanal fishing (Parana 1982; Sema and IAP 1996). At once, the government took away their land and sea, the source of food, nutrition, shelter, and rent. This affronts the most fundamental human right of subsistence supply.

While native communities could not remain on their land, tourists from anywhere could enjoy the conserved nature. Honey Island became a valued tourist hub. Government built infrastructures for visitors (boat peers, electricity, sanitation, communication, etc.). Cultural and economic tradition changed. Until the 80s, fishing was the primary source of rent, by the end of the 90s tourism had become the major source of income for most families (Gonzaga et al. 2014).

In a survey carried out between 2005 and 2006, Fuzetti and Correa (2009) identified only 98 fishers remaining on the Island, when the population was 910 inhabitants. In a sample of 46% of the interviewed fishers, 81% had learned to fish as a family tradition, but only 7% had an offspring working in fishing. The modernisation of the island's infrastructure has attracted entrepreneurs from the continent to invest in tourism facilities on the island. This developed a job market for indigenous youth that became more attractive than fishing. Gradually, the island's traditional lifestyle has changed, assimilating a continental urban style of consumption (Gonzaga et al. 2014). However, the isolation of Ponta Oeste preserved the fishers tradition, while community slowly becoming extinct.

The 2009 Land Use Plan (Parana 2009) imposed new territorial restrictions on the island. There were more legal limitations for all five communities on the island.

However, it consummated expropriation of Ponta Oeste residents who resisted difficulties for almost three decades. Their territory shrunk from 31.8 hectares to just 1.6 hectares. There was recognition of constitutional provision to guarantee participation of local communities in public decision making. But again, no subsidiary consultation ever happened.

Resistance against the territorial restrictions grew strong in Ponta Oeste community. They filed an appeal to court for amendment of the Law 16,037/2009. It demands re-establishing prior territory, restoring infrastructure and recognising maritime territory as inseparable from corresponding land (ANPPO 2017; MPPR 2017). The base for the appeal was the Convention 169 of the International Labour Organization and the Decree 6040/2007 of Brazilian legislation.

The Article 7 of the new Land Use Plan (Parana 2009) designated Ponta Oeste as Occupation Area of Traditional Local Population. The rights of "traditional local population" are in the Decree 6040/2007. It enacts the National Policy for the Sustainable Development of Traditional Peoples and Communities. There is recognition that self-declared "traditional local population" has the right of cultural preservation, community practices, ethnic identity, territories and access to natural resources traditionally used for physical, cultural and economic reproduction (Brazil 2007).

The Public Prosecutor's Office for Protecting Human Rights in the State of Parana followed the appeal of Ponta Oeste community. A Technical Report of the Cultural Patrimony Coordination of the State Secretariat for Culture shows the unconstitutionality of several provisions in the Law 16,037/2009 and in the procedures of public administration of Honey Island (Parana 2012). This resulted in a recommendation for Parana Institute of Environment (IAP) and for National Secretariat of the Patrimony to recognise the legitimacy of Ponta Oeste demanded territory. Also, it recommended social public help and guidance for community sustainable management (MPPR 2012, 2016).

The results identify that while expressing a discourse of sustainable development and conservation, the public administration denied citizenship for the residents of Ponta Oeste. There were denials for constitutional right of subsidiary opinion in public policies, for access to electricity and fresh water, for sheltering, and for food supply from their own land.

Also, public agents used discretionary power to inflict more severe fines on supposed environmental crimes. Harder and Freitas (2015) argue that the situation exemplifies the authoritarian model of control in which the "reasons of State" are used to legitimise the exclusion of the different rationality, non-hegemonic, and socially minority cultures. Thus, they keep people without away from political capital.

While we were preparing this paper for publication, the lawmakers of the State of Parana, Brazil, approved the Law 20,244/2020 (Parana 2020), which attends the appeal of Ponta Oeste community. They righted the wrongs of the prior contested Land Use Plan. The enduring resistance paid off, environmental justice prevailed, yet not everyone survived to enjoy it.

5 Final Remarks

Although there has been a dynamic theoretical evolution about conservation practices, some environmental public policies in Brazil keep old concepts of nature and people apart. Persist in the country a colonial narrative of empty natural territories waiting for development and civilization. Changes need courage and enduring persistence, as exemplified in the Honey Island case.

The twentieth century's environmental conservationism aimed to avoid the turning point of irreversibility. Currently, it is strengthening toward the understanding of how to guarantee resilience for anthropogenised nature. The same way, stand the challenge of how to be inclusive with culture diversity of multi-ethnic societies around the world.

Conservationism requires balanced coexistence between human needs and that of other beings and elements. Not only in conservation areas, but integrated with all aspects of daily life, socially and politically. It comprises a democratic sharing of nature's omnipresent wealth, valuing biodiversity by allowing humans and non-humans to live and coexist (Buscher and Fletcher 2019, 2020). Participatory community conservation or preservation could represent a positive evolution for governing biodiversity. The recognition of adaptive potential of local community presumes new perspectives for the sustainable management of natural resources.

In the presented social-environmental confrontation at Ponta Oeste, it was observable that territory has a symbolic identity component, associated with perception of belonging to the spatial dimension of active life (Santos 2000). The intertwined material and spiritual exchanges conditions individuals' placement in their environment. This determines their social identity regarding territorial perception (Gonzaga 2018).

The resistance of the indigenous community in Ponta Oeste emerges from the feeling of belonging. Its roots are in the place where they elaborated history and imagined their future. Laws and regulations have the power to reclassify overnight native residents: from sustainable extractive agents to alien invaders of their own territory. No matter if it is where they have long lived and take care of. Local communities do not want nor deserve exclusion from preserving their natural environment. Social-environmental conflicts require political dialogue. Some technicians assumed that conservation policies and preservation areas will protect environment for future generations. But who is this generation they mention? If there is a displacement of native conservationist, who will benefit from conservation?

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Methodology for Assessing the Impact of Environmental Determinants on Human Health: Case Study of Atmospheric Industrial Pollution in Urban Communities—Manaus/Amazonas/Brazil

Paulo Custódio, Camila Paiva França Telles, and Nelson Azevedo Barros

1 Introduction

The issue of environmental pollution presents itself as one of the major problems in the world today, causing not only impacts on the environment, but also serious problems for human health. Data from the World Health Organization (WHO) show that nine out of ten people live in regions with significant levels of pollutants and that translate, according to updated estimates, into an alarming number of seven million deaths each year. On the other hand, the WHO also attributes to each disease linked to pollution the following mortality rates: diseases of the cardiovascular system (24%), stroke (43%), heart disease (25%), lung cancer, lung diseases chronic obstructive and respiratory infections including pneumonia (29%), being a critical risk factor for Chronic Noncommunicable Diseases (NCDs) (WHO 2018). This demonstrates that air quality is directly linked to human health, which makes its control even more pressing and relevant.

In Brazil, the average number of deaths is 50,000 deaths from diseases triggered by air pollution every year. At the level of the Amazon, the levels of pollution are alarming, mainly due to emissions from fires for deforestation in the region. But this is not the only source of atmospheric pollutants in the region, since, even in the

P. Custódio (✉) · N. Azevedo Barros
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: nelson@ufp.edu.pt

C. P. F. Telles
Department of Pediatrics, Faculty of Medicine, Federal University of Amazonas (UFAM), R. Afonso Pena, 1053—Centro, Manaus, AM, Brazil

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middle of the urban space, other activities are developed, namely industrial ones, which can put people's health and well-being at risk.

In Manaus, the level of pollutants in the air is twice as high as what is considered tolerable by the WHO. An example of this situation is the report released by the Institute for Space Research (INPE) in October 2017, where it is reported that the Amazonian capital presented an annual average of 20 $\mu g.m^{-3}$ of particles with an equivalent aerodynamic diameter of 2.5 μm ($PM_{2.5}$), twice the WHO guidelines for the annual average of this pollutant, which is 10 $\mu g.m^{-3}$. In terms of maximum values for $PM_{2.5}$, INPE also carries out daily monitoring of air quality in the capital via satellite, and at midday, in the same month and year, it presented a maximum hourly average of 500 $\mu g.m^{-3}$ of $PM_{2.5}$, which compares with the Brazilian average of 320 $\mu g.m^{-3}$ (Andrade Filho et al. 2013). Thus, Manaus, presents problems in terms of the concentration of $PM_{2.5}$, both in terms of average values and in terms of maximum values, which gives even greater relevance to this problem.

Considering the above, any air pollution control measure in this region will be a relevant step towards the quality of life of its population, according to the Sustainable Development Goals of the 2030 Agenda (United Nations 2015a, b).

Thus, the present study aims to present a methodological proposal to assess the impact of industrial atmospheric emissions in urban communities, in the city of Manaus-Amazonas/Brazil, as an environmental determinant of people's health. The integrated method allows the adoption of basic rules, to establish new knowledge or review pre-established knowledge. In this sense, it is proposed to use the methodology of exploratory and descriptive research, in a vision of interaction and integration of these inseparable methods in the process of selection, interpretation and analysis of the data and information necessary for this research.

2 Evaluation Methodology

As previously mentioned, the methodology involves the application of two research methods that are complementary to each other and which are explained below. Finally, the theoretical view of an integrated model that is based on the sequential application of these two methods will also be presented.

2.1 Exploratory Method

The Exploratory Method is little mentioned in research and scientific studies, however, it is from the knowledge obtained by this method, that the procedures and bases for the development of the studies begin.

This method is comprehensive and relevant in the field of health research. Examples of the resource are the works of Fenner et al. (2012), who conducted health research through social networks, exploring the great potential of using

information and communication technologies to involve young people; the work of Feyer et al. (2013), who identified couples who choose to deliver at home, monitored by obstetric nurses, and information obtained from medical records, characterizing the profile of the patients; the work by Popadiuk et al. (2017), this study aimed to analyze how the Ministry of Health (MH) has been implementing the Transexualizador Process (PrTr) in the Unified Health System (UHS), through the search of official documents in the public domain, and analysis of the Committee's Memories LGBT Health Technician from MH. The research combined quantitative and qualitative methods of study, taking as a methodological basis the normative research proposal for the evaluation of health programs and systems. The study resulted in a total computation of the sexual reassignment surgeries performed in UHS (2008–2016), which show nullity of deaths and regional inequalities in access; and in the monitoring of actions to implement the National Comprehensive Health Policy for Lesbians, Gays, Bisexuals, Transvestites and Transsexuals. It is also worth mentioning, in this context, the work of Barbosa et al. (2018), who assessed the quality of life at work of health professionals in the presidial system; the work Verhaegh et al. (2017), which were based on the analysis of communication and interprofessional collaboration during hospitalization to provide effective care; the work of Oka and Laurenti (2018), who analyze the concepts of sex and gender in the various publications and articles in the health area and by Lander et al. (2018), through the Patient and Public Involvement Program (PIP) that assess recruitment, patient and public involvement in the medical field and the representativeness of the various groups. The study concludes that the recruitment of laypeople in PIP activities, and the decision are controversial, given the numerous challenges answered by the research participants.

The Exploratory Method is based on an epidemiological survey, with an open structure and design, aiming at a better knowledge and understanding of the context.

The results achieved are subjective and tend to consider people's views on this reality. At this level, new discoveries and patterns are sought.

This type of survey has a flexible structure, with the objective of allowing the interviewee greater freedom to expose his experience in relation to his reality, and the interviewer greater mobility in obtaining more enlightening answers. Aimed at the use of simple and popular medical terms and expressions, it is structurally a facilitating instrument for quick and flexible understanding between researcher and interviewee. The structure or layout of the Survey should consist of simple questions, with direct, concise and open answers, which will make it possible to stimulate dialogue between the parties.

It is important to highlight that the clarity and quality of the questions, should result in the most appropriate answers as possible, presenting a good level of details and information, which in a certain sense will give more precision and quality of the information and data provided by the interviewee. After this stage of application of exploratory research, variables and factors will be defined for formatting and applying the Descriptive Method.

Exploratory research constitutes the framework of descriptive research, since it, based on information and ideas, will guide and establish determining and clarifying points for conducting descriptive and transversal research in the area of human health.

The target audience of the interviews should be selected at random, regardless of gender, age, race, religion, among others, however, observing the inclusion criteria in the research. As for the interviewers, they must act without pre-established concepts, closed assumptions or unfounded predispositions, which are distant from the reality of the environment under study and which will negatively influence the decisions or conduct to establish the model to be applied. Exploratory research is an initial procedure and as it is carried out, adjustments are made, since the interviewer's view of the environment is not always the same as the reality where the interviewee lives. In the proposed inquiry, fundamental items are present to survey the health reality of the communities.

2.2 Descriptive Method

The Descriptive Method presents reliable and final characteristics when applying its quantitative descriptive model. In this Descriptive Method the striking characteristic is the impersonality in the treatment of the data and the results achieved, and therefore, a well-known environment featuring a closed model structure is accepted as the basis of the research.

This is the case of the works by Agostinho et al. (2013), who, based on patient records, identify dermatological pathologies and describe clinical and demographic data of the people affected; in the work of Vieira et al. (2015), who carry out studies in the Emergency Care Unit [ECN], with clinical diagnoses of pulmonary and cardiovascular diseases; in Nogueira et al. (2015), analyze nursing diagnoses in people with chronic venous ulcers; with Felipe et al. (2015), study aspects of inappropriate drug use and undesirable complications and health problems; by Paz et al. (2016), use medical records, and characterize the occurrences of (HIV) in population groups of pregnant women; in the work of Pachu and Viana (2018), they investigate the prevalence of breastfeeding in the Neonatal Intensive Care Unit—UTIN, at hospital discharge of the newborn; and Vechia (2019), which addresses the prevalence of respiratory diseases in children and adolescents.

Here, there is a concern to seek more accurate and reliable results regarding the data and information that are used. Thus, the use of quantitative data, such as what is present in data and information randomly extracted from medical records, strengthens this perspective of an absolute, almost indisputable reality. On the other hand, the Descriptive Method, when applied to an exposed and control community, strengthens the results and allows the establishment with more confidence of comparisons of the results and advances in the explanations of the cause—effect type, demonstrating great efficiency in works related to the health.

The variables or factors collected will be analyzed in a quantitative, associated or related way, allowing the production of tables and graphs, which are the object of this research, and which contribute to the characterization of human health in this environment.

The Descriptive Method of entering and processing health data, it prioritizes the use of quantitative variables of the discrete or continuous type. For that, some initially qualitative variables must be treated, with weighting, frequency distribution, percentage or other procedures that allow the transformation of qualitative variables into quantitative ones.

2.3 Integrated Model

The proposed integrated model uses theoretical, philosophical bases, instruments, ideas and methodologies that allow the development, alignment and consolidation, in search of clarifications and results that explain and justify facts and phenomena, distortions, deviations, trends, of a nature diverse, with a social, economic, cultural, environmental, health, anthropological focus, among others.

The present model proposes the use of data in a broad and associated perspective, aiming at the construction of landmarks and references from the theoretical basis of the methods, seeking conclusive results from a reality. The variables and analysis factors, the most consistent and appropriate statistical methodology and procedures for the analysis of data and information, among other aspects, which are fundamental for the conduct of the health study, proposed here, are considered in the constructive process of the instruments.

Both research methods present specificities and nuances, which characterize them, it is in this sense that joint use and interaction in development, strengthens this proposal, which has an associative, cumulative, perceptive, pragmatic, interactive bias, shaping ideas and objectives of the study in the area of human health.

The implementation of the proposed model in an integrated analysis is carried out based on a set of factors and elements, which allow the achievement of broad and reliable results. Data, information and documents collected and authorized are used together with public institutions in several areas of knowledge, with emphasis on health.

The methods presented are materialized through the exploratory epidemiological survey and a quantitative descriptive model, which have different approaches and with equally different results. In the first case (Exploratory Method), with qualitative results, and in the second (Descriptive Method), with quantitative results.

Several authors have already followed this integrated approach in work in the field of health. This is the case of Silva et al. (2013), who analyze the multiprofessional team's conceptions about the implementation of palliative care in an adult intensive care unit; Barros et al. (2014), who carry out interviews with analysis in medical records using the Bardin content analysis technique, where 24 interviews were carried out, with the aim of organizing and optimizing patient care; Moreira

et al. (2014), who raise nursing diagnoses in people with chronic venous ulcers; Hunter et al. (2018), who evaluate the theoretical foundations of health research, to support and adapt research methodologies in health studies. In addition to these works, Caveião et al. (2014), also use in a complementary way the Exploratory and Descriptive methods and identify the competencies involved in the learning process of the nursing administration student and, finally, I et al. (2018), by reviewing the medical records of women who underwent cesarean delivery, assessed the potential of the method, for better care and recording of information.

Table 1 presents characteristics of the Exploratory and Descriptive Methods. These are common to any area of study that uses the aforementioned methodological procedures.

Table 2 specifies the characteristics of the procedures that will be applied in both methods, Exploratory and Descriptive.

3 Case Study

In the present study, it is proposed to use the Exploratory and Descriptive Methods in research related to the effects of pollutants on human health in urban communities in the city of Manaus—Amazonas/Brazil. The greater applicability and the results of these procedures are directly related to a better knowledge of reality from the data and information raised from the research subjects, in the choice of the

Table 1 Summary of the characteristics of the exploratory and descriptive methods

Features	Exploratory method	Descriptive method
1. Of the reality studied	Understand the context	Describe and assess reality
2. Degree and extent of data	Fill gaps and get subjective results	Consistent, concise and objective information
3. From the researched world	Make new discoveries; new standards	Known and absolute reality
4. From conception to the researched subject	Prioritize people's point of view	Impersonal, known, conceived reality
5. The reality of the study environment	Observation of the environment as a whole. Multiple and open perspectives	Defined environment, and with medical records
6. Structuring the study	Non-mandatory, flexible structure	Closed model structure
7. Of the instruments applied in the study	Open interviews	Closed models
8. Setting or formatting the results	Final report with flexible and open structure	Final report; graphical, quantitative representations in fixed structures

Table 2 Synthesis of the characteristics of the epidemiological exploratory survey and the quantitative descriptive model

Features	Epidemiological exploratory survey	Quantitative description model
1. As for the registration of data	Open interview	Closed model of analysis and evaluation of medical records
2. As to the nature of the data	Qualitative	Quantitative
3. Regarding the effectiveness in the treatment of data and information	Subjective data	Objective data
4. As for the forecast of Results in the analysis of the study	Inconclusive in itself	Conclusive
5. As for the consistency of facts and information	Hypothetical, factual, conjectural	Evidence, realities and truths
6. As for the expectations of the results of the instruments used in the study	Prognosis, unstructured, or semi-structured, qualitative	Diagnosis, structured, quantified
7. Regarding the methodological character of the study	Speculative, empirical	Practical, investigative
8. As for the sample size	Small sample	Expressive sample

appropriate procedure in the data analysis, in the conditions surrounding these environments and in the researcher's sensitivity in dealing with human beings.

3.1 Domain

In the city of Manaus, two communities were defined to carry out the study, one of which will serve as an exposed community (*Parque São Pedro*) and the other as a control community (*Jesus Me Deu*). The *Parque São Pedro* community (exposed) has an industrial source with relevant atmospheric emissions, with a potential impact on the health of the population (Fig. 1). The *Jesus Me Deu* Community will be the reference (control), since it is located upstream of the emitting source in terms of the prevailing winds in the region. These communities, with about 20,000 inhabitants each, have identical/homogeneous socioeconomic structures, with diversified retail trade, similar residential standards, basic public services (Church, Schools, Police Stations) and few leisure facilities.

The results of the application of these methodologies will be analyzed with statistical treatment and procedures.

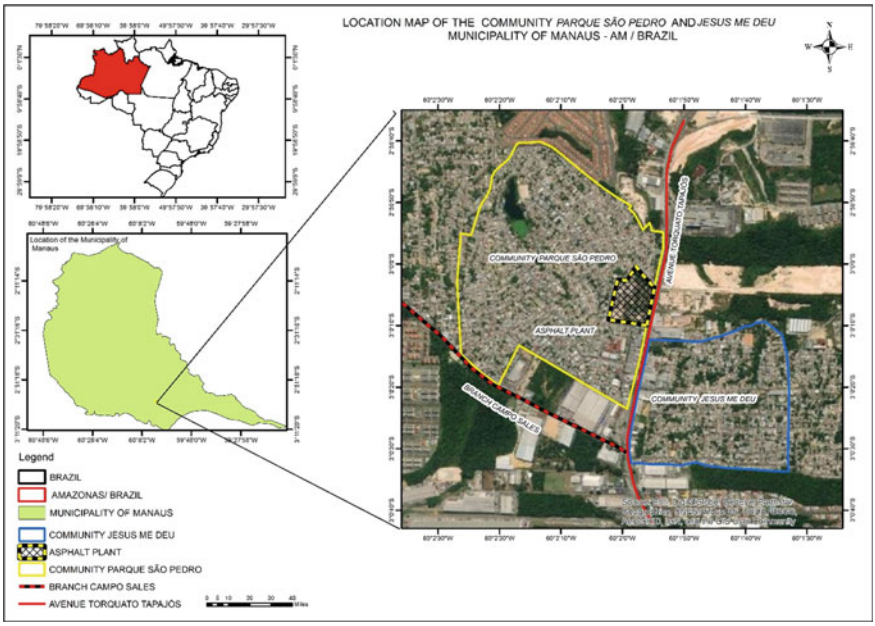

Fig. 1 Framework of the city of Manaus in Brazil, as well as of the communities, exposed (*Parque São Pedro*) and Control (*Jesus me Deu*), and emitting source (Asphalt Plant)

3.2 Methodology

As proposals for application instruments, the Exploratory Method and the Descriptive Method suggest the application of the epidemiological exploratory survey instruments and descriptive model of the medical records, respectively, with representations or configurations that express the analysis of the data and information obtained in the two phases of the research and therefore, they record a complete survey and commitment of the researcher to the quality of the information that will be treated within these instruments.

These two methods will be used in an integrated manner as explained later in the text. In the following topics, the application of Exploratory and Descriptive Methods, which constitute the Integrated Method now presented, will be presented in the research to be carried out.

3.2.1 Application of the Exploratory Method

The Exploratory Method, which will be made possible through an epidemiological exploratory survey (interview), proposes a qualitative and transversal approach to data and information. The survey will be applied to a number of 40 respondents,

in each of the two communities, *Parque São Pedro* (exposed) and *Jesus Me Deu* (control).

The epidemiological exploratory survey to be applied in this proposal, consists of two pages, consisting of open questions and semi open questions, allowing the interviewer and interviewee a good interaction and dynamics in the interview process. This factor facilitates the emission of ideas, thoughts and positions, from both subjects of this research. The information and data obtained will be duly registered to contribute to the process of establishing variables and factors, which will give sequence and direction for the elaboration of the Descriptive Method that will later be applied.

The research participants will be chosen randomly in the community, having to meet the inclusion criteria to participate in the research, and the interview process will be carried out in their homes.

The epidemiological exploratory inquiry (interview) will address basic issues, such as: personal data, age, gender, address, respecting the legislation regarding the criteria related to confidentiality, among others. In a second part, with an open approach, questions will be raised about the central object or problem of pollution in the area, if the problem exists, degree of concern, the vision of how it affects the health of each resident of the community, family members with related disorders with issues of pollution, among other aspects of relevance so that this information is treated and coded to enable the structuring of the Descriptive Method of quantitative nature.

In Appendix 1, an epidemiological exploratory inquiry to be applied in this study is presented.

3.2.2 Application of the Descriptive Method

In the Descriptive Method, it is proposed to survey and record information from the medical records of each community (exposed and control). This work will be carried out within the BHU's that keep the information from the medical records.

The patients in the medical records will be chosen randomly, however, they must meet the initial inclusion criteria to participate in the study. The identification of the interviewee will be kept confidential, according to the relevant legislation.

The model will be applied to 729 medical records, with a 95% accuracy margin and 3% error in each of the communities. Five years of data (2015–2019) will be analyzed, with a total of 146 medical records per year.

It is proposed to use a statistical program, where tasks and steps will be performed to obtain different graphical representations, which allow comparison and analysis procedures, researching from these and observing the statistical behavior of the data, making correlations and checking trends.

The method has nine variables, arranged in columns, understanding that in a large universe of health issues, the factors chosen to compose the model, are representative to assess the health conditions of the exposed and control community population, proposed in this study. When filling out the model, the information in

the medical record does not exist, the value 0 (zero) will be recorded in the annotation field.

The present model is at an experimental level, in the process of refinement and adjustments, and should undergo modifications, with the inclusion or exclusion of some factor.

The variables in this model are provided for: interviewee code (initials of the name); residence time; gender; age; symptoms; disease stage; number of endemics; number of consultations, levels of health care.

The Interviewee's Code (number/initials of name)

In this variable, there was a full concern to protect the nominal identification of the interviewee, in compliance with Resolution 466, of December 12, 2012, of the CNS, which among other provisions, recommends secrecy in the identification of the researcher (interviewee) under penalty of sanctions to the researcher. Therefore, an identification of the respondent will be made using a numerical identification code, in the case ranging from 1 to 729 respondents and the identification by the initial letters of the respondent's name.

Residence Time

As a discrete quantitative variable, this factor is representative, as the plant's activity, according to preliminary information, has been occurring for more than 10 (ten) years in this community. Many residents have lived in the community since its foundation. The health conditions of residents who have lived since then can be a reference in the analysis of health status, not only individually, but also of the population as a whole. The residence time can characterize the chronic or acute state of health for the population of the community, who for living for a considerable time, presents old and permanent symptoms.

Gender

As a nominal qualitative variable, the gender of community members needs to be identified, qualified and quantified.

Age

It is presented in this model as a discrete quantitative variable, the identification of age being essential, and the characterization of the age group where the highest prevalence by age and in the age range is concentrated or occurs.

Symptoms

Respiratory and dermatological symptoms or diseases are considered in the research. In the case of the interviewee presenting only one symptom/disease, this fact can be considered on a scale of values of less serious concern and attention, in relation to other patients, who have two, three or more illnesses in their medical records. The occurrence of these diseases can be assessed quantitatively, depending on the number of occurrences in each individual. Therefore, through the number of occurrences (absolute data), frequency or percentage, and proportions, it is possible

to determine and quantify the prevalence, for example, of the type of pulmonary or dermatological disease. This variable presents expressive and relevant results, when compared or correlated with other variables such as: age, gender and length of residence.

Disease stage

This variable is qualitative ordinal, and it can be transformed into a quantitative variable, adopting the same weighting criteria. The frequency of the level of the individual's stage of illness allows, through the frequency index, to determine the prevalence of the illness. By the characteristics it is possible to establish that the initial level, a small weight will be assigned and the serious level, the greater weight. The researcher, when consulting the medical record, must pay attention to obtain this information. This variable, among other associations, can be correlated with the age of the interviewee, gender, number of consultations, among other variables.

Number of Endemics

Discrete quantitative variable, which directly expresses the health conditions of the patient in the medical record, being able to establish or assign the quantitative of endemic diseases to the degree of illness and involvement of the patient in the medical record. As a proposal, indexes 1, 2, 3 can be suggested, being attributed to index 1, little manifestation in diseases, 2 to an intermediate endemic condition, and 3 or more to a condition that deserves greater care and, consequently, more medical attention. This variable can be correlated to others, such as: age group, age, bringing interesting results for assessing the population's health status.

Number of consultations

Discrete quantitative variable that in itself responds to the patient's health condition, since the largest number of patient visits to BHU, demonstrates the patient's condition and worrying state. Indexes (1, 2, 3) can be attributed to this variable, which in increasing order demonstrate the individual's degree of health, with degree 3 being the level of greatest concern. This variable can be related to others such as: age, gender, age group, symptoms.

Levels of health care

This ordinal qualitative variable establishes the patient's health conditions at levels of concern for treatment, and can be expressed in levels: primary, secondary and tertiary, suggesting that we consider or give weight to them, considering that at the primary level the patient lacks basic care, being able to assign level 1, in level 2, that is to say secondary, the care and attention to the patient already happen with concern and more specific and special care, in all the senses. At level 3, the concern, care and treatment take place at deeper levels and can reach surgical interventions, and with treatments of a high level of demand and medical attention. This variable can be treated at the frequency level and correlated with other variables proposed here, such as: age, gender, length of residence and others.

3.2.3 Criteria for Inclusion of Interviewed in Applied Methods

The participation of the population of the *Parque São Pedro* (exposed) and *Jesus Me Deu* (control) communities, will have no restrictions on aspects of religion, age, gender, race, social and economic conditions, however some inclusion criteria are necessary, taking into account in view of the search for more reliable and consistent results for the research.

Inclusion criteria in the Descriptive Method

The following criteria guide the selection process of the interviewees for health interviews, based on the proposed model:

1. Eventual workers of the asphalt plant company, will be included in the research, regardless of the time of residence in the community;
2. All citizens who present themselves to the interviewer in conditions of apparent sanity and mental balance will be included;
3. People who claim to have lived in the community for at least three years will be included in the research, allowing to increase the degree of precision in the study;
4. People will be included individually in the exploratory epidemiological survey. The interview corresponds to your environment and life reality, your health status, diseases linked or attributed to pollution, treatment of endemic diseases, use of BHU, aspects of the daily environment and personal data, according to the legal requirements of confidentiality;
5. In the event of more than one case, in the same household, of diseases related to the pollution effects of the asphalt plant, the interviewee can report the case, this information being recorded on the same survey form;
6. People will be included who, although they have declared that they do not have any endemic associated with the respiratory and dermatological system, caused by pollutants, object of study, unless they do not meet item 2 of this topic (Inclusion Criteria);
7. All citizens will be included, regardless of gender, age, age group, social and economic class, race and religion, unless they do not meet items 2 and 3 of this topic (Inclusion Criteria).

Inclusion criteria Descriptive Method

The following criteria guide the selection process to carry out the treatment of data and information extracted from medical records and insertion in the proposed descriptive model:

1. Same being chosen at random;
2. All medical records will be considered regardless of the conditions of gender, age group, social and economic class, race and religion;
3. All medical records are clear in terms of writing and filling.

3.2.4 Risks Relating to the Application of the Methods Used

All research with human beings involves risks for the participants. In this proposal for the application of study methodologies, the concern is present and for that, following legal recommendations, based on Resolution No. 466, of December 12, 2012 of the National Health Council (CNS), the appropriate measures will be taken for interviewees, with the same level of concern and responsibility in the use of instruments for the application of the epidemiological exploratory survey (Exploratory Method) and the quantitative descriptive model (Descriptive Method).

Risks of Application of the Exploratory Method

In line with the Resolution of the National Health Council—CNS 466/12, item V, in Brazil, or similar legislation in your country, the epidemiological exploratory survey will be applied obeying and respecting all rules and legislation regarding the interviewee's participation guarantees, the right to voluntary and free participation, preserving the confidentiality of the participant's data, among other aspects, with all concern to safeguard the physical, moral and psychological integrity of the interviewee. Although there are risks, unforeseen events and failures in the interview process, these can be related to the interviewer's lack of skill or knowledge about reality and the social environment, or even the lack of mastery of the content and items proposed in the research. In the initial process, interviewers will undergo training that aims to reduce mishaps. If applicable, the interviewer must report in writing to the General Coordination of the study the events and misconceptions in general that deserve to be considered in order to propose solutions and decision-making measures.

Risks of Applying the Descriptive Method

As for the risks related to the application of the quantitative descriptive model, integrated in the Descriptive Method, these are directly linked to the use of the medical record, as an official document of the patient's medical life, and also to the quality, clarity and richness of details of the information contained in the medical records.

The medical record goes beyond information and statistical data about the patient's health. The medical record is an act of trust and hope, which the patient deposits in the person of the Doctor, who consecrates himself during the medical consultation. This device portrays the entire physical and mental condition of the patient, in highly confidential details, which allows the Physician a set of complete and detailed statistical information, to promote an accurate diagnosis or the establishment of a standard of medical conduct, in relation to each patient and from this point on, establish health protocols and conduct the best actions for the health and well-being of the patient.

In this sense, it is understood that the risk is linked to the correct reading and interpretation of the data and information contained in the medical record, so that false or mistaken readings and interpretations are not carried out, generating incompatible or unrealistic results. I emphasize that all work with the Basic Health

Units [BHU], must be carried out by the researcher, and if he is not a health professional, he must carry out the research with the support and participation in the entire process and analysis under the supervision of a health professional health, as a rule, the Community Health Agents [CHA], who will facilitate the reading and interpretation of the medical records, giving precision and quality to the study.

In Manaus, the computerization of health posts regarding the use of electronic medical records only occurred in 2020, and for the present proposal a retrospective study is simulated, for the years 2015–2019, over a period of five years, where the medical records were physical, being filled out manually by the professionals. Another aspect for the justification for not using the data after 2019 is the fact that the prevalence of COVID 19, among diseases, will bring noise in the study, considering that the object of analysis of the proposed methodologies is directed to diseases respiratory system and dermatology, linked to the presence of asphalt plant activity.

A proposal for a descriptive model for the evaluation of medical records can be found in Appendix 2.

3.2.5 Integrated Application

The flowchart that describes the stages of construction of the Integrated Method between the Exploratory and Descriptive Methods, presents a harmonic interaction, between the elements and the parts, so that, the final set and results, allow an understanding of the problem as a whole, with focus on identifying the main points of attention to the human health problems of the communities, and identified through the correlations of the elements and variables expressed in representations (Fig. 2).

As can be seen in Fig. 2, the application of the Exploratory and Descriptive Methods are complementary, which will allow to fully achieve the research objectives, through the results that are expected to be obtained, as presented in the following section.

4 Expected Results

The product of the integrated use of exploratory and descriptive methodologies, will allow to obtain expressive and clarifying results, demonstrated through graphs and tables of various types, results of the analysis and correlation of factors and variables, arranged in the quantitative descriptive model. The analysis of the factors and variables that will be carried out through the IBM * SPSS * STATISTICS version 25 program, has been used as a procedure in several studies and for its effectiveness, being recommended in studies of this nature.

The range of interactive analyzes and correlations between variables will be large, and the impartial or impersonal character in the treatment of data by the

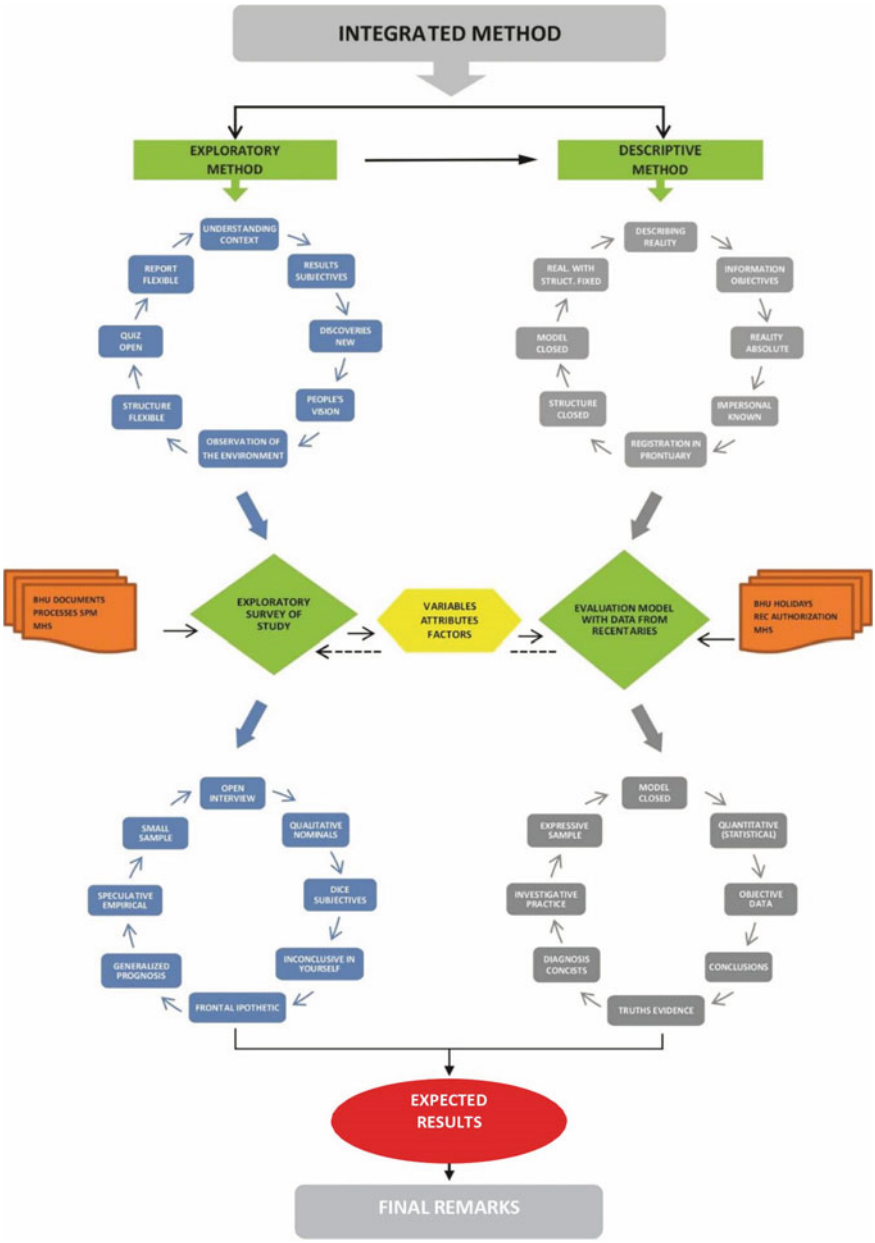

Fig. 2 Flowchart of epidemiological studies in urban communities of Manaus—Amazonas/Brazil REC: Research Ethics Committee; SPM: State Public Ministry; MHS: Municipal Health Secretariat; BHU: Basic Health Unit

statistical program, constitutes one of the favourable points of the proposed methodology as a whole. The answers given by the methodology used in the interpretation of the variables and factors, allow independent analyzes of personal influences, that is, without the interference of the researcher in the result of the expressed product.

In the end, through the application of the presented methodology, it is expected to obtain a clear correlation between the effects observed in the exposed community (*Parque São Pedro*) and the emitting source (Asphalt Plant).

This type of study highlights the importance in the urban environment of environmental determinants, such as air pollution, in the health and well-being of the population, which will allow its control. Thus, it constitutes an important step towards the fulfillment of the Agenda 2030 Sustainable Development Goals, particularly in cities like Manaus, where air quality is a public health problem.

5 Final Remarks

The present methodological proposal is presented with a recommendable level of consistency and applicability, which represent distinct phases in observing, questioning, collecting, treating, recording, analyzing and interpreting in order to portray evidence of a human health reality.

As the proposal is focused on health studies, the methodology in general, gathers and presents reflections to be turned and applied to other areas of human health, and even so, the health variables are broad and complex, requiring adaptations, adjustments and knowledge in the model so that it becomes flexible and applicable.

In this sense, the proposed model has as a striking characteristic the dynamic character, in terms of shape, retrospective or prospective character, time of data analysis, types of variables and factors, sample size, period of analysis of sample data, correlation with the question which interferes with human health, among other aspects, not constituting itself as a finished model and in research situations distinct from this one, which presents specificities, forcing each researcher to take new positions, theoretical and pragmatic considerations.

However, it is understood that the conception and rationale in this proposal, is the basic orientation for the advancement and development of the model and its application in studies and research projects, offer results as much as better due to the researcher's commitment in the search for the truth.

It is recommended that the use of the methodology of this study, due to its nature involving human beings, be preceded by the forwarding of documents and legal procedures for approval and authorization of the study in human health, to a Research Ethics Committee (REC), through of the Platform of your State or country.

Considering the recommendations present in Agenda 2030, which establishes the reduction of atmospheric pollution, to improve the quality of life and human health, the present methodology for identifying problems through cross-cutting

procedures represents advances in the process of complying with this Agenda and, in particular, with the Sustainable Development Goals.

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Appendix 1: Epidemiological Exploratory Survey

Interviewee ……. ……. geographical coordinates: Latitude ……. Longitude……. Age……Genre……

Residence time ……

What is the benefit or harm of the presence of the asphalt plant in the vicinity of community ……..

Do you have or did you have an employment relationship with the asphalt Plant……when……bonding time……current activity…… ……. ……. ……. Is aware of any type of preventive or corrective action performed by the administration of asphalt plant… … ……. ……. ……. Number of cases and occurrences of diseases in the family attributed to the presence of the asphalt plant in the area ……. ……. Are you in the habit of going to BHU, preventively? ……. ……. ……. ……..……. ……. How many hospitalizations ……. How many days the patient was hospitalized……

The treatment was of the type: Conventional ( ) Non-pharmacological ( )

Diagnosis of Symptoms/Sings

Start/finish	Acute/chronic (persistent)	Casual (intermittent)

Note…… …
……..…… …
…… …… ……..

Symptoms/Manifestations Observed in the Participant Interviewee

( ) runny nose	( ) wound	( ) dry cough
( ) cough with phlegm	( ) bleeding	( ) fever
( ) chest pain (rib)	( ) palpitation	( ) sneeze
( ) Fatigue diagnosed	( ) headache	( ) pneumonia
( ) tearing	( ) itching of the body	( ) tiredness

Affected Region or Body Part

Pulmonary (respiratory system)	Dermatological (epidermis)
.	

Note…… ……
……..…….…… ……
……..

Illness Cycle Disease Onset

Disease onset	Duration (temporary, constant, permanent)	Intensity (small, moderate, intense)
.	.	

Note…… ……
…… ……..……
……..

Treatment of Symptoms/Signs most commonly observed/diagnosed

Symptoms/ Signs	Time is frequency of treatment	Treatment/ medicine prescribed	Treatment not Pharmacological	Number of Consultations carried out
.	.	.	.	

Note…… ……
……..……
……

Answers Obtained with Treatment/Medication:

Cure	Signs (aftereffects)	In the treatment stage

Note…… …… ……
……..…… …… ……
……

Cost of Medicines/treatment

Own Cost	Funding for Public Agencies	Other forms of funding
		.

Note…… …… … …… …… ……

Note The elaboration of the Exploratory Epidemiological Survey for application in the *Parque São Pedro* and *Jesus me Deu*/communities—Manaus—Amazonas/Brazil, followed Resolution 466, of December 12, 2012, of the National Health Council—CNS as a Reference.

Appendix 2: Quantitative Description Model

COMMUNITY ..... YEAR.....

Interviewee code (Initials / Name)	Residence time	Gender				Age	Symptoms		Disease stage(Days)			Number of Endemics	Number of Queries	Lev		
		Swan		Transgender										P.	S.	T.
		Mas.	Fem.	trans.	Transs.		Pulmon.	Dermat.	Init.	Inter.	Cov.			Levels of health care		
01																
02																
03																
04																
05																
06																
07																

Abbreviation note: Mas. (Male); Fem. (Female); trans. (Transvestite); Transs. (Transsexual); Init. (Initial); Inter. (Intermediary); Cov. (Serious); Pulmon. (Pulmonary); Dermat. (Dermatological); P. (Primary); S. (Secondary); T. (Tertiary).

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Paulo Custódio, Researcher, Ph.D student in Research Unit in Energy, Environment and Health (FP-ENAS), Master in Geography (Space Organization) from Universidade Estadual Paulista Júlio de Mesquita Filho—UNESP, Graduation in Licenciatura—Economic Science from Universidade Federal do Amazonas—UFAM Bachelored and Licensed-Geography by the Pontifical Catholic University of Rio de Janeiro-PUC, MBA Specialist in Audit Expertise and Environmental Management, by the Postgraduate Institute of Goiás—IPOG, Specialist in Geography of Amazonas, by the Federal University do Amazonas—UFAM. Environmental Analyst at Amazonas Environmental Protection Institute—IPAAM (retired). President of the Dakota Institute for Environmental Conservation, Preservation, Assistance and Technology—Dakota Institute.

Camila Maria Paiva França Telles, Researcher, Associate Professor, Ph.D, MSc Department of Pediatrics, Faculty of Medicine, Federal University of Amazonas (UFAM), Title of Specialist in Pediatric Rheumatology by the Brazilian Society of Rheumatology, Specialist in Pediatric Rheumatology at Instituto da Criança—USP Medical School. Specialist in Pediatrics from the Brazilian Society of Pediatrics, Residency in Pediatrics from the Escola de Saúde Publica do Ceará—Hospital Infantil Albert Sabin. Physician graduated from the Federal University of Pará.

Nelson Azevedo Barros, Ph.D in Environmental Sciences, Master in Thermal Engineering and graduated (5 years) in Environmental Engineering. He has over 25 years of experience in air quality research (monitoring, numerical modeling and management), including assessing the impact of air quality on human health. He also has several years of experience in monitoring and managing indoor air quality and a long experience in participating in research and projects. With more than 100 international and national publications, it has a Scopus h-index 8 and a Google Scholar h-index 11. He has collaborated with 20 international journals on peer review of scientific manuscripts for publication. He serves on the review board of the Atmosphere Journal and the Editorial Board of the Journal of Ecological Engineering. He is currently an Associate Professor at UFP, coordinator of the Doctoral Program in Ecology and Environmental Health and coordinator of the Energy, Environment and Environmental Health Research Laboratory (3ERL), Research Group of the Energy, Environment and Health Research Unit of Fernando Pessoa (FP-ENAS).

Social Inequity and Health: From the Environment to the Access to Healthcare in Composite Indicators, the Portuguese Case

Alexandre Morais Nunes and Diogo Cunha Ferreira

1 Introduction

The health sector is seen as a factor that promotes well-being and quality of life, considering that individuals' health status affects their physical and psychological well-being and their social and economic situation (Pförtner and Richter 2011). A healthy economy depends a lot on a healthy population, with quality of life (Betti 2017). However, this relationship does not depend only on itself but also on other factors that may impact economic growth and are not necessarily related to health status. Some examples include education, the environment, and transportation (Sihto et al. 2006). This one is the vision of health in all policies proposed by the World Health Organization (WHO), which, in essence, intends to promote the health of the population, proposing an intervention at the level of health determinants (World Health Organization (WHO) 2010).

The reduction of health inequalities promotes the improvement of the population's health status, impacting the quality of life, the labor market, the households' economy, social inclusion, and the poverty levels. Given this relationship, governments have favored economic development on their political agenda for the past few decades. Thus, the health policy development has, as a priority, the reduction of inequalities, based on the understanding that health status improvement contributes

A. M. Nunes (✉)
Center for Administration and Public Policies, Institute of Social and Political Sciences, University of Lisbon, Rua Almerindo Lessa - Polo Universitário Alto da Ajuda, 1300-663 Lisbon, Portugal
e-mail: anunes@iscsp.ulisboa.pt

D. C. Ferreira
Civil Engineering Research and Innovation for Sustainability, Instituto Superior Técnico, University of Lisbon, Av. Rovisco Pais 1, 1049-001 Lisbon, Portugal
e-mail: diogo.cunha.ferreira@tecnico.ulisboa.pt

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positively to the country's development, ensuring sustainability. The opposite is, however, an obstacle to economic growth (WHO 2010).

The concept of "*health in all policies*" lies in the multidisciplinarity and importance given to the health sector in defining the political agenda for all State sectors. It is highlighted with due responsibility, transparency, and involvement of all stakeholders. The SARS-COV-2 pandemic has put this idea to the test. On the one hand, on the negative side, given the tremendous economic and social impact generated by the retraction of revenue and increased expenditure by States (Sarkodie and Owusu 2020). On the other hand, with a positive impact at the environmental level with the policies of social distancing instituted that led to the suspension of several industrial activities and the respective reduction of energy consumption and also to the reduction of road and air transport with effects on the reduction of carbon emissions (Verisk 2020).

Given the above, the relationship between social inequalities in health and issues of sustainability and innovation, which have made health issues in all policies a recurrent and priority theme, becomes apparent. Thus, this chapter aims to analyze these concepts in a transversal way, not forgetting the promotion of innovation to guarantee the necessary sustainability that should improve citizens' quality of life. It is a hot topic, especially in the post-pandemic period, which affected an entire balance of societies and which should certainly require a review of the objectives of the agenda 2030.

In addition to the theoretical question, this chapter carries out a study of the Portuguese case for measuring the quality of life, a highlighted concept in the literature. For example, according to Papanicolas and Smith (2018), health assessments can play a crucial role in assessing the health system and improving its performance. Shankardass et al. (2018) highlight the interest in promoting research in health promotion and quality of life that includes actions on the structural determinants of health, including the focus on the implementation of Health in All Policies. Solar and Irwin (2007) also reinforce the need for these studies, particularly in cases where these determinants are the basis of deep inequalities. Thus, one can understand the quality of life in municipalities as the outcome of both local and global policies in a panacea of fields, including access to health and education, purchasing power, employment, quality of the environment, and security, to name a few. However, little is known about the quality of life in Portuguese municipalities, neither the contributions of environment, education, culture, living conditions, and health, among other aspects, to this field.

2 Healths in All Policies

In countries with a Social State model, some problems need quick answers and a definition of strategies for implementing new policies. Examples are health policies and systems that must be cohesive, contributing to society's development, given their influence on the economy and people's lives by contributing to the

improvement of well-being and living conditions, whether social or work (Nunes 2021).

The expression "*health in all policies*" represents an intersectoral approach's clear strategy, based on evidence, such that actions and policies of initiative from sectors outside health have repercussions on health and equity in access to it. These repercussions can be positive or negative. Thus, improving the quality of life and public health indicators requires concerted and coordinated action by institutions linked to health and organization outside that scope (Greaves and Bialystok 2011). This new way of thinking about health allows equating the States' social spending with the spending on health, providing better economic results for the country (Kershaw 2020).

Such a concept originates in public health and aims to strengthen the relationship between health and other sectors: e.g., education, economy, environment, agriculture, and transport. This association is based on the principle that health status is determined by several factors such as housing, the workplace, eating habits, and consumption. These depend not only on individual options but also on social, economic, environmental, and cultural factors, whose health policies can positively influence (Puska 2007).

The idea of health in all policies, although only recently discussed, has been perpetuated for several decades, namely since the very declaration that created the World Health Organization (WHO):

> Governments have a responsibility for the health of their peoples which can be fulfilled only by the provision of adequate health and social measures (World Health Organization 1946).

Since then, this view has been broadened over time, being present, for example: in the Declaration of Alma Ata (1978), in the Ottawa Charter (1986); in the Treaty of Amsterdam (1997); in several WHO conferences; in the Lisbon Treaty (2007); in the principles of the Commission on social determinants of health (CSDH) (2008); and, since 2014, through the "*Plan of action on health in all policies of WHO*."

In articulating between the health sector and other sectors, health entities must understand the functioning and agenda of policies and the impact that health has on them. However, it is necessary to assess the health consequences in view of the options taken in other sectors. To facilitate and promote positive development, the report "About social determinants of health" by the World Health Organization (WHO 2010) recommends: the creation of platforms promoting a better articulation between all sectors; the evaluation of the efficiency of joint works and the formulation of intersectoral catheter policies; the development of mechanisms and resources supported by human resources with the necessary preparation and the involvement of other sectors in achieving a specific goal (for example, health policy objectives must include environmental factors), culminating in a joint action that promotes better health and well-being.

These recommendations became compulsory because of the SARS-CoV2 pandemic. The lack of articulation between various sectors disrupted each country's diverse social strata, bringing up-to-date themes like the relationship between social determinants in health and the issue of health in all policies (Nunes 2021).

3 Social Determinants in Health

Intervention at the health determinants level is a fundamental part of all policies' health promotion strategies and reduces inequalities (Sihto et al. 2006).

The WHO (1998) has defined health determinants as a range of personal, social, economic, and environmental factors that determine individuals or populations' health status. However, the current definition given by the same entity (WHO 2020) adds that the social determinants of health represent the circumstances in which people are born, grow up, live, work and age. In turn, people are shaped by the distribution of money, power, and resources available locally, nationally, and worldwide. These are primarily responsible for health inequalities, recognized as the basis for unjust and avoidable differences in health status observed between different countries.

The social determinants of health have different origins, which can be biological, behavioral, educational, economic, among others. In general, those have a strong influence on implementing "health in all policies," with the principle that intervention can reduce health inequalities. According to Puska (2007), this approach can contribute to the much-desired reduction in health inequalities.

Meeting the definition adopted by the WHO for "*determinant in health*," Nunes (2021) considers the existence of multiple determinants influencing people's health status. The author organizes them into five major categories (see Fig. 1), focusing on which relate to each citizen's options and those based on other factors of a more economical and social nature.

Each of the determinants, alone or together, can condition or benefit the health status. Examples of determinants include: (i) biological: age, gender, and genetic factors; (ii) socio-economic: income, employment, socioeconomic status, and social exclusion; (iii) environmental: habitat, air quality, water quality, and social environment; (iv) lifestyles and living conditions: food, physical activity, smoking, alcohol, sexual behavior; (v) access and equity: level of education, health status, social services, transport, and leisure.

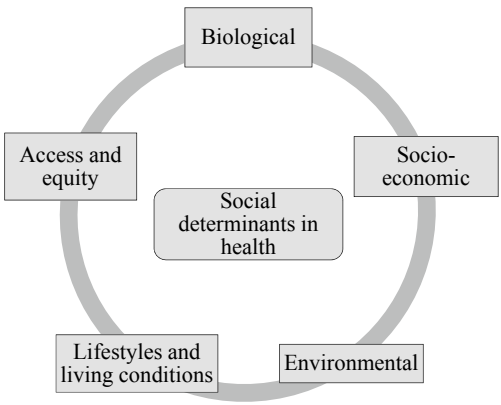


Fig. 1 Categories of social determinants in health (adapted from Nunes 2021)

Regardless of the definitions or the grouping of factors suggested by various authors, Dahlgren and Whitehead's model (1991) is internationally recognized as a benchmark, considering that the social determinants in health influence the health status and consequently the way we live due to a combination of several factors.

In Dahlgren and Whitehead's model, it is impossible to control genetic or physiological/biological factors. However, other determinants, such as behavioral ones, can be controlled, for example, by changing risky behaviors (inadequate diet, overweight, drinking alcohol, and smoking). To circumscribe these determinants (more individual), others condition them at a macro level, such as social and community networks, living, education, and work conditions, representing a set of socioeconomic, cultural, and environmental conditions.

Another reading that can be done regarding the diagram in Fig. 2 is the stratification of health determinants presented by Nunes (2021) (see Fig. 2). It presents four levels or layers: the smallest, at the base, concerns the individual, and the largest, at the top, integrates the community.

According to Buss and Pellegrini, Dahlgren and Whitehead's model allows identifying points for policy interventions to minimize the differences between social determinants in health originated by social position. According to those authors, health policies can intervene: in lifestyles (through promoting healthy lifestyles and behaviors, through health education, using the media and promoting easy access to healthy foods, prohibiting advertising of substances such as alcohol and tobacco, as well as promoting physical exercise in public spaces); in the

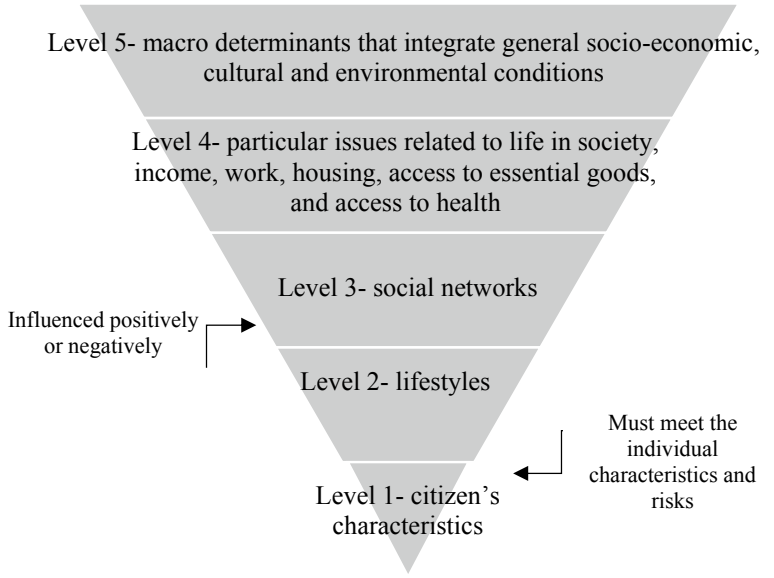


Fig. 2 Diagram of health determinants by levels, following the perspective of Dahlgren and Whitehead (adapted from Nunes 2021)

community and social networks (to enhance behavior through the implementation of proximity policies with the most disadvantaged and vulnerable population); in living and working conditions (ensuring sanitation and suitable environmental conditions), a field requiring health intervention in all policies due to its multidisciplinarity; and in macroeconomic policies on socioeconomic, cultural, and environmental issues, because of the desirable sustainable development. This development must satisfy current needs without compromising future generations' ability to meet their needs.

Exemplifying with the Portuguese case, the General Directorate of Health dedicated a chapter to the determinants in health in the last portrait of the Portuguese population health status (Ministry of Health 2018), having highlighted:

- The level of education, considering that a higher degree positively conditions these citizens' behavior. In this way, citizens benefit from the new knowledge that allows, for example, adopting a set of healthy behaviors daily that lead to a lower probability of suffering from a particular pathology (e.g., lower prevalence of obesity, diabetes, and hypertension) and mental illness (e.g., depression and anxiety). This question can also be applied to the recent pandemic associated with the SARS-CoV-2 virus (COVID-19), where the level of education may contribute to greater literacy and capacity to deal with the disease's spread. It is hoped that this literacy will facilitate understanding information regarding the forms of transmission and the appropriate behaviors at each moment. Although significant steps have been taken in Portugal to promote the educational level, there is a significant part of the population with low education, which essentially corresponds to the older population;
- The employment, recognized by the Ministry of Health as a significant determinant of physical and mental health. There is a correlation between unemployment and the higher prevalence of the chronic disease, directly related to eating habits, since these pathologies are sensitive to healthy eating.
- In line with unemployment, income is a determinant that conditions access to goods and services essential to health and well-being. There is an association between income and health status assessment, in which individuals with lower income tend to negatively assess their health status when compared to individuals with higher income;
- Among the behavioral determinants, the following are highlighted in the report on the Portuguese citizens' health status:

  i. Overweight, identified in 5.9 million Portuguese (57% of the population), namely with a higher prevalence in the elderly (8 in 10) and less educated individuals, and in about 30.7% of children (11.7% of children are obese);
  ii. Inadequate eating habits, which contribute to the loss of 15.4% of healthy years of life;
  iii. Physical activity practiced regularly by only 41.8% of citizens (nearly 14% of annual deaths in Portugal could be prevented with regular physical exercise);

iv. Tobacco consumption is considered one of the leading causes of premature death in Portugal, with one death every 50 min (smokers represent about 28.3% of men and 16.4% of women in Portugal).

4 Sustainability, Innovation, and Quality of Life

State intervention in reducing health inequalities has been a priority in the search for sustainability. It is considered that it is only possible to obtain greater productivity at work, well-being, and better quality of life if the following conditions are met: healthy population, access to information, adequate living conditions, and timely access to appropriate and safe health services.

The search for sustainability and quality of life through the inequalities reduction is based on several factors that promote the "health in all policies" approach among the various agents involved in the construction of public policies. The mutual recognition of the importance of the various sectors, the involvement of the government, parliamentary leaders, and public administration leaders, the allocation of public health responsibilities in all political processes in the most diverse areas, with a set of pre-established objectives and goals are some noteworthy cases. Additionally, we have the sharing of responsibilities by the agents involved in decision-making processes, the promotion of close monitoring by the central government, greater openness to support stakeholders in a consultative manner, for example, by creating working groups, the incentive, experimentation, and innovation in creating new governance models that integrate social, economic, and environmental objectives and prevent possible conflicts of interest throughout all political and decision-making processes (WHO 2010).

Notwithstanding, innovation combined with citizen participation in decision-making can also contribute to sustainability goals, particularly in the health sector. On the one hand, it is necessary to involve the citizen in the processes to adjust her/his needs. On the other hand, this action is conditioned by low literacy (Pedro et al. 2016).

The design of the recommendations for a new agenda should be based on cooperation, social mobilization, and training strategies that allow the presentation of strategic lines to (re)define society's needs in favor of national and international strategic interest. For this, as was clear from the SARS-CoV-2 pandemic, it is necessary to mobilize the whole of society and focus the citizen at its center, with their state of health being fundamental to sustainability. It is in line with the health value theory that will make it possible to measure the health outcomes that matter to citizens and that impact users' quality of life (Porter and Teisberg 2005).

The following section presents a model developed by the authors of this chapter that provides an assessment of residents' quality of life, based on a vast set of indicators related to the quality of life.

5 From the Environment to the Access to Healthcare in Composite Indicators: The Portuguese Case

Based on the previous discussion, one can understand the quality of life as the outcome of both local and global policies in a panacea of fields, including (but not limited to) access to health and education, purchasing power, employment, quality of the environment, justice, and security, to name a few. In this section, we construct a composite indicator useful to evaluate the quality of life of citizens. We take 277 Portuguese municipalities (located in Portugal mainland) as the case study, evaluated using data from 2019. Municipalities in Madeira and Azores' islands and two others in the mainland were removed from the dataset because of substantial data gaps. Data were collected from the official source, INE, which stands for *Instituto Nacional de Estatística*, the Portuguese words for *National Statistics Institute*. We consider the following four primary dimensions (or criteria) to characterize and measure the quality of life:

i. Health, primarily associated with access to the local healthcare services (primary care centers in most of the Portuguese municipalities);
ii. Living conditions, related to purchasing power and welfare, as well as security and justice;
iii. Environment, associated with environment protection, access to safely managed drinking water and sewerage systems (which can cause waterborne diseases when not properly managed), recycling and separation of waste, and wildfires; and
iv. Education and culture, related to youngsters' enrollment in school and the public education offer, ensuring universal access to everyone.

Figure 3 presents the twenty-three variables chosen to represent the quality of life. Most of them are beneficial as the higher, the better. Nonetheless, five should be decreased as they are undesirable to quality of life: rate of deaths by specific causes (circulatory/digestive/respiratory system illnesses, malignant tumors, injuries and poisonings, diabetes, and suicide); crimes registered by police per thousand inhabitants; road traffic accidents with victims per thousand inhabitants; and degree of burnt area.

Table 1 presents some basic statistics associated with the twenty-three variables used to characterize Portuguese municipalities' quality of life. Namely, we considered the quartiles, the average, and the distributions' extremes as the most relevant measures to describe each variable. In most of the dimensions, Portugal exhibits considerable heterogeneity, which shall impact the citizens' quality of life. For instance, regarding access to healthcare, only a handful of municipalities have more than ten doctors per 1,000 inhabitants: Coimbra, Porto, Lisbon, Faro, and Oeiras, which are all urban councils located in the coastline, also exhibiting large values of crude birth rates and pharmacists per 1,000 inhabitants, and low death rates due to specific diseases. Indeed, there is a well-documented negative association between healthcare access and the prevention/treatment of some diseases.

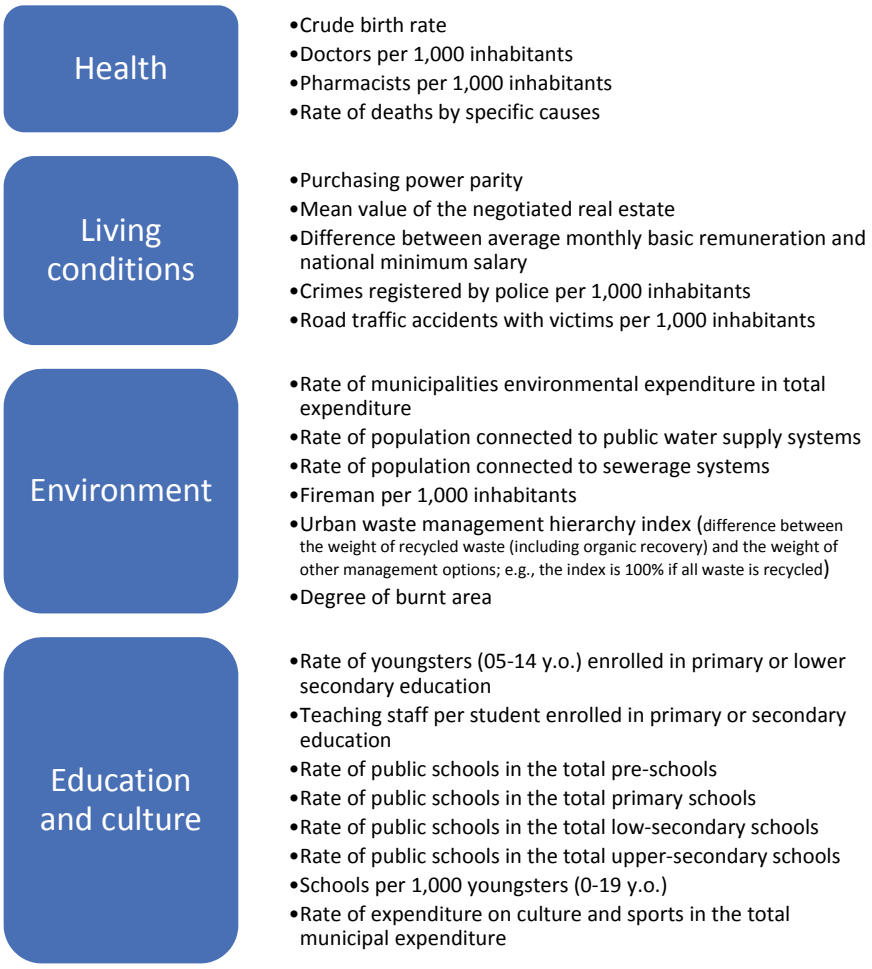


Fig. 3 Variables considered to construct a quality of life related composite indicator

Also, in terms of living conditions, we can observe situations where citizens of some municipalities enjoy a much larger purchasing power due to higher wages (compared to the national minimum salary), but simultaneously more crimes and road traffic accidents. The five variables used to characterize the living conditions are, indeed, positively correlated (with a statistical significance of 5%) with each other, except crimes and road traffic accidents. Therefore, there is a kind of trade-off between wealth and criminality and accidents, and the perceived satisfaction with the living conditions should depend on the relative importance that each citizen attributes to each criterion. However, a good performance in one criterion shall not compensate for poor performance in other(s).

There is also a significant difference among councils regarding the environment, its protection, and access to essential services (like potable drinking water and sewers). For instance, more than three-quarters of the considered municipalities spend less than a tenth of their budgets on environmental protection. Also, in nearly 25% of them, a tenth of people have no drinking water access. Even more worrying is the high quantity of municipalities that do not offer access to sewerage systems to all of their inhabitants. Interestingly, except for the two dimensions used to characterize the access to essential services, there is no association between these environmental dimensions. Thus, more municipal expenditures on environmental protection do not seem to produce any meaningful effect on waste separation and recovery. Education and culture is another field in which Portugal shows considerable asymmetry, especially in the offer of educational services measured by the number of public schools and teachers. Meanwhile, neither of these variables share a significant correlation to each other.

We use benchmarking techniques to construct the composite indicator mentioned above. These techniques compare empirical observations to search for the best practices (or benchmarks) within the field, the municipal level's quality of life. Benchmarking techniques can be either parametric or non-parametric, depending upon the definition of a pre-specified production function that relates production factors (or inputs) and products (or outputs). In our case, we notice that variables are relative, most of them defined in terms of ratios (e.g., the crude birth rate in one year is the ratio between the number of live births and the number of person-years lived that year). Because of that, we cannot construct a cost- or output-function as done in parametric techniques. Instead, we opt for the non-parametric ones, based on empirical data only. There are several alternatives among these techniques, but the most famous one is Data Envelopment Analysis (DEA), developed in the 1970s by Charnes, Cooper and Rhodes.

More recently, Cherchye et al. (2007) allowed relative data inclusion into the performance assessment model by restricting the DEA model. Since then, multiple studies have been published using that new DEA version, better known as the Benefit of Doubt (BoD), in many fields, including: healthcare (Shwartz et al. 2016), environment (Rogge 2012), social inclusion (Giambona and Vassallo 2014), corporate social performance (Aparicio and Kapelko 2019), and quality of life (González et al. 2018). In line with these references, we also adopt BoD for measuring the quality of life, given the model's advantages documented in the literature. However, differently from other studies, we:

a. introduce a directional nature as in Mehdiloozad et al. (2014), in which finding benchmarks for each municipality follows a path defined by a directional vector, typically equal to the data point (Ferreira and Marques 2016);
b. allow the introduction of additional bounds stating that targets (or optimal values) for desirable variables should be above those bounds, while the undesirable ones should be below—this implies that municipalities classified as best practices must exhibit, at least, a fair performance in all variables;

Table 1 Statistics associated with variables considered in our case study

Health

	Crude birth rate	Doctors per 1000 inhabitants	Pharmacists per 1000 inhabitants	Deaths by specific causes (%)
Min	1.50	0.38	0.24	46.20
Q1	5.60	1.42	0.76	69.70
Q2 (median)	6.80	2.01	0.96	73.30
Average	6.83	2.79	1.04	72.23
Q3	8.10	3.13	1.22	75.90
Q4 (max)	12.00	34.60	5.10	84.50

Living conditions

	Purchasing power per capita	Mean value of the negotiated real estate	Difference between average monthly basic remuneration and national minimum salary	Crimes registered by police per 1,000 inhabitants	Road traffic accidents with victims per 1,000 inhabitants
Min	55.30	2596.00	83.00	11.80	0.00
Q1	67.40	21,214.00	151.00	21.90	2.80
Q2 (median)	77.30	44,594.00	199.00	25.70	3.50
Average	80.55	58,664.01	226.90	27.75	3.57
Q3	89.20	80,278.00	266.00	31.50	4.10
Q4 (max)	219.60	391,421.00	1374.00	86.00	10.80

Environment

	Municipalities environmental expenditure (%)	Access to public water supply systems (%)	Access to sewerage systems (%)	Fireman per 1,000 inhabitants	Urban waste management hierarchy index*	Degree of burnt area (%)
Min	0.50	42.00	17.00	0.40	0.00	0.00
Q1	4.90	91.00	66.00	2.33	27.00	0.00
Q2 (median)	6.70	98.00	84.00	3.84	63.00	0.10
Average	7.32	93.95	76.81	5.28	65.33	0.58
Q3	8.80	100.00	93.00	6.91	99.60	0.40
Q4 (max)	24.30	100.00	100.00	19.53	150.60	17.20

Education and culture

	Rate of youngsters enrolled in school	Teaching staff per student	Public schools (% of pre-schools)	Public schools (% of primary schools)	Public schools (% of lower secondary schools)	Public schools (% of upper-secondary schools)	Schools per 1,000 youngsters	Expenditure on culture and sports (%)
Min	0.52	0.00	0.00	48.40	0.00	0.00	3.45	2.30
Q1	0.73	0.05	57.90	93.30	77.80	50.00	6.04	7.20
Q2 (median)	0.79	0.15	70.20	100.00	100.00	66.70	7.59	10.30
Average	0.81	0.35	70.69	95.12	88.61	68.01	8.20	11.00
Q3	0.87	0.33	84.20	100.00	100.00	100.00	9.82	14.60
Q4 (max)	1.41	4.84	100.00	100.00	100.00	100.00	18.81	28.80

Note Q denotes the distribution's quartile; min and max stand for the minimum and the maximum, respectively

*The urban waste management hierarchy index was rescaled to return only positive values (as the model described below cannot use negative data)

c. transform the variables into their logarithms as in Banker et al. (1984) and Emrouznejad and Cabanda (2010), which presents two main advantages:

   (i) it does not fail to identify the production regions of increasing marginal products (Davoodi et al. 2015; Ferreira et al. 2019); and
   (ii) it avoids the zero weight problem of standard DEA models (Tofallis 2014); thus, all variables are considered for the quality of life score computation, and the compensatory effect of the optimization framework underlying BoD is mitigated.

Using BoD, we construct a score for each area featuring the quality of life (health, living conditions, environment, education and culture). Each score ranges from 0 to 1; the top value indicates excellent performance. Then, we rerun the BoD model using those four scores as new variables to construct the overall quality of life composite indicator. Since BoD is an optimization tool that maximizes each variable's weights (provided other constraints, as explained above), the performance in each dimension is maximal. In other words, municipalities cannot get a better score arguing that the obtained set of weights is unfair. As for bounds, we take the median of each variable distribution. Therefore, we assume that to reach excellence, compared to other municipalities, each one must observe desirable variables above the median and undesirable variables below the median. For instance, regarding the access to healthcare, the benchmark(s) must have at least 6.80 live births, 2.01 doctors, and 0.96 pharmacists per 1,000 inhabitants, and, at most, 73.30 deaths due to circulatory/digestive/respiratory system illnesses, malignant tumors, injuries and poisonings, diabetes, and suicide per 100 deaths.

The relationship (ratio) between these targets and the empirical observations gives us insights into inefficiency sources. The average, weighted or not, of all target-to-data ratios, returns a performance score. In this case, we do not impose any weights beyond the ones optimized by BoD. Besides, if the target-to-data ratios are equal to one for all variables, the score is also one. In opposition, any ratio different from one implies an inefficiency source and a score lower than one. Thus, we should look at these ratios to identify the most relevant sources posing barriers to excellence in quality of life (see Table 2).

Table 2 presents the main features of the targets' distributions. As we can see, targets obey previous constraints.

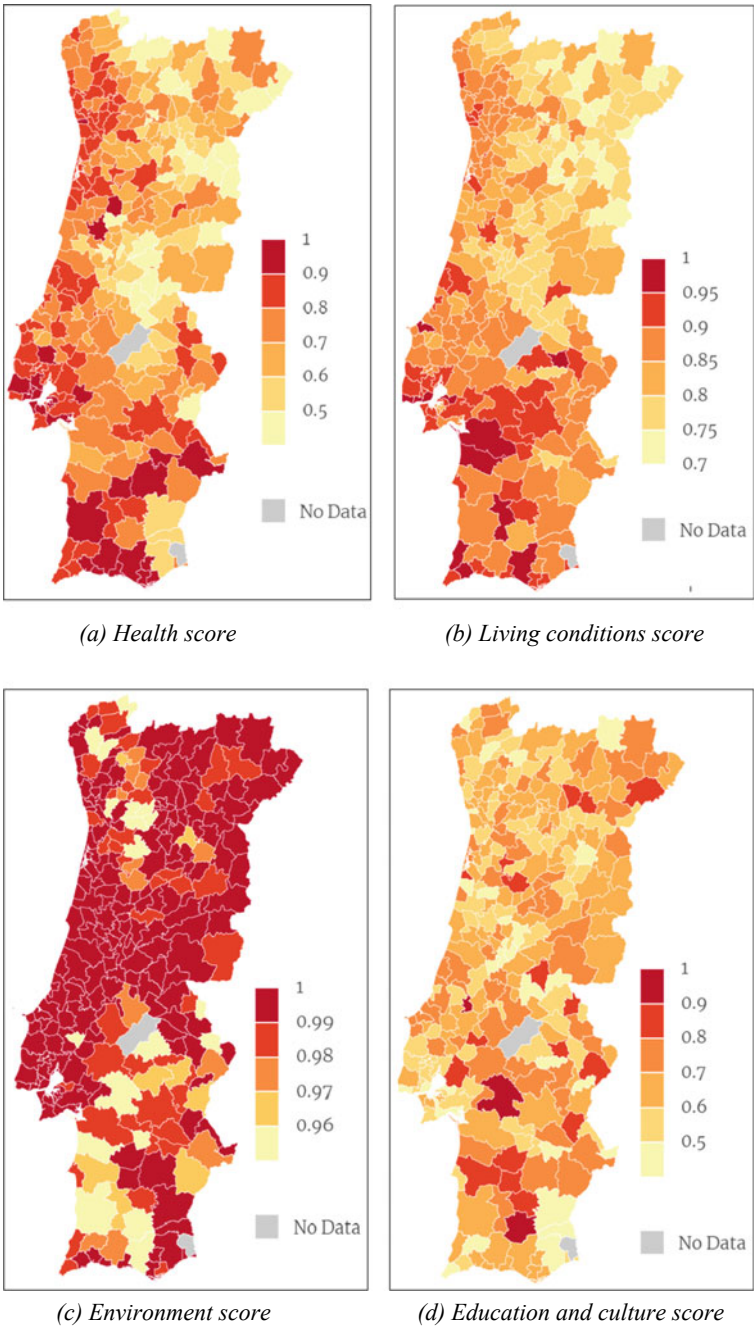
From the first half of variables in Table 2, we may observe the ones that demand local policies for quality of life improvement. The average target-to-data ratio is in parenthesis for each variable. These variables belong mainly to: access to healthcare (natality, availability of resources, and follow-up of acute and chronic cases); living conditions (essentially, the wealth and the security); and education and culture (availability of schools and teachers, and municipal expenditures on culture and sports). Interestingly, the model does not identify the environment as a significant source of inefficiency in Portuguese municipalities to provide better quality to their citizens, except for the need for policies promoting waste selection, organic recovery, and the circular economy's development.

Table 2 Indicators average for ranking variables in descending order of required changes for optimum

1. Mean value of the negotiated real estate (7.92)
2. Teaching staff per student enrolled in primary or secondary education (4.73)
3. Rate of deaths due to specific causes (4.35)
4. Difference between average monthly basic remuneration and national minimum salary (3.27)
5. Purchasing power per capita (2.48)
6. Doctors per 1000 inhabitants (1.88)
7. Crude birth rate (1.80)
8. Rate of expenditure on culture and sports in the total municipal expenditure (1.79)
9. Crimes registered by police per 1,000 inhabitants (1.75)
10. Schools per 1000 youngsters (1.66)
11. Urban waste management hierarchy index (1.53)
12. Rate of public schools in the total upper secondary schools (1.34)
13. Rate of youngsters enrolled in school (1.30)
14. Rate of public schools in the total pre-schools (1.30)
15. Fireman per 1000 inhabitants (1.29)
16. Pharmacists per 1000 inhabitants (1.25)
17. Road traffic accidents with victims per 1,000 inhabitants (1.23)
18. Rate of municipalities environmental expenditure in total expenditure (1.20)
19. Population connected to sewerage systems (1.16)
20. Rate of public schools in the total lower secondary schools (1.15)
21. Population connected to public water supply systems (1.07)
22. Rate of public schools in the total primary schools (1.06)
23. Degree of burnt area (1.01)

In this sense, some steps can be taken in policy formulation that, based on the principles of multidisciplinarity and health in all policies, should improve life quality. Examples include:

i. In terms of access to health services: assigning family doctors to all citizens; reducing waiting lists; promotion of health and disease prevention actions;
ii. At the demographic level: ensuring active and dignified aging; creating better conditions for birth and parenting in the renewal of generations; enhancing the support for families;
iii. In terms of living and social conditions with a view and intergenerational sustainability: development of a less precarious and more dignified labor market; promoting reconciliation between work and family life; reduction of severe asymmetries in the distribution of income and wealth and reinforce protection and security as a fundamental pillar of democracy;



(a) Health score *(b) Living conditions score*

(c) Environment score *(d) Education and culture score*

Fig. 4 Geographical distribution of performance levels per area used to characterize the quality of life. Municipalities were characterized using scores computed for **a** health, **b** living conditions, **c** environment, and **d** education and culture

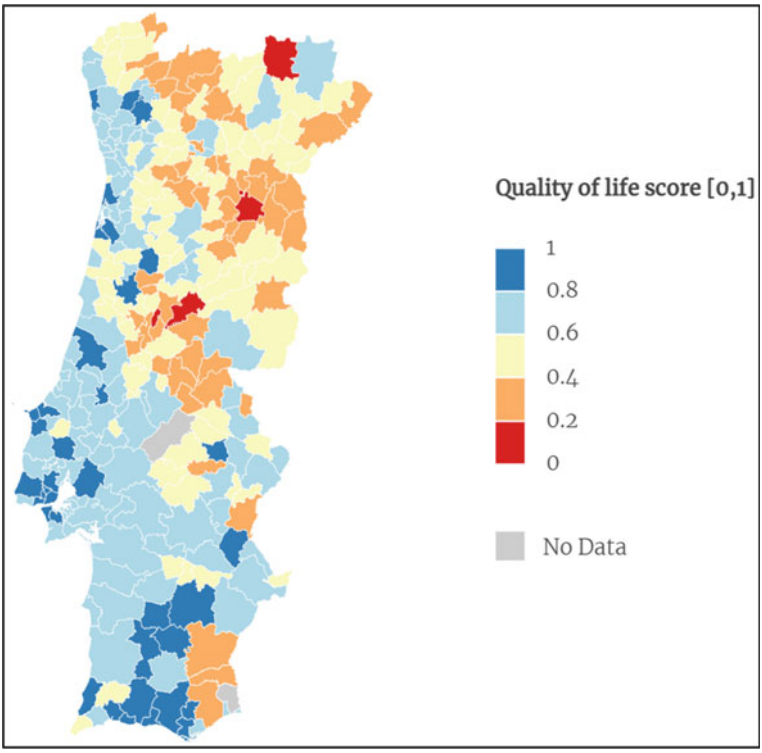


Fig. 5 Geographical distribution of the quality of life composite indicator

iv. At the level of education and culture: developing articulated and integrated proximity responses that should prevent the verified inequities on access to school; reducing the negative impacts on development and social interaction; and
v. In drinking water and sanitation services: ensuring efficient use of water resources; improving the integrated management of the urban water cycle, including water supply, wastewater collection and treatment, and rainwater drainage, which should contribute to the citizens' quality of life and the protection of the environment.

Even though we have identified no substantial environmental inefficiencies, it is always necessary to act at the environmental level, such as:

i. the economy decarbonization, as a contribution to the global and European goals assumed in the Paris Agreement (2016);
ii. the transition of energy to renewable production (solar energy and hybrid systems);

iii. the reduction of electric energy production from coal, closing or reconverting these thermoelectric plants;
iv. the improvement of urban solid waste management, abolishing non-reusable plastics, reinforcing waste separation, and investing in waste reuse and recycle;
v. the investment in pedagogy and environmental awareness within schools.

Figure 4 shows the geographical distribution of performance levels per area used to characterize the quality of life, while Fig. 6 does the same for the composite indicator. It is possible to observe in Fig. 5 the asymmetries of the various indicators, highlighting health where the question of up-country is evident. Education and culture seem to be an area demanding alarming attention. It is worth noting that inequity is more focused on the North/South issue and not so much on the Litoral/Interior in terms of living conditions. Additionally, municipalities seem to exhibit a good performance regarding the environment, which results from the water, sanitation, and waste management policies implemented in the 1990s. In aggregate terms, Fig. 5 shows that, in general, there are better living conditions in the municipalities of the coastal region and the south of the country (Table 3).

This study aimed to show the relationship between factors related to the "health in all policies" and their association with different areas in a multidimensional field. In practical terms, through the Portuguese case, the quality of life was analyzed based on a set of indicators that accounted for the understanding of the quality of life in the municipalities due to local and global policies. Thus, using robust benchmarking methods on the various criteria underlying quality of life, composite indicators were built, establishing a link between aspects such as access to health and education, purchasing power, quality of the environment, and security.

As main conclusions, we observed regional asymmetries with more significant evidence regarding health and living conditions, but uniformity in environmental issues and education and culture. The considerable heterogeneity in health (and the overall quality of life) seems to be justified, in part, by geographic variables. Remarkably, the dichotomies coastline/inland and North/South are evident in Portuguese municipalities' performance distribution.

In this exercise, it is worth highlighting some limitations due to data availability issues in some variables and municipalities. Undoubtedly other indicators could complement our analysis. However, their perfectly known data are not available, limiting their application and our findings' robustness. Still, this study's idea is to show the tool's potentiality, which can be applied to other realities, at least those in which there is greater transparency of data and political will.

Finally, it should be possible to replicate this model in other countries, such as analyzing the effects of the SAR-CoV-2 pandemic by applying it with data before the pandemic in a first analysis and with data after the pandemic in a second analysis. In this way, it is possible to establish a differential corresponding to the quality of life changes due to the pandemic outbreak. We should consider the indicators that refer to a set of health inequalities generated and, consecutively, reinforced the need for health promotion in all policies, as well as the agenda and policy revision, with the appropriate adjustment according to the observed effects.

Table 3 Distribution of targets

Health

	Crude birth rate	Doctors per 1000 inhabitants	Pharmacists per 1000 inhabitants	Deaths by specific causes (%)
Min	**6.80**	**2.27**	**0.96**	1.00
Q1	11.88	2.79	0.84	10.93
Q2 (median)	11.96	3.38	1.03	20.90
Average	11.77	4.76	1.30	23.39
Q3	12.00	5.40	1.50	33.78
Q4 (max)	12.00	34.60	5.10	**73.30**

Living conditions

	Purchasing power per capita	Mean value of the negotiated real estate	Difference between average monthly basic remuneration and national minimum salary	Crimes registered by police per 1,000 inhabitants	Road traffic accidents with victims per 1,000 inhabitants
Min	**77.30**	**44,594.00**	**199.00**	5.79	0.00
Q1	184.27	286,685.87	642.73	11.16	2.28
Q2 (median)	211.36	367,974.39	727.58	14.26	2.74
Average	197.92	331,712.61	687.14	16.67	2.91
Q3	217.87	383,969.24	736.69	19.10	3.33
Q4 (max)	219.60	391,421.00	1374.00	**25.70**	**3.50**

Environment

	Municipalities environmental expenditure (%)	Access to public water supply systems (%)	Access to sewerage systems (%)	Fireman per 1,000 inhabitants	Urban waste management hierarchy index	Degree of burnt area (%)
Min	**6.70**	**98.00**	**84.00**	**3.84**	**63.00**	0.00
Q1	7.01	100.00	88.38	4.67	67.23	0.00
Q2 (median)	7.46	100.00	90.60	5.11	80.87	0.05
Average	8.33	99.54	85.96	6.24	83.35	0.07
Q3	9.57	100.00	97.32	8.12	106.72	0.09
Q4 (max)	24.30	100.00	100.00	19.53	150.60	**0.10**

Education and culture

	Rate of youngsters enrolled in school	Teaching staff per student	Public schools (% of pre-schools)	Public schools (% of primary schools)	Public schools (% of lower secondary schools)	Public schools (% of upper-secondary schools)	Schools per 1,000 youngsters	Expenditure on culture and sports (%)
Min	**0.93**	**0.34**	**84.33**	**100.00**	**100.00**	**100.00**	**11.01**	**14.77**
Q1	0.97	0.36	85.61	100.00	100.00	100.00	11.50	15.67
Q2 (median)	1.00	0.50	86.76	100.00	100.00	100.00	12.16	16.53
Average	1.04	0.81	89.13	100.00	100.00	100.00	12.88	17.88
Q3	1.09	0.89	90.65	100.00	100.00	100.00	13.56	19.49
Q4 (max)	1.41	4.84	100.00	100.00	100.00	100.00	18.81	28.80

Note Q denotes the distribution's quartile; min and max stand for the minimum and the maximum, respectively

Bold entries mean that targets obey to the minimum requirement imposed to be a benchmark

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Sustainable Practices and Solutions

The Territorialisation of the UN Agenda 2030 and Cross-Cutting Issues in Energy, Environment and Health: The Case of Portugal

Eduardo Medeiros

1 Introduction and Methodology

Sustainable policy transitions require a shift towards more collaborative societal values coupled with a sustainability supportive fiscal framework. The materialisation of sustainable policies and practices in the field of energy, the environment and health also require the establishment of building blocks for a more empowered, informed and vibrant civil society in addressing sustainable development challenges. Policymaking processes also need to follow participatory, subsidiarity and place-based governance principles (Barca 2009; Stead 2014). Moreover, eco-innovation practices can only succeed if all involved actors (SMEs and large companies, research institutions, consumers, etc.) proactively contribute to this transition towards a more sustainable territorial development pattern (Bontoux and Bengtsson 2015). Finally, the physical renovation of buildings to improve energy efficiency and the production of clean energy renders a tangible platform to materialise these intended sustainable policy transitions (Kanters and Wall 2014).

By entailing several complex and interacting systems (Medeiros 2020b; Sachs 2015) sustainable development deals with a myriad of aspects of global development. Ultimately, however, it "has its roots in conservation and the desire to protect the planet's ecosystems" (Blewitt 2018: 2). Partly as a result of constructed social processes that are normally associated with environmental concerns, the social dimension is often incorporated in the familiar typologies of sustainable development: (i) people, planet, and profit; (ii) environment, economy, and equity; or (iii) environmental, economic, and social processes (Boström 2012). Taking this further, the notion of ecosocial innovation, entailing human needs for a healthier and environmentally sustainable world, has been developed since the 1980s in Europe (Matthies et al. 2019).

E. Medeiros (✉)
ISCTE, Lisbon, Portugal
e-mail: Eduardo.Medeiros@iscte-iul.pt

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Understandably, the analysis of sustainable policy transition processes is particularly complex and challenging. The same goes for the research on cross-cutting issues in energy, environment and health, which is the central theme of this book. This chapter will mainly focus on analysing the contribution of EU Cohesion Policy (2014–20 period—Portugal 2020) related strategy and funding to foment a sustainability transition in cross-cutting issues in the aforementioned three policy arenas. From a methodological standpoint, this chapter is mostly based on desk research of project databases. In addition, primary data sources were the Portugal 2020 strategy documents, supplemented with other national strategic documents, scientific articles, and books.

The bulk of the analysis is centred in examining the Portugal 2020 project database to determine how far there is a successful combination between the proposed components of the concept of sustainable policy transitions (Fig. 1). The proposed conceptual framework is supported by five crucial analytic components to stimulating sustainable policy transitions in the fields of energy, environment and health:

1. Social innovation: support to education and participatory society models. This involves support to empowered citizens and organisations as well as social responsibility and solidarity to address policy shortcomings on sustainable policy transitions;
2. Institutional innovation: support to decision-making processes towards sustainable policy transitions by institutions at all territorial levels. This includes strategic planning, participatory governance processes, and policy integration and evaluation processes;

Fig. 1 Analytic components of the sustainable policy transitions concept. *Source* Own elaboration

3. Eco fiscal and financial models: support to green taxation and financial benefits and regulatory approaches to support sustainable and renewable sources of energy. This includes encouraging the adoption of healthy and sustainable dietary patterns;
4. Ecological orientation: support to renewable and clean sources of energy, environmental protection and eco-friendly health products, which involves support for ecologic patterns of production and consumption;
5. Physical renovation: support for the use of renewable and clean sources of energy and increased energy efficiency in buildings and other physical infrastructure.

An essential counterpart of the analysis is the examination of the territorial dimension (Medeiros 2017) or territorialisation (Zaucha et al. 2014), of the aforementioned cross-cutting projects in energy, environment and health. Also important is the verification, or otherwise, of a 'territorialicy' approach to the Portugal 2020 strategy, "understood as a process of incorporating a territorial driven policy design, implementation and evaluation paradigm" (Medeiros 2020b). Ultimately, the research aims at answering the following main research questions:

1. How integrated are energy, environment and health policy issues in the Portugal 2020 strategy and implemented projects?
2. Which areas are benefiting more from cross-cutting issues in energy, environment and health, from Portugal 2020?

To lay the groundwork for the research, a theoretical discussion is launched in the following section, shedding light on current academic debates on energy, environment and health issues. The next section presents the analysis of Portugal 2020's contribution to supporting sustainable policy transitions in the fields of energy, environment and health, and the respective territorialisation in the Portuguese continental territory. The last section presents the conclusion.

2 A Theoretical Discussion on Sustainable Policies and Practices in Energy, Environment and Health

The decarbonisation of the energy sector has built up momentum within policy-makers' agendas, at all territorial levels, in the past decades. Even so, it remains a major policy challenge, since decarbonisation processes entail not only a need for the deployment and diffusion of renewable energy technologies, but also policy commitments at various levels. However, sustainable energy policy frameworks at the national level often hinder regional innovation policy ambitions (Steen et al. 2019). As such, national government policies supporting a greener energy transition are an essential counterpart in stimulating investment in sustainable energy trajectories. This can be achieved via strong and effective policy instruments such as financial incentives and other pro-active measures which can attract stakeholders

from business ecosystems and the public arena, to share capabilities, expertise and resources from different policy fields (Blasi and Sedita 2020).

On top of this, several studies have highlighted the crucial role of environmental regulations penalising economic activities which directly, or indirectly, harm the environment (Lundmark and Bäckström 2015). In this domain, based on research from several scientists, Sterlacchini (2020) suggests, amongst others, the implementation of the following environmental policy instruments: (i) taxes and charges directly applied to the pollution source or on the input or output of a production process; (ii) subsidies for environmentally-friendly activities; (iii) technology-support policies and (iv) voluntary approaches. The implementation of renewable energy regulations is, however, heavily conditioned by effective public policies aiming at stimulating technology demand. The problem is that the prevalent policy-induced market demands reward a rather conservative attitude of adapting behaviour to enhance efficiency and minimize cost, the propensity of entrepreneurial firms to engage in radical innovation and the ability to sustain superior performance could be reduced (Doblinger et al. 2016: 217). Worse still, in many instances, the political attention placed in energy innovation for climate mitigation is insufficient, vis-à-vis regional needs (Tawney et al. 2015).

At the urban level, emerging policy awareness on the need to promote environmental sustainability paths has begun to permeate many policy agendas. In China, for instance, policy measures are being implemented to promote the use of new energy vehicles in the city of Shenzhen. Despite resulting from a state-led innovation approach, it has strong involvement from local actors, since they recognise the advantages in solving critical urban problems such as air pollution and urban traffic congestion (Lauer and Liefner 2019). Moreover, the alleviation of poverty in many parts of the rural world requires access to improved and innovative energy services, aligned with socioeconomic, environmental, technological, institutional and sociocultural transformation processes (Perrot and Sanni 2018).

The salient point is that numerous factors affect the transfer and development of green energy technologies in many parts of the world, especially in developing countries, some of which are related to complexities associated with the energy sector (Tawney et al. 2015). Despite being considered a kind of "an empty box in which every stakeholder tries to put whatever is on the top of their priority list" (Szulecki et al. 2016: 548), the EU produced an energy union strategy, published on 25 February 2015,[1] which could contribute to counteracting the current domination of energy policies by nation states. The potential advantages of a supra-national energy strategy implementation should also be complemented by an integrated framework for analysing sustainable innovation policies, as a more suitable policy approach to research on emerging clean energy technologies (Meelen and Farla 2013). Profoundly preconditioned by governing processes, innovations in environmental policies depend in part on governing processes favouring the development of procedural and organisational instruments, coupled with policy coordination processes (Jordan and Lenschow 2008), as well as multidimensional, systemic and transformative approaches (UN 2019).

The most recent Global Environment Outlook (UN 2019) has revealed a reduced level of environmental policy integration and insufficient capacity from current environmental policies to effectively preserve the natural environment (i.e. limiting emissions and preserving natural resources). To invert this scenario, this report sparks major support for transformative policies on institutional and social innovation. In this domain, Jacob and Ekins (2020: 709) go on to argue that "achieving sustainable development implies transformative change of current economic and technological systems that serve the needs of society". Green innovation provides an essential vehicle to addressing the challenges of environmental deterioration and climate change and involves the improvement of products or processes aiming at achieving environmental sustainability. This echoes the acquisition of new green competences (Li et al. 2019).

On a positive note, Quitzow (2013) postulates that there are rising opportunities for increasing levels of environmental policy integration, in particular, for promoting environmental innovation. Moreover, the expanding markets for new environmental technologies will lead to the adoption of new standards and regulations enabling the promotion of successful environmental policies. Ultimately, environmental innovation strategies are impelled by a combination of government regulations, market forces via firms (Bianchi 2013), and social and institutional integration between several stakeholders which include NGOs. For Schweizer et al. (2016: 902–3), there are three distinct social mechanisms for incrementing environmental innovation strategies: (i) public regulations and exogenous events; (ii) environmental or instrumental concerns motivating NGOs to participate; and (iii) interactions and arrangements between constellations of actors.

The exact ramification with which environmental innovation strategies are diffused is, however, rather complex. At an international level, it is known that "the political choices of one country affect the subsequent choices of other countries" (Busch and Jörgens 2005: 865). These authors also conclude that there are several reasons which justify why policymakers at the national level tend to emulate policies being implemented in other countries, including increased pressures for conformity, and the possibilities for increasing political legitimacy. Be that as it may, an effective implementation of environmental policies not only requires strong political and entrepreneurial leadership but also "facilitating conditions and supportive political and institutional contexts" (Jordan et al. 2013: 160). Conversely, financial barriers on environmental related innovations produce formidable negative effects on the implementation of sustainability policies (Ghisetti et al. 2017). To face these barriers, there is a need for green innovation related products, technologies and lifestyles which can "guarantee that key natural processes will be able to maintain a life supporting quality over the long run and intra- and inter-generational equity goals should be met" (Truffer and Coenen 2012: 2).

Being a complex concept, health does not just refer only to the absence of diseases, but also to crucial socioeconomic, cultural and environmental conditions, social and community influences, individual lifestyle factors and living and working

conditions (World Health Organisation (WHO) 1997). In this context, climate change and increasing levels of air pollution bring widespread concerns for people's health (Chowdhury and Dey 2018), with much regional and local variation. In this regard, urban areas are commonly more problematic since they concentrate higher levels of pollution. Furthermore, the rise of temperatures in large cities tends to increase rates of photochemical smog production (Akhta and Palagiano 2018). Alongside this, forest fires can also affect health conditions both in rural and urban areas, due to the resulting emissions (Cisneros et al. 2018). In sum, there are clear links between health and environmental processes in distinct territorialisation patterns that require a global perspective (WHO 1997). Added to that, global health is deeply rooted and influenced by urban lifestyles, city leadership and city planning (Grant and Fudge 2020). For the WHO (1997: 27) there are seven main principles related to city health planning:

1. Equity: need to provide all people the right and opportunity to realise their full potential;
2. Health promotion: need to follow the principles outlined in the Ottawa Charter;
3. Intersectoral action: health is influenced by actions and decisions of most sectors;
4. Community participation: need for informed, motivated and active participating communities;
5. Supportive environments: need to address the creation of supportive physical and social environments;
6. Accountability: need to have accountability for decisions that affect citizens' health;
7. The right to peace: need for peace as a prerequisite for health.

Bearing witness to the complexity of health processes, these seven principles outline several cross-cutting policy domains if implemented with a sustainable development perspective. These domains are extensive to climate change mitigation, food consumption, transportation, household energy, agriculture, and large-scale energy production. However, to fully achieve health benefits from all these policies there is a need to consider intersectoral concerted action (IOM 2013), corporate responsibility and internal policies aiming at improving health and environmental conditions in the workplace, in the relationships with the surrounding community, and in goods produced (Asbury and Ashwell 2007). Finally, the effects of climate change–induced alterations in the indoor environment on occupant's health have gained relatively little attention. This dimension can be analysed, for instance, in terms of how effective buildings are in combatting adverse conditions (IOM 2011).

3 Portugal 2020 Investments in Cross-Cutting Issues in Energy, Environment and Health

3.1 Strategic Visions

Adopted to apply the principles of the Europe 2020 strategy for stimulating growth and job creation in Portugal for the upcoming years, Portugal 2020 defined a strategy prioritising the need to promote smart, sustainable and inclusive growth, in order to meet the Europe 2020 targets. This strategic vision was organized in four main thematic areas: (i) competitiveness and internationalization; (ii) social inclusion and employment; (iii) human capital; and (iv) sustainability and efficiency in the use of resources. As can be seen in Table 1, the Portugal 2020 strategy embraces cross-cutting environmental and energy issues, mirrored in the goals of supporting a transition to a low-carbon economy in all sectors, the preservation and protection of the environment and promotion of resource efficiency, and the promotion of sustainable transport. In overall terms, the relation between these environmental sustainability goals are not deeply interlinked with the health-related issues in the strategy. Even so, in thematic objective 6 (Table 1) a specific goal is proposed to regenerate environmental liabilities, namely in: (i) industrial and mining

Table 1 Portugal 2020 thematic objectives

Thematic objective	Executed funding (M€)	Executed funding (%)
1. Strengthening research, technological development and innovation	5,389	17.45
2. Improving access to ICT as well as its use and quality	343	1.11
3. Reinforcing the competitiveness of SMEs	9,309	30.15
4. Support for the transition to a low-carbon economy in all sectors	1,598	5.18
5. Promoting adaptation to climate change and risk prevention and management	545	1.77
6. Preservation and protection of the environment and promotion of resource efficiency	2,518	8.16
7. Promoting sustainable transport and eliminating bottlenecks in major network infrastructures	870	2.82
8. Promoting sustainability and quality of employment and supporting worker mobility	2,516	8.15
9. Promoting social inclusion and combating poverty and discrimination	2,467	7.99
10. Investments in education, training and vocational training for skills acquisition and lifelong learning	5.051	16.36
11. Strengthening the institutional capacity of public authorities and stakeholders and the efficiency of public administration	269	0.87

Source Portugal 2020 database (30 September 2020) own elaboration

installations, including both soil decontamination and regeneration and reuse; and (ii) water and air quality and public health (ADC 2014).

At a more general level, Portugal 2020 entails health concerns related to environmental liabilities resulting from industrial and mining activities that, for the most part, are currently deactivated or abandoned. These have generated risks of various kinds of contamination, with high penalties for public health, ecosystems and territories. Moreover, the current objectives of public air quality policy aim to reduce the population's exposure to deficient levels of air quality and to comply with the objectives set out in EU directives for the protection of human health. Thus, investment priorities go towards improving evaluation models, the provision of integrated decision support information (studies on the influence of marine aerosols and regional pollutant transport), and the application of measures, with a special focus on reducing critical pollutants. Finally, in terms of environmental noise management and control policies, Portugal 2020's main goal is to reduce the negative effects on human health, by promoting sustainable mobility and noise reduction. Of particular importance are financial incentives that support the production of relevant information to support decision-making, as well as the implementation of noise reduction measures, such as: alteration of the type of road surface, construction of acoustic barriers, creation/extension of green spaces for the separation between sources of noise and inhabited areas; and reinforcement of sound insulation on the facades of sensitive buildings (ADC 2014).

In a complementary manner, the recent (2018) National Spatial Policy Programme (Programa Nacional da Política de Ordenamento do Território—PNPOT—in Portuguese), in its strategic territorial diagnosis, recognises that the management and occurrence of floods, which are extreme seasonal natural phenomena in Portugal, have consequences for human health, the environment, the heritage, and economic activities. In addition, within the national innovation system as a whole, the application sectors targeted by innovation processes comprise a wide range of activities including health and energy. In the tourism arena, the PNPOT highlights the need for a change in consumption patterns and motivations that favour destinations that offer diverse, authentic experiences and environmental quality, the growing demand for healthy habits and health products (DGT 2018).

3.2 Territorialisation

Formally implemented in Portugal since its first programming period (1989–1993), EU Cohesion Policy has contributed to promoting territorial development processes in all Portuguese regions. This is visible in policy areas such as the modernisation of infrastructure, the improvement of human capital and the support given to innovation and the economic operators (Medeiros 2014). Despite those efforts, the EU policy goal of territorial cohesion (Medeiros 2016, 2019) has never been achieved at the national level (Medeiros and Rauhut 2020). EU Cohesion Policy funding also relates to the financial prioritisation of support for economic

competitiveness and human capital processes (Medeiros 2014). Under the Portugal 2020 strategic guidelines, around 30% of the expected allocated funding is due to be spent on sustainability and resource efficiency related projects (Medeiros 2020a). However, as seen in Table 1, by late 2020, only around 15% of this investment had been assigned to these environmental related policy goals, with a more or less even distribution across the Portuguese municipalities (Fig. 2).

Instead, the support for the transition into a low-carbon economy in all sectors has only received a little more than 5% of the total Portugal 2020 funding. From this, three specific investment priorities dedicated to the energy sector received almost 2% of the funding: (i) promotion of the production and distribution of energy from renewable sources; (ii) promotion of energy efficiency and the use of renewable energies in companies; and (iii) support for energy efficiency, intelligent energy management and the use of renewable energies in public infrastructure, namely public buildings, and in the housing sector. These projects favoured a few municipalities as seen in Fig. 3.

More importantly, however, are the five most financed projects in the energy sector which supported, respectively: (i) urban rehabilitation actions complemented

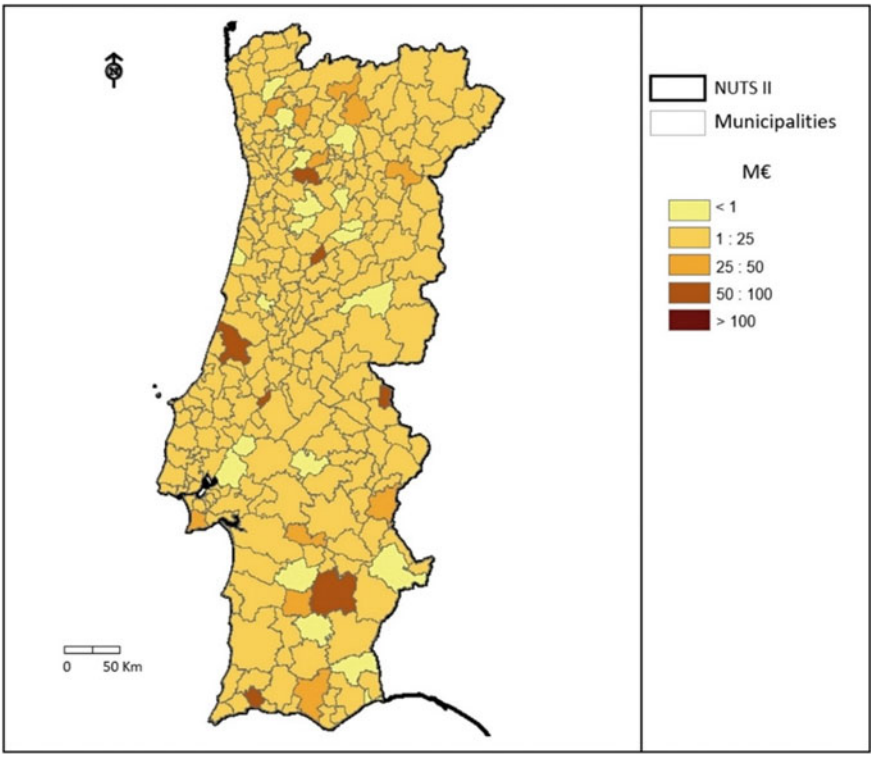

Fig. 2 Total expenditure of Portugal 2020 in the specific priorities of investments in the environment. *Source* Agency for development and cohesion database—own elaboration

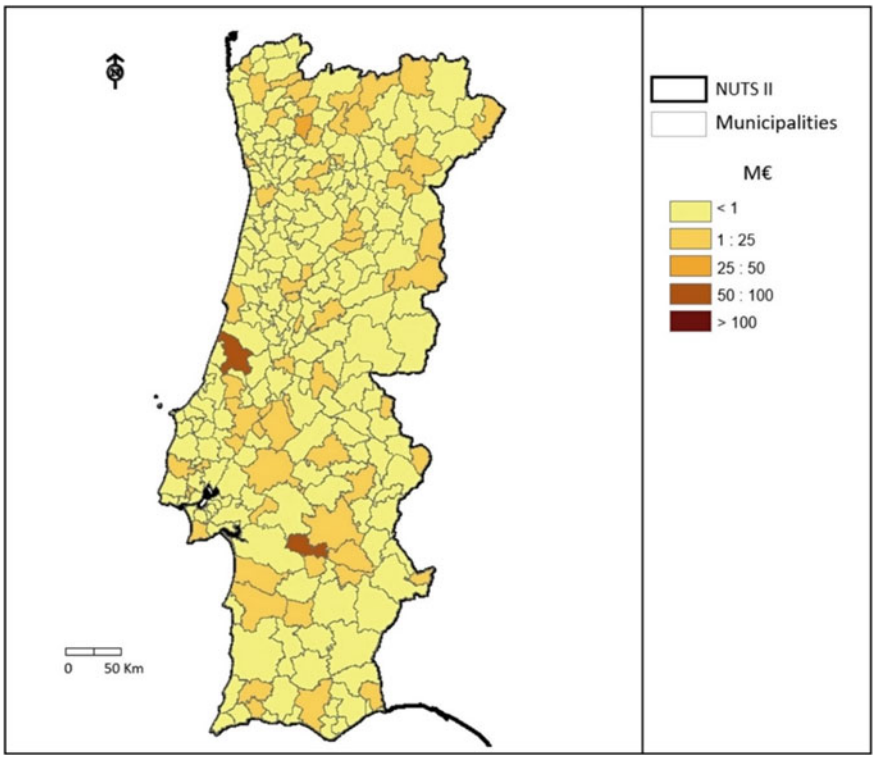

Fig. 3 Total expenditure of Portugal 2020 in the specific priorities of investments in energy. *Source* Agency for development and cohesion database—own elaboration

with energy efficiency in housing; (ii) the electricity storage infrastructure, through the expansion and transformation of a hydroelectric plant; (iii) the construction of a submarine cable and a cut-off post that will allow the connection to the grid of the pilot zone of Viana de Castelo, where offshore renewable energy production projects will be installed; (iv) the installation of an energy storage system; and (v) the improvement of energy efficiency at Santa Maria Hospital in Lisbon. The latter project is a good example of a cross-cutting project between the energy and the health sectors. Other examples are energy efficiency projects in health facilities like Viana do Castelo Hospital, the Institute Ricardo Jorge; the School of Health in Viseu, the National Superior School of Health, and the Health Centres in Santo André, Alcácer do Sal, Grândola and Odemira.

A specific Portugal 2020 priority of investments in health had only received, by September 2020, 502 M€, for a pool of close to 700 projects, with an uneven concentration across the Portuguese municipalities (Fig. 4). From these, 73 involved cross-cutting issues with energy/environmental policy goals, representing slightly over 28 M€ in total. Figure 5 illustrates the uneven territorialisation across

continental Portugal. This will be further discussed in the next topic, with a particular focus on best practices of sustainability and innovation.

3.3 Sustainable Policy Transitions

A detailed analysis of the Portugal 2020 project database on the priority of investments in health, with other cross-cutting issues on energy and the environment, leads to the principal conclusion that Portugal 2020's main overall contribution to sustainable policy transitions is on the physical renovation component (Table 2). In this regard, there are a few best practices on sustainability and innovation that could be replicated in other countries, including:

- The entire physical rehabilitation/renovation of health centre infrastructure and the surrounding areas, with the goal to creating mobility conditions for all users and occupants of the space, and to increasing the use of sustainable energy and increase energy efficiency;

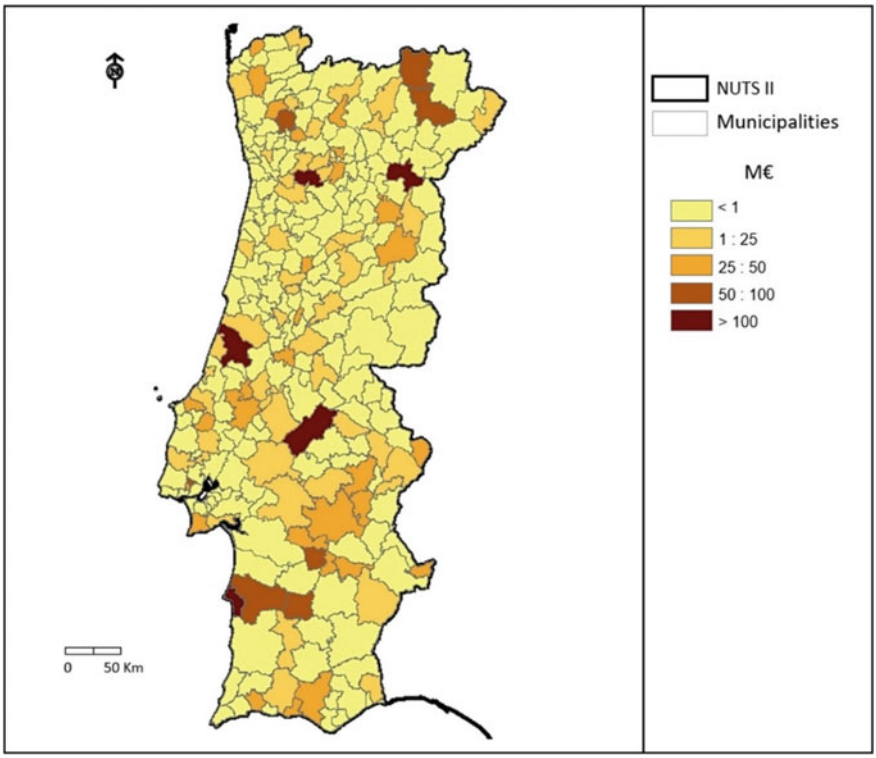

Fig. 4 Total expenditure of Portugal 2020 in the specific priority of investments in health. *Source* Agency for development and cohesion database—own elaboration

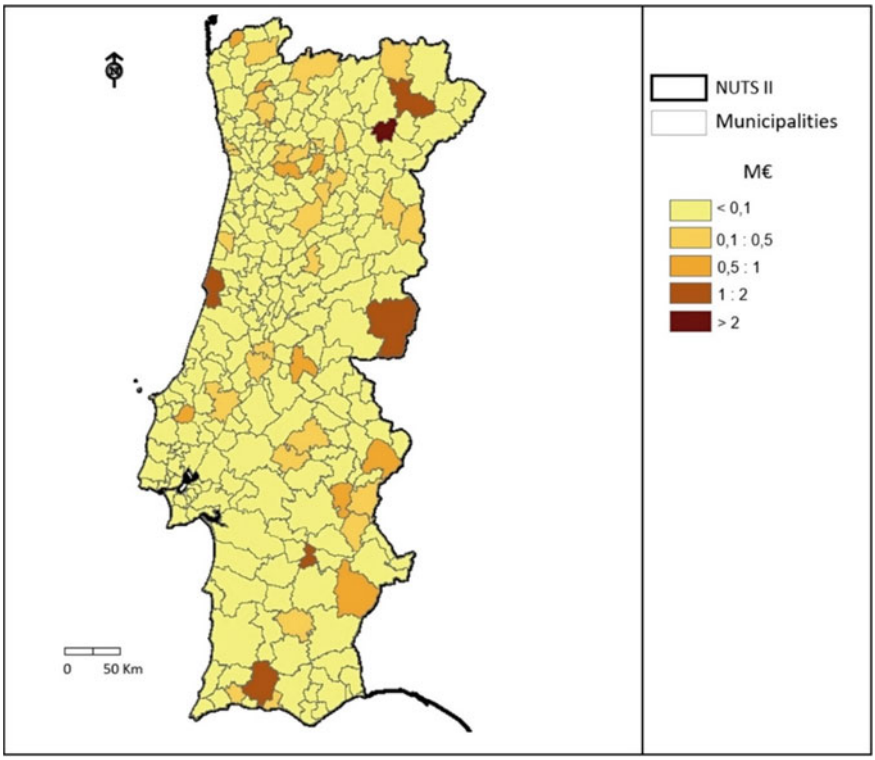

Fig. 5 Total expenditure of Portugal 2020 in the specific priority of investments in health with cross-cutting energy and environmental issues. *Source* Agency for development and cohesion database—own elaboration

- The creation of better living conditions for health centre users, by improving energy efficiency within the building. This is done by increasing the use of natural light through the creation of interior gardens, and internal corridors, by better insulation of the building walls and pavements, using smart technology like LED (light-emitting diode) lights, replacing and improving the insulation of window frames and blinds, roof coverings, façades and external openings, and replacing and installing more efficient equipment.
- A few projects also added a positive ecological orientation to a sustainable policy transition. This was mainly done by the acquisition and implementation of renewable energy equipment (mainly solar panels– photovoltaic and thermic) to reduce the carbon footprint of buildings (Dahal et al. 2017; Kanters and Wall 2014; Medeiros 2020c). Conversely, the social innovation, institutional innovation and eco fiscal and financial models were largely absent in the analysed project goals, which confirms a systematic focus on hard rather than soft forms of policy implementation and planning processes (Ferrão 2011).

Table 2 Portugal 2020 cross-cutting health/energy/environmental most financed projects and relation between sustainable policy transaction components

Projects main goal	SI	II	EF	EO	PR
1. Infrastructure renovation—energy efficiency (V.F. Xira)					X
2. Infrastructure building—energy efficiency (Sines)					X
3. Infrastructure renovation—energy efficiency (Mafra)					X
4. Infrastructure renovation and enlargement—energy efficiency (Elvas)					X
5. Infrastructure renovation—energy efficiency (Ílhavo)					X
6. Infrastructure renovation—energy efficiency (F.C. Rodrigo)					X
7. Beneficiate social equipment (Caldas da Rainha)					X
8. Infrastructure renovation—energy efficiency (Entroncamento)					X
9. Infrastructure renovation—energy efficiency (Coimbra)					X
10. Infrastructure renovation—energy efficiency (Vouzela)					X
11. Beneficiate social equipment (Reguengos de Monsaraz)					X
12. Use of solar energy (Leiria)				X	X
13. Infrastructure renovation—energy efficiency (Sertã)					X
14. Infrastructure renovation—energy efficiency (Anadia)					X
15. Infrastructure renovation—energy efficiency (Macedo de Cavaleiros)					X
16. Infrastructure renovation—energy efficiency + asbestos removal (Viseu)				X	X
17. Infrastructure renovation and enlargement—energy efficiency (V.N. Poiares)					X
18. Infrastructure renovation and enlargement—energy efficiency (Vizela)					X
19. Infrastructure renovation and solar panels—energy efficiency (Valongo)				X	X
20. Infrastructure renovation—energy efficiency (Pombal)					X
21. Infrastructure renovation—energy efficiency (Azambuja)					X
22. Infrastructure renovation and enlargement—energy efficiency (Mealhada)					X
23. Infrastructure renovation—energy efficiency (Marinha Grande)					X
24. Infrastructure renovation—energy efficiency + asbestos removal (Valongo)				X	X
25. Infrastructure renovation and solar panels—energy efficiency (Vinhais)				X	X
26. Infrastructure renovation—energy efficiency (Almeirim)					X
27. Infrastructure renovation—energy efficiency (Vale de Cambra)					X
28. Infrastructure renovation—energy efficiency (Porto)					X
29. Infrastructure renovation—energy efficiency (Almeida)					X

(continued)

Table 2 (continued)

Projects main goal	SI	II	EF	EO	PR
30. Infrastructure renovation—energy efficiency (Santarém)					X
31. Infrastructure renovation and enlargement—energy efficiency (Moita)					X
32. Infrastructure renovation and solar panels—energy efficiency (Elvas)				X	X
33. Infrastructure renovation and solar panels—energy efficiency (Anadia)					X
34. Infrastructure renovation—energy efficiency (Celorico da Beira)					X
35. Infrastructure renovation—energy efficiency (Sabugal)					X
36. Infrastructure renovation and enlargement—energy efficiency (Porto)					X
37. Beneficiate social equipment (Leiria)					X
38. Infrastructure renovation and enlargement—energy efficiency (Barcelos)					X
39. Infrastructure renovation and solar panels—energy efficiency (Bragança)				X	X
40. Beneficiate social equipment (Albergaria-a-Velha)					X

Note SI Social innovation, *II* Institutional innovation, *EF* Eco fiscal, *EO* Ecological orientation, *PR* Physical renovation
Source Portugal 2020 database (30 September 2020) own elaboration

Inspired by the United Nations SDGs (Medeiros 2020d) and the EU green policy agendas, which have recently led to the publication of a European Green Deal (see EC 2019), Portugal 2020 has also supported several high-budget projects promoting low-carbon strategies for all types of territories, including urban areas. In the latter case, one example is the promotion of sustainable multimodal urban mobility and support for more sustainable buildings, by improving energy efficiency and decarbonizing buildings across the country. Besides these physical renovation aspects, some projects support the implementation of financial instruments, for example, the IFRRU 2020 (Instrumento Financeiro de Reabilitação e Revisalização Urbana—the Financial Instrument for Urban Rehabilitation and Revisalization) brings together several funds with the objective of providing financial products with more favourable conditions, compared to others currently existing on the market. Examples of funding are projects that support urban rehabilitation complemented by energy efficiency in housing, and one focused on implementing an integrated urban solid waste management system supported by a vision of economic, social and environmental sustainability, on the Azores island of São Miguel.

In the social innovation domain, a few Portugal 2020 financed projects aim to stimulate economic activities in urban environments through the adaptation and creation of spaces to welcome productive initiatives that stimulate creation, networking, training and social innovation. One example is the construction of a new Technology Transfer and Valorisation Centre (CVTT—Centro de Valorização e

Transferência de Tecnologia) for Social Innovation in the NOVA University in Lisbon, in order to constitute the first national infrastructure to promote a university/company/organization interface for research and development of innovative projects to solve various social issues. However, information about specific projects cannot currently be unveiled.

In the sustainability domain, by the end of 2019, Portugal 2020 had financed interventions which aimed to: (i) improve the energy consumption of 8,700 households; (ii) protect people and goods along 93 kms of coastal strip; (iii) benefit more than nine million people with forest fire protection measures; and (iv) reinforce the waste recycling capacity by 415,000 tons/year. In terms of concrete results, one can highlight the good general performance regarding the Europe 2020 Strategy indicators associated with the energy and climate dimension. In this domain, Portugal achieved a good performance in the indicator 'emissions of Greenhouse Gases' with a 19 pp below the maximum variation to which it was committed. The same goes for indicators related to renewable energies in gross final energy consumption, and energy efficiency. In the first case, Portugal achieved 30.3% of renewable energy consumption, compared to a target of 31%. In the second case, it reached a 22.4 Mtoe score compared to a target of 22.5 Mtoe (ADC 2019).

Finally, when it comes to the main challenges in implementing sustainable policy transitions, it is important to note that the existence of a set of conditionalities to support energy efficiency, such as the eligibility of operations and expenditure, financing conditions and state aid rules have limited its application potential. Moreover, many entities' lack of experience in the area of energy and energy efficiency is also a constraint and will also imply a learning curve in the management of such projects. Furthermore, there is a need to combine the promotion of urban mobility for low carbon purposes, improve accessibility of services, and focus on prevention and reduction of exposure to potentially harmful environmental events. Indeed, the need to favour ecosystem-based approaches, in particular, by improving efficiency in the recirculation of secondary raw materials and by-products and ensuring smarter management processes is yet to be fully achieved. Additionally, there is a need to improve the maintenance and rehabilitation of the infrastructure related to the urban water cycle, in order to reduce the high level of losses in the municipal water distribution systems (ADC 2019).

4 Conclusion

This chapter debated the cross-cutting issues in energy, environment and health in the Portugal 2020 strategy and implementation process, with a view to implementing the UN Agenda 2030 sustainable development vision. Examining Portugal 2020's project database of approved projects until September 2020, not only presented a territorialised vision of municipalities benefiting from approved projects in such sectors, but also tried to examine the level of integration between the three.

For this, the author proposed a conceptual framework for analysing sustainable policy transitions processes based on five main components: (i) social innovation; (ii) institutional innovation; (iii) physical renovation; (iv) eco fiscal and financial models, and (v) ecological orientation.

The examination of the project database revealed that the investments in energy and health favour a few Portuguese municipalities, unlike the investments in environmental sustainability which are spread across the Portuguese continental territory. It was also clear that a large part of the approved projects in the energy and health sectors follow the spirit of the UN 2030 Agenda, supporting environmental sustainability processes, in particular by funding the use of renewable sources of energy and by improving energy efficiency in buildings. At the same time, there are a vast number of projects supporting environmentally friendly modes of public transportation.

The application of the proposed conceptual approach, however, showed that, despite encountering some degree of integration between the energy, environment and health sectors, these cross-cutting issues are mainly related to the physical renovation of buildings with a goal to make them more energy efficient. Moreover, there are a few examples of projects supporting the implementation of solar panels (photovoltaic and thermal) on buildings, in order to produce energy and heat water, thus reducing the environmental footprint. Irrespective of these positive measures, not that many projects directly sustained social and institutional innovation, as well as eco fiscal and financial models aiming to support the energy shift from a carbon to a carbon-free economic environment.

In conclusion, there are a few positive takeaways from our analysis that can be replicated in other territories. Firstly, the Portugal 2020 strategy is clearly supportive of the UN 2030 Agenda vision for more sustainable and green development, which has helped to guide the project application in this greener policy direction. Secondly, the support for the physical renovation of buildings to become more energy efficient and use renewable sources of energy is a positive step towards a more environmentally sustainable territory. However, there is still room to improve the implementation of sustainable policy transitions in Portugal in future EU Cohesion Policy programming periods. One crucial entry point here is the need to increase the support of social innovation aspects by using education and participation models which can empower citizens and organisations towards environmentally sustainable practices in their daily lives, for a healthier livelihood. The same goes for the need to increase support for decision-making processes towards sustainable policy transitions by institutions at all territorial levels (institutional innovation), and stronger actions to support green taxation and financial benefits for implementing sustainable and renewable sources of energy in a country like Portugal, blessed by exposure to abundant year-round sunshine.

Notes

1. https://ec.europa.eu/energy/topics/energy-strategy/energy-union_en.

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Sustainability Practices in a Public University in Bahia, Brazil

Rives Rocha Borges, Maria Alzira Pimenta Dinis, and Nelson Barros

1 Introduction

Fundamental to society as a whole, the SDGs (United Nations Sustainable Development Goals Knowledge Platform 2015a) from 2030 Agenda (United Nations Sustainable Development Goals Knowledge Platform 2015b), must have their goals pursued by institutions, whether they are private or public. Universities as bodies for the production and dissemination of knowledge are important players in building a culture for sustainable development, as well as in the establishment of leaders to contribute with the future development of sustainable solutions. The importance of universities in the construction of environmental sustainability is a fact. Universities act in the development of individuals, which can become multipliers of an awareness focused on a sustainable society. The implementation and dissemination of sustainability actions can contribute to promote and develop both skills and behavioural changes. At first, these changes may occur in the university community. Next, the knowledge sedimented can go beyond the university *campus* and promote behavioural changes in society (Backman et al. 2019; Leal Filho et al. 2020a, b; Sisto et al. 2020).

R. R. Borges (✉)
University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: 37706@ufp.edu.pt

R. R. Borges
Federal University of Bahia (UFBA), Rua Augusto Viana, s/n – Palácio da Reitoria, Canela, Bahia 41825-904, Brazil

M. A. P. Dinis · N. Barros
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça Nove de Abril, 349, 4249-004 Porto, Portugal
e-mail: madinis@ufp.edu.pt

N. Barros
e-mail: nelson@ufp.edu.pt

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The values of sustainable development, such as valuing and preserving the environment, technological and economic development, social equality, as well as society's well-being are pursued by HEIs also as a way of providing the community with better health conditions (Paletta and Bonoli 2019).

However, implementing sustainable development measures is not simple, particularly if an university with more than one *campi* and a population of staff, students and visitors over 50,000 people, and where accomplishing sustainable development is an arduous and continuous task (Franco and Tracey 2019; Federal University of Bahia 2020a). Sensitizing the university community and society in relation to the need to implement actions that make HEIs *campus* sustainable, so that these actions are multiplied in the external environment is a challenge and a cross-cutting issue worldwide.

The universities can contribute to the construction of environmental awareness through their actions pursuing sustainable development, whether academic or administrative. Changes in the curriculum of the various courses taught, investment in research activities, promotion of events aimed at sustainable development are desired actions in the academic area. However, it is necessary to modify the organizational culture, such as designing sustainable buildings, to promote conscious consumption, e.g., energy, water and paper, to reuse rain's water, to use clean energy, to encourage the use of non-polluting vehicles, such as bicycles in the c*ampus* internal areas, as well as to plant native vegetation in the *campus*, and to reduce and to recycle waste (Sisto et al. 2020).

Around the world, several activities are already used by other universities as strategies achieving sustainability in HEIs. The search for collaboration, establishing partnerships with organizations that also focus on SDGs is fundamental. Among these activities that can be listed in the academic part are: research and exchange programs in the area of sustainable development, events such as symposia, forums, conferences, seminars, workshops, aimed at disseminating sustainability awareness. In the operational scope, the green areas must also be considered, where the planting or replanting of native vegetation can be worked, stimulating the proliferation of pollinating insects such as bees, as long as they are part of the local biosystem so that there is no ecological imbalance; rational use of energy or implementation of clean and renewable energy systems; waste management; accessibility; promotion of racial and gender equality. However, all these actions are only possible if sustainable practices are implemented as a university culture (Paletta and Bonoli 2019).

With the advent of 2030 Agenda (United Nations Sustainable Development Goals Knowledge Platform 2015b), where 17 SDGs and one hundred and sixty-nine (169) goals (United Nations 2015a, b) are inseparable and which seek to achieve the eradication of poverty; economic growth; social inclusion; environmental sustainability and peace for all by the year 2030, among other specific objectives, the HEIs start to occupy a strategic position, because their mission is to stimulate and promote education through research and innovation that can respond to the social, economic and environmental challenges proposed by the SDGs and their goals (Mawonde and Togo 2019).

Some universities around the world started to prepare the MR, which aim to guide the institution's contributions in response to the 17 SDGs of the 2030 Agenda (United Nations 2015a, b). This tool demonstrates the institution's commitment to the balance of business, environment and society, because it highlights and gives visibility to the strategies and operations adopted (Di Nauta et al. 2020).

At Brazil, effective sustainability practices in the federal public service begins with the Normative Instruction no. 10, of November 12, 2012. The instruction sets rules, to be used by public agencies to elaborate the SLP. These plans are the basis to the MR. With a focus on environmental protection, social justice and balanced economic development, guides actions that seek to create the culture of sustainable logistics in public agencies, the rationalization of the resources used and the segregation of waste based on its composition. When considering social policies, these plans must adopt selective solidarity collections, i.e., it is necessary to go beyond the segregation of recyclable waste. Such waste must be disposed to associations and cooperatives of recyclable material collectors (Planning Ministry 2012). Collectors of recyclable material are workers who segregate recyclable waste and use it as a source of income.

Among the 17 interrelated SDGs covered by the 2030 Agenda, it is possible to highlight some, directly related to the mission of the HEIs, e.g., quality education, sustainable cities and communities, responsible consumption and production, live below water, and partnerships for the goals. Installed on several *campi*, the university which is the object of this study presents different aspects comprising territorial, i.e., climate, temperature, vegetation; temporal, i.e., buildings with a construction time of more than two hundred years, in contrast to others with less than ten years; course-related aspects, i.e., undergraduate, postgraduate, *lato* and *stricto* sensu; students and staff aspects, i.e., ethnicity, gender, age, economic power; and staff professional qualification. This diversity of aspects, the scenarios to be worked on and the search for SDGs proposed by 2030 Agenda are discussed.

In 2016, the university object of this study constituted the Management Commission for Sustainable Logistics with the task of preparing the SLP and implement sustainability practices in accordance with the current legislation. The Commission ratified the need to rationalize the use of physical space and installations. Other actions to develop sustainability at the university were implemented. The institution's geographical position was considered for this. Other objectives have been suggested by University Council. Buildings grouped by knowledge's areas were the most important. This action facilitated the waste's segregation (Federal University of Bahia 2016a).

This work seeks to report about the green areas' conservation and fauna's protection, with greater emphasis on the selective waste collection actions, waste disposal, reverse logistic, implemented by a public university, in Bahia, Brazil, in order to highlight the gains for the natural environment, for the institution and for the culture of a sustainable society.

2 Green Areas' Conservation and Fauna Protection

When sustainable development is articulated within HEIs, it is believed that innovation should be implemented with a focus on quality education. It is necessary to think about sustainability in an integrated way, in other words, the curricular matrices of the courses must act together with the organizational actions (Leal Filho et al. 2019) undertaken by the HEIs, the emphasis of this chapter.

In this study, the focus is on organizational and non-curricular actions. In this context, the university in question implements a program with the objective of expanding the flora of one of its *campus* with native species Atlantic Forest, to restore degraded ecological sites, as well as the planting of ornamental plants in articulation with the internal urbanized spaces (Federal University of Bahia 2016b, 2017, 2018, 2019, 2020b). Associated with this action, fauna passages are also installed, to be used by small primates that inhabit the place. Based on the positive feedback from the academic community, having a more harmonious coexistence with the local fauna and flora, this action was expanded to the others *campi*.

Degraded urban spaces can contribute to increased air pollution, noise, and temperature rise. In addition to these, the reduction or loss of green spaces impacts, among others, physical activity, and the possibility of being in contact with nature and its relaxing effects. The contribution of green spaces to environmental sustainability and health equity is considered significant (Crouse et al. 2019; Kruizse et al. 2019) in the scope of HEIs global sustainability.

The replanting of native vegetation favours the reappearance of species, including butterflies, birds, bees, that act as pollinators and contribute to the flora and fauna's perpetuation. Consequently, the environment on the university *campus* becomes a pleasant place, where it is possible to enjoy direct contact with nature. There are reports of temperature reduction both outside and inside buildings, thus conforming the importance of such actions.

3 Sustainable Buildings

With the growing record of environmental contamination and destruction of natural resources, the civil construction sector has been called for the design of green buildings and projects, i.e., sustainable buildings. The aim is to create environmentally responsible structures and processes, which use renewable resources during the construction life cycle.

Buildings built less than twenty years ago were designed with the concept of sustainable development in mind. They are designed prioritizing natural lighting and ventilation and, installation of taps with controllable water flow and flush boxes with double water activation. Outdoor areas include wood, as a way to minimize the building's internal temperature. These buildings provide occupants with comfort and health through temperature and humidity control, natural lighting and

ventilation, which improves indoor air quality. Conscious consumption and waste management are also foreseen in the project preparation phase (Agyekum et al. 2019).

In the study presented here, the university houses the first medical school in Brazil, dating from the early nineteenth century. The entire university buildings were built over three centuries, which represents diversity in design styles and construction materials. The medical school, preserved by historical heritage and which cannot have altered construction patterns, has undergone adaptations such as installation of taps with controllable water flow and flush boxes with double water activation (Federal University of Bahia 2016a).

4 Waste Management

Progress provides gains and losses for society. Those include technological gains, increased production and purchasing power by the population. As a consequence, there is an increase in the acquisition of consumer goods, which results in an increase in the waste produced. It is therefore necessary to properly dispose of this waste produced to avoid pollution and degradation of the environment. Understood as a complex sustainability issue, waste management is a concern for countries, either due to the difficulty in implementing landfills, or due to possible environmental contamination resulting from the incorrect disposal of the waste. For this reason, waste management is related to several SDGs proposed by the 2030 Agenda (Debrah et al. 2021a), such as SDGs 11, 12, 14 and 17.

Much of the waste produced without proper treatment by developing countries, such as the case of Brazil, is transported to open dumps. This inadequate disposal has a negative impact on the environment (Sekito et al. 2019). Waste generated from domestic or industrial activities can result in health risks and also have a negative impact on the environment, what makes a waste management program fundamental (Tun 2018). The first step in waste management is to segregate the material. This segregation is only possible with the engagement of the whole society, which will only perceive itself as an active actor in the process if there are actions to disseminate knowledge on the benefits and dangers of waste disposal (Debrah et al. 2021b).

Currently, the composition of packaging, according to the development and lifestyle of society are, for the most part, inorganic material, which is difficult to decompose. Thus, more than ever it is necessary to encourage the waste's segregation. The 3R approach, i.e., reduce, reuse and recycle, now going far beyond this, aims to minimize the amount of waste from generation to disposal, contributing to the reduction of risks to public health and the environment. Properly managed waste, through reduction, reuse and recycling, in addition to being a path to a sustainable society, can contribute to the reduction of landfills, for the production of organic fertilizers, as well as for the reduction of greenhouse gases (Bashir et al. 2020; Rashid et al. 2020).

The public university object of this study concentrates several areas of knowledge, as human and social sciences, earth sciences, and health sciences. It also houses hospitals schools of human and animal health. This diversity provides a vast generation of waste. Recyclable waste generated by university activities can be grouped in seven main categories:

- Paper and cardboard;
- Metal, plastic and glass;
- Residual vegetable oil;
- Fluorescent lamps;
- Batteries and small electronics, including LED lamps;
- Printer items; and,
- Solid and liquid chemicals.

Paper, cardboard, metal, plastic and glass are properly segregated in containers at the university units and, then transported to a warehouse where they are packed in containers. From this point on, the destination is recyclable material collectors' cooperatives. The profit obtained as income is used for staff family subsistence, families of low-income recyclers who do no work at the university. Reverse logistics is used in fluorescent lamps, batteries, small electronics and LAD lamps, because they contain toxic substances internally. They are sent to the manufacturers for the proper reuse of the parts. The residual vegetable oil collected in the kitchens of restaurants and internal canteens at the university are partly sent to a biodiesel producing company and a smaller portion for cooperative members, which use it in soap production. Finally, chemical wastes, solid or liquid, are destined for sale, through bidding, to specialized companies. Non-recyclable hospital waste, i.e., infectious and cutting material, is stored in the generating units and collected periodically by a qualified company for proper incineration (Federal University of Bahia 2016b, 2017, 2018, 2019, 2020b).

5 Method

In order to promote sustainable development, the university in this study prepared, implemented and shared several actions. Aiming to demonstrate these actions, an exploratory research was carried out in the period between the years 2015 and 2019. The MR for a specific year refer to the results obtained in the immediately preceding year. The chosen period considered the establishment of rules by the Federal Government for the elaboration of the SLP and the effective implementation of this plan by the university (Planning Ministry 2012; Federal University of Bahia 2016a).

The collected data are available on the MR, allocated in the university's own website. It should be noted that, until the conclusion of this chapter, the Report for the year 2020 had not been released. The units of measurement are the same used by the university to measure waste (Federal University of Bahia 2016b, 2017, 2018, 2019, 2020b).

6 Results and Discussion

The MR analysed (Federal University of Bahia 2016b, 2017, 2018, 2019, 2020b), data were found that deal with conservation of green areas, wildlife protection, sustainable buildings and waste management. With an emphasis on wastes, more easily quantified, the remaining is superficially mentioned. These documents are written by commission nominated by the university's rectory, based on data made available by the different units. No data was found on waste such as paper and cardboard, metal, plastic and glass for the years 2018 and 2019 and chemical waste in 2019.

Figure 1 shows that solid waste, paper and cardboard, had a generation in the year 2015 of 48.1 tons (representing 53.0% of all waste generated). In the same year, 5.2 tons of metal, plastics and glass were generated (5.7%), 0.4 ton of batteries, small electronics and LAD lamps (0.4%), 14.5 tons of infected material and sharps (16.0%), and 22.6 tons of chemical waste (24.9%). These values were collected before the implementation of the University's SLP.

In 2016, there was a reduction in the generation of some waste. The generation of 36.9 tons of paper and cardboard represents a reduction of 11.2 tons (26.8%); the reduction of chemical residues was of the order of 11.1 tons (49.1%); and the reduction in batteries and small electronics was 0.1 tons (25%). The other wastes showed an increase in the generation. Metal, glass plastics increased by 2.8 tons (53.8%); the increase in infected and sharps was even greater, 16.1 tons (113.8%). The increase in the generation of metal, plastic and glass waste, as well as infected

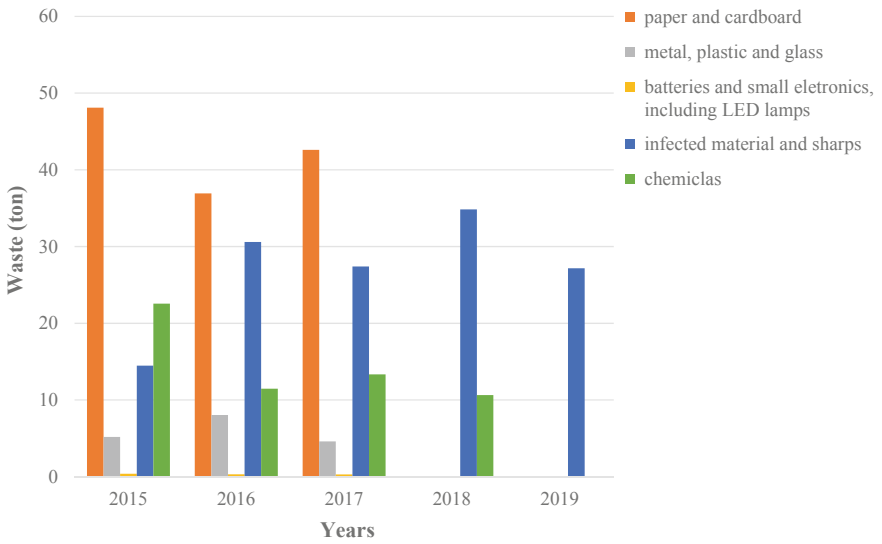

Fig. 1 Solid waste generation in the studied public university, Bahia, Brazil, 2015–2019

and sharps, may have occurred due to better waste management from the implementation of the SLP.

The waste generated in 2017 from paper and cardboard was 42.6 tons (48.3%); metal, plastics and glass 4.6 tons (5.2%); batteries, small electronics and LED lamps 0.3 tons (0.3%); infected material and sharps 27.4 tons (31.1%); and chemicals 13.3 tons (15.1%). Except for metal, plastics and glass, which had a reduction of 3.4 tons (42.5%), the other wastes had their production increased.

27.4 and 34.8 tons were generated by infectious and sharp materials in the years 2018 and 2019, respectively.

Waste lamps and printer items are shown in Fig. 2, having the quantities measured and expressed in number of elements collected. The history of this waste is limited to the years 2015–2017.

The years 2018 and 2019 are not available. In 2016, a greater number of discarded lamps is reported, 14,600 units. When comparing this value with 2015, an increase of 1,600 units is found, i.e., 12.7%. It is possible that quantities of lamps discarded in the year 2016 has to do with switching to lower energy consumption lamps. In 2017 the quantity discarded, 5,700 units, is much lower, 39.0% less than in the previous year.

It is noticeable the gradual reduction of discharged printer items, 1,103 units in 2015, 534 units in 2015 and 220 units in 2017. Between 2016 and 2071 there was a reduction in discarded printer items around 98.0%. This fact is explained by the implantation of an electronic document system.

Waste vegetable oil produced in restaurants and canteens is shown in Fig. 3. It corresponds to 8,301 in the year 2016 and 5,141 in the year 2017. The consumption of vegetable oil in 2017, compared to 2016, decreased by 38.1%.

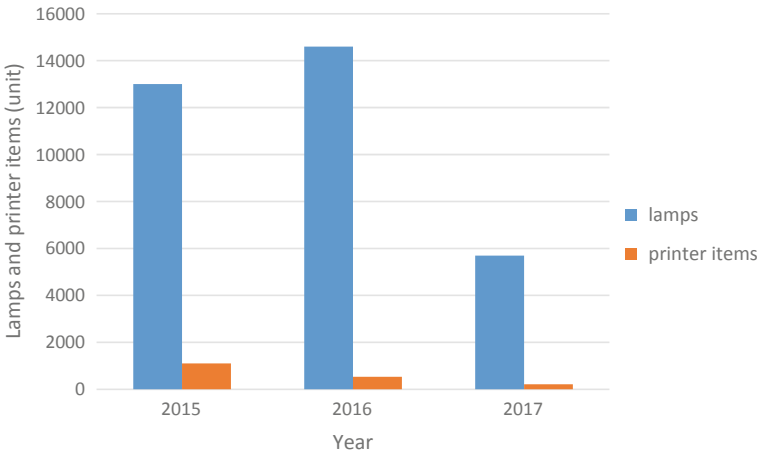

Fig. 2 Lamps and printer items generation in the studied public university, Bahia, Brazil, 2015–2017

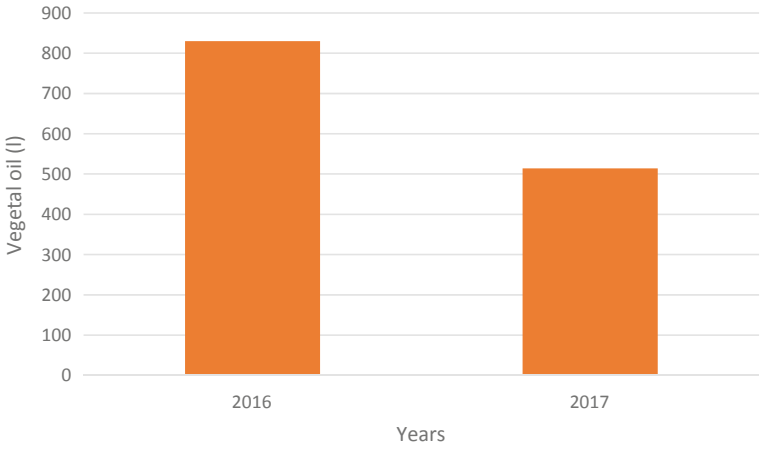

Fig. 3 Vegetable oil generation in the studied public university, Bahia, Brazil, 2016 and 2017

The reduction in vegetable oil consumption may be directly related to the outsourcing to a private company for the preparation of food served in the university restaurants.

7 Conclusions

Used as guidelines in strategic planning processes when adopted, the MR constitute institutional communication tools. These documents demonstrate to society the goals of sustainability and sustainable development within the scope of global sustainability in HEIs, proposed by the 2030 Agenda, in order to make adopted strategies and interventions available to public knowledge and to demonstrate the HEIs commitment to the environment and social contribution. Failure to implement these reports makes it difficult to perceive and understand measures implemented in order to meet the SDGs.

Thus, the MR adopted by the HEIs present in a general way all actions carried out by the institutions. Among these, sustainability actions are reported. This allows to understand how these actions are evolving, which ones still need to be implemented, how they are assessed and how the community is effectively engaged in the process. The reports do not include actions for the implementation of technology aimed at the use of renewable energy, or reuse of rainwater and washbasins. The latter would effectively contribute to increase the concept of sustainable buildings within the university *campus*.

The studied public university *campus* has invested in native vegetation, intending to achieve green area sustainability. The university has also managed to make changes to the existing building in order to pursue sustainability, translated

through adaptations envision water consumption. However, and as far as the studied public university is concerned, the most effective records found were those of waste generation presented in results, although data for a specific period were missing. Solid wastes such as paper, cardboard, plastics, metals and glass are donated to cooperative companies. These cooperatives use workers who survive on the collection and resale of recyclable solid waste. For many of these workers, the collection and sale of recyclables is the family's only subsistence income.

From the implementation of the SLP in 2016, the university has shown a commitment to the adequate collection and disposal of waste generated in the university community. Throughout the years 2015–2019 it is possible to perceive the attempt to reduce or reuse generated waste.

When it comes to the generation of waste paper and cardboard, some fluctuations are noticed. As for infected and sharps materials, there is no way to have greater control, since it depends on the number of medical procedures performed. It is necessary for the university to review how the generated waste data is carried out, so that there are no gaps like those identified in the years 2018 and 2019.

Within the scope of 2030 Agenda, the MR can positively contribute to achieving the University's SDG. Guide sustainable construction projects that use clean energy. Encourage the reuse of rainwater. Promote waste management. Establish partnerships with recycling cooperatives. Contribute to poverty reduction by donating recyclable waste to recycling workers. Selling this waste can improve the income of these workers. Promote education for sustainable development. Form generations aware of the need for environmental preservation of the planet.

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Rives Rocha Borges is Ph.D. candidate at University Fernando Pessoa (UFP), Porto, Portugal. Graduated in Civil Engineering at Federal University of Bahia (UFBA), Bahia, Brazil. Graduated in Mathematics at Federal University of the São Francisco Valle (UNIVASF). Administration Specialist, Occupational Safety Engineering Specialist, Occupational Hygiene Specialist, M.Sc. in Health, Environment and Work, and Civil Engineer at Federal University of Bahia, Bahia, Brazil. Math's Teacher at State Public Network, Bahia, Brazil.

Maria Alzira Pimenta Dinis Ph.D., M.Sc. and Associate Professor at University Fernando Pessoa (UFP), Porto, Portugal. Researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit, Porto, Portugal. Her specialised expertise includes CO_2 geological storage, Reservoir modelling, environmental science, Environmental education, Environmental and Human Health, Waste management, Sustainability and others. Editorial Advisory Board Member in Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, Taylor & Francis, Editorial Board Member in Rudarsko-geološko-naftni zbornik (The Mining-Geological-Petroleum Engineering Bulletin), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Guest Editor in Sustainability, MDPI AG, Environmental Institutional Awareness in the Context of Sustainable Development and PUBLONS Academic Advisor. Author of numerous publications and experienced reviewer.

Nelson Barros is graduated in Environmental Engineering, M.Sc. in Thermal Engineering an Ph. D. in Environmental Sciences. Member of the Editorial Board of the Journal of Ecological Engineering. Currently, is Associate Professor at University Fernando Pessoa, coordinator of the Ph.D. program in Ecology and Environmental Health and coordinator of the Laboratory of Research in Energy, Environment and Environmental Health (3ERL), a Research Group of the Fernando Pessoa Research Unit in Energy, Environment and Health (FP-ENAS).

Environmental Waste Sustainability: Organic Valorisation and Socioeconomic Benefits Towards Sustainable Development in Ghana

Justice Kofi Debrah, Diogo Guedes Vidal, and Maria Alzira Pimenta Dinis

1 Introduction

The inadequate Municipal Solid Waste Management (MSWM) has a significantly high impact on human health and the environment (Oliveira et al. 2020; Vidal et al. 2019). Around 2.01 billion tons of solid urban waste are generated globally and annually in the world, with approximately 46% of solid waste being collected in developing countries, contrasting with 90% collected in Europe, Central Asia, and North America. The waste generated is expected to increase to 3.40 billion tons by 2050 (Kaza et al. 2018). It is believed that more than 700 million households in urban communities' worldwide lack access to adequate sanitation (UNICEF 2015). Nations with inadequate environmental sanitation access suffer from diseases such as cholera, diarrhoea and reduce the quality of life or human well-being (WHO 2019). Within a sustainable waste management context, waste is collected, transported, and disposed of in a way that it does not negatively affect the environment and public health for future generations (Azzi 2017), oppositely to what happens in low-income countries, where MSWM is an urgent environmental and health problem (Debrah et al. 2021b).

In Sub-Saharan Africa, about 180 million tons of waste are generated (Ayeleru et al. 2020). The World Bank report shows that Sub-Saharan regional waste will rise to 269 million tons by 2030 and is also expected to increase to about 516 million tons by 2050 (Kaza et al. 2018), representing an estimated growth 91.8%.

J. K. Debrah (✉)
Faculty of Science and Technology, University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: 40511@ufp.edu.pt

D. G. Vidal · M. A. P. Dinis
UFP Energy, Environment and Health Research Unit (FP-ENAS), University Fernando Pessoa (UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: madinis@ufp.edu.pt

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This projection is mainly justified by the fast-growing urbanization development programs in the Sub-Saharan region. Given the expected waste generation, conscious development must rely on an adequate waste management infrastructure within the sub-Saharan Africa region. Yeo et al. (2020) indicates that only about 44% of waste generated is collected, 60% being organic waste. The uncollected waste causes environmental and health problems (Debrah et al. 2021a) that need urgent and efficient solutions for a healthy and sustainable environment.

According to the UN Worldometers (2020-https://www.worldometers.info/world-population/ghana-population/), Ghana, located on the Gulf of Guinea coast in western Africa, is around 31,072,940 inhabitants, with 56.7% of the population concentrated in urban areas. The rise in population growth contributes to increased waste production in most developing countries, especially in Ghana. The study conducted by Miezah et al. (2015) indicated that 12,710 tons of solid waste were generated daily when the country's population was 27,043,093 inhabitants. Another study conducted by Bert (2019) reported that the total waste production in Ghana is approximately 22,500 tons/day, in a period in which the average population was estimated at 30 million. Using the average of 0.75 kg/person/day assumed by Bert (2019) compared to the 31,072,940 inhabitants of Ghana's population (https://www.worldometers.info/world-population/ghana-population/2020), it is estimated that 23,304 tons of waste are in fact generated daily.

Another issue impacting Ghana's environmental sustainability concerns the proper urban waste collection. About 70–80% of solid waste is not collected in urban centres in most developing countries (Kirama and Mayo 2016), including Ghana. Most of the waste that is not collected in Ghana is incinerated and ashes dumped into the environment, decomposing and originating toxic compounds contaminating the air and the drinking water, with negative consequences to public health (Al-Delaimy et al. 2014; Ziraba et al. 2016). The waste generated in all metropolitan, municipal, and district assemblies (MMDAs) in Ghana can undergo valorisation, resulting in economic benefits for sustainable development.

This study's main objective is to evaluate the organic waste generated in the Ashaiman community in Ghana and assess the waste-related environmental sustainability in this region. An analysis of how organic waste collected in the Ashaiman locality undergoes treatment in an anaerobic digester to produce organic fertilizer, wastewater irrigation, and biogas for electricity, boosting economic benefits, was performed in Safi Sana Ghana. This research also seeks to demonstrate that a healthy and sustainable environment is the better way to face the challenges associated with the Sustainable Development Goal (SDG) 6 of the 2030 Agenda implementation (UNDP 2015—https://www.undp.org/content/undp/en/home/sustainable-development-goals.html). Additionally, this study seeks to estimate the environmental impacts of locally produced organic fertilizers and the relevance of energy production from organic valorisation for farmers and households in the communities of Ashaiman in Ghana and their association with SDGs 3, 7, 8, and 13.

2 Theoretical Framework

In the developing world, organic waste composition collected from markets, restaurants, hotels, schools, and other sources is heterogeneous (Alibardia and Cossu 2015) with more biodegradability properties and higher moisture content (Alibardia and Cossu 2015; Lebersorger and Schneider 2011).

Several technologies are available for the treatment of organic waste in most developing countries. Dry anaerobic digestion (AD) is mainly used due to its low cost in construction and operation. In Ghana, a dry AD was made with a second-hand shipping container that produces 55–60% methane gas (CH_4) content from the organic waste (Lohri et al. 2013a). Though not enough to satisfy the needs, it can be used for energy production.

(i) **Environmental waste management sustainability—Organic waste fertilizers and wastewater irrigation for agriculture**
Organic waste is biodegradable (Alibardia and Cossu 2015), since it is able to be decomposed. However, in most developing countries, about 50–70% of urban city waste is composed by organic matter (NIUA 2015; Poletto et al. 2016), but much of this waste is just not collected in urban areas, which end up decomposing. According to Kaza et al. (2018), about 33% of organic waste remains in cities deposited in open dumps, with less than 7.7% of organic waste being recycled or reused. Non-collected organic waste in Ghana is gradually increasing due to an urban settlement with inadequate waste management infrastructures in reusing this type of waste. A survey conducted by Miezah et al. (2015) indicates that organic waste in Ghana totals, on average, 61%. The same study reports that the content of organic waste from districts and metropolitan areas is around 62 and 59%, respectively, depending on cities' developmental and economic activities in those regions within Ghana. In Ghana, most of the organic and municipal waste collected is transported to landfills for final disposal. Organic waste disposed of in landfills produces an estimated amount of CH_4 gas in the order of 68% (Gregory et al. 2014), which can be used to produce electricity. Some developed countries such as Germany and Sweden have banned the dumping of untreated organic waste in landfills to avoid the emission of CH_4 gas into the atmospheric environment, aiming to achieve a clean environment for climate mitigation. African countries need to progress in this direction but to be able to do this, requires deliberate effort by governments to invest in waste management facilities and mandatory policies to address the environmental issues.
The waste collected in the Ashaiman community, Ghana, is currently processed by AD to produce organic fertilizer, wastewater irrigation, and biogas energy to increase environmental sustainability.

(ii) **Anaerobic digestion (AD)**
AD is a worldwide recognized and scientifically acceptable technology used in generating energy from organic waste. It brings benefits to the environment, contributing to reducing energy crisis and natural resources sustainability

(Dennehy et al. 2017). In the UK, as in many other European countries, AD and composting are acceptable methods used to treat collected organic waste (WasteDataFlow 2017). In the United States of America, AD is mostly used in wastewater treatment plants and as a method for manure treatment (Eden 2019; Moriarty 2013; Wang et al. 2021).

AD and the composting process are somewhat similar. AD allows the treatment of sludge and organic waste without oxygen. The decomposition of AD resulting from organic matter is biogas, consisting of 60–70% CH_4, 30–40% carbon dioxide (CO_2), and other waste gases (Moriarty 2013). Biogas is capable of operating in almost all equipment destined for natural gas, a major advantage, particularly in the context of less developed countries. Greenhouse gas (GHG) emission reductions and reduced water pollution are some of the benefits derived using biogas as a renewable energy generation. With all the benefits of AD, this technology is rarely used in most developing countries, including Ghana (Kwabena Agyei Agyepong 2018), due to the high capital needed to construct and maintenance costs (GMI 2013), alongside operational challenges such as lack of appropriate technology and management experts (Lohri et al. 2013b), scarce in this region. The lack of consistent access to energy in developing countries leads to the use of traditional sources of energy such as firewood (Ram and Bahadur 2020; Surendra et al. 2013), which can be overcome by using AD technology applied to organic wastes. According to GMI (2013), the biogas produced by the AD system in the developing countries is used for cook stoves, reducing family expenses in purchasing fuel for cooking and also prevent deforestation, since forest wood serves as the primary source of energy for heating (Miguiri et al. 2020; Yaseen et al. 2020). Developing countries also lack good business models for effective AD market penetration (Lohri et al. 2013b).

3 Materials and Methods

A cross-sectional case study with exploratory—descriptive methodology was carried out in Ashaiman community, Ghana, to determine the organic waste generated and transformed by Safi Sana Ghana (2020) company to produce organic fertilizer, biogas and wastewater irrigation for environmental sustainability. The company is presented as a case example aiming to illustrate how to contribute to sustainability within Ghanaian society.

3.1 Characterization of the Study Region

Ashaiman, Ghana, is the case study analysed in this work. It is a region located 41 m above sea level and has a total area dimension of 45 km^2. Its location is about 30 km from Accra's metropolitan centres and is projected to the north and east by

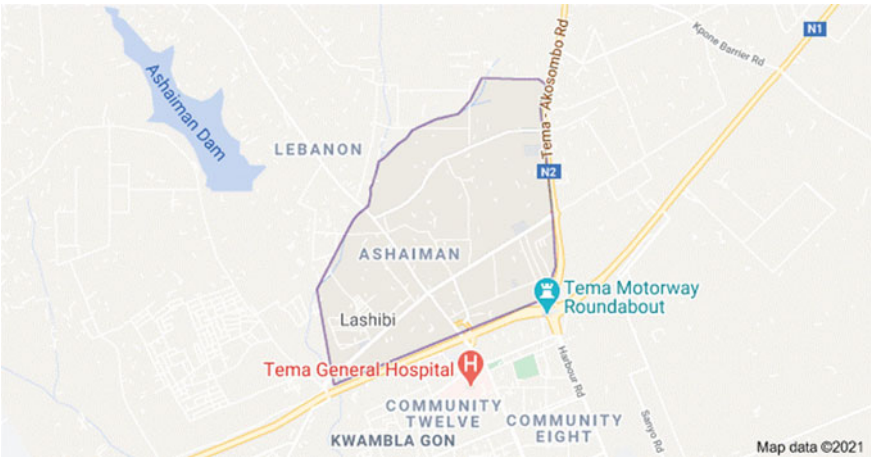

Fig. 1 Ashaiman Municipality location in Ghana. *Source* Illustration done in google.com map (http://g.co/kgs/3QTfRg)

Kpone Katamanso's municipality and south and west with Tema Metropolitan. Figure 1 represents the map of Ashaiman municipality, Ghana.

Ashaiman's average temperature is 26.7 °C, and annual rainfall is 827 mm (https://en.climate-data.org/africa/ghana/greater-accra-region/ashaiman-688176). The 2020 population census of Ashaiman municipality is estimated at 240,841 inhabitants, with a population density of 12,325/km^2. The population size was calculated using the 2010 population census by the Ghana statistic with a 2.35% load over 19.5 km^2. Demographic data for the region reveals a majority of 50.1% of female inhabitants. The municipality has almost a third (31.9%) of its total population of young people aged 0–14 years, indicating a large population pyramid with an inverted base since the elderly population comprises 2.4% of the total population (Ashaiman Municipal Assembly 2017). According to Fanta (2013), the municipality of Ashaiman attracts many rural migrants from all over Ghana, especially in the dry savannah regions, where climate change affects farmers (Nyantakyi-frimpong et al. 2016). 1.9% of the resident population are individuals from West African countries (Ghana Statistical Service 2014). Some of the migrants arriving in Ashaiman are also engaged in agricultural activities and waste collection in the municipalities.

4 Waste Generation in Ashaiman, Safi Sana Ghana Case Study

It is estimated that Ashaiman has more than 41,515 families, with about five members per family. The study further indicates that solid waste in 31,266 households is collected within the municipality for final disposal, with less than 1%

of families burying their waste as a final disposal method (Ashaiman Municipal Assembly 2017).

Ashaiman counties generate approximately 186 metric tons of solid waste per day (205 tons per day) (Tsigbe 2020). Miezah et al. (2015) indicate that 62% of all solid waste generated in all municipal communities comprises organic matter. Therefore, it is estimated that 127.1 tons of solid organic waste are produced in Ashaiman daily. These organic wastes are obtained in markets, cafeterias, school canteens, hotels, and individual residences. As examples of solid organic wastes from this region, fish wastes, smaller amounts of vegetables and fruits, and food wastes could be mainly mentioned.

Organic waste collected from Ashaiman municipality is transported to Safi Sana Ghana (2020) for treatment and reuse. The organic waste collected, mainly in markets and other places intended for food, is separated by trained personnel for later transportation to Safi Sana Ghana. About 25.42 tons per day (20%) of Ashaiman's classified organic waste collected in markets, restaurants, and slaughterhouses are mixed with about 20 tons of faecal waste from the Ashaiman locality to form a waste mix. The mixed waste is then treated in the double waste stream AD for the production of biogas. The treated waste is taken to drying beds to separate dry matter and water to produce organic fertilizer and wastewater irrigation. An estimated average of 2 tons of organic fertilizer and 20,000 L of wastewater irrigation is produced daily from solid and faecal organic waste in Safi Sana. The treated water obtained from the drying bed, in this process, is used as irrigation for the cultivation of seedlings and agricultural activities in the community. Figure 2 represents the stages of the organic waste transformation, contributing to environmental sustainability in Ghana.

The organic fertilizer resulting from the AD process is used to grow seedlings and is also applied to various land for agricultural purposes within Ghana. It is estimated that around 800,000 seedlings are produced annually by farmers in the community through Safi Sana's Ghana activities to increase agricultural production income in the community. Regarding the transformation of organic waste, biogas production is used to produce 2,200 kWh of electricity daily, as Safi Sana Ghana adds it to Ghana's national electricity grid for consumption (Safi Sana Ghana 2020).

5 Environmental Impacts and Benefits of Organic Waste Processing and Organic Waste Products Transformation Towards SDGs

Safi Sana Ghana (2020) closed-loop configuration's safety activities have no negative environmental impact associated with organic fertilizer, wastewater irrigation, and produce energy. It promotes and contributes to the region's environmental sustainability in focus and contributes to the safe management of liquid faecal waste in the municipality of Ashaiman, Ghana. About 20 tons of liquid waste from faecal

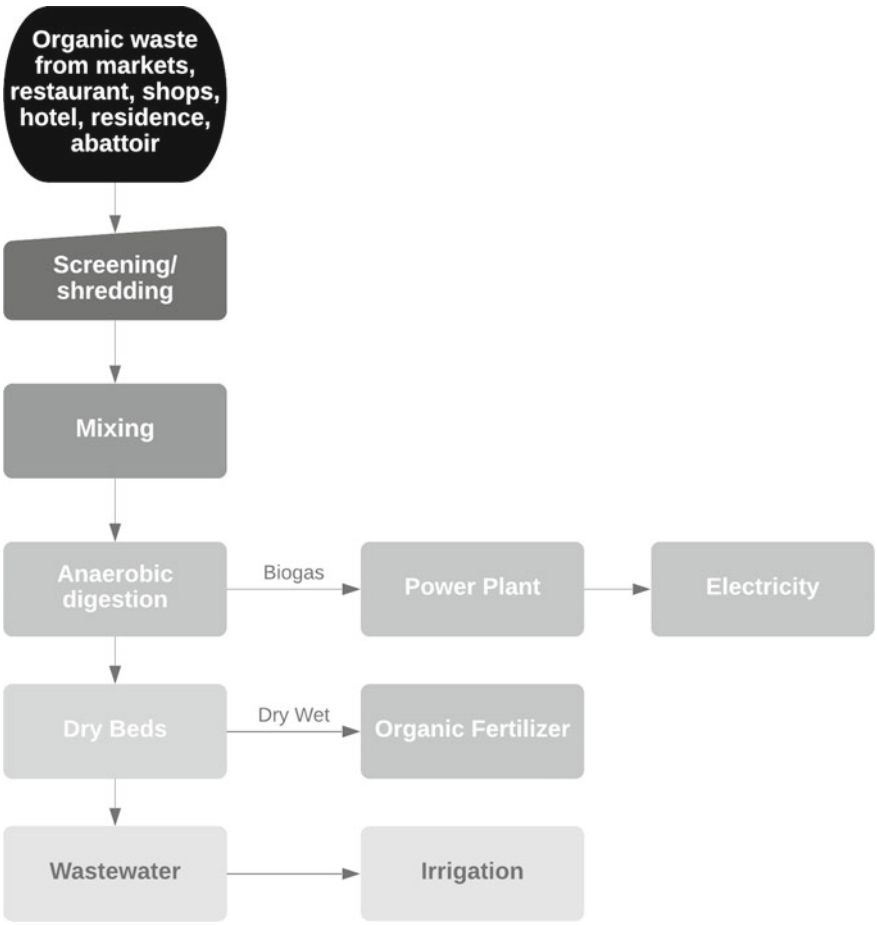

Fig. 2 Steps in the AD organic waste transformation to produce electricity, fertilizer, and wastewater irrigation in Safi Sana, Ashaiman, Ghana

sludge are treated daily, benefiting more than 40 thousand people in the localities. Although faecal waste treatment is carried out on-site, vacuum truck operators handle and manage liquid faecal waste from the siphon point to the final treatment stage. The treatment of liquid waste has helped reduce the enormous challenges associated with SDG 6 in the Ashaiman community. According to SDG 6 of UNDP (2015), addressing clean drinking water and sanitation, Ashaiman is successfully achieving the recommended goal, since the transformation of liquid faecal waste has reduced the negative impacts on public health, as well as the environmental impacts of sanitary waste in this community.

In turn, Safi Sana Ghana's waste transformation process equally promotes SDGs 3, 7, 8, and 13 related to the development of environmental sustainability in Ashaiman, Ghana. The residents of the region are trained/oriented on managing the

generation of their waste, segregating it for later treatment. During the training, public health education and health promotion, and hygiene care actions are carried out in the locality. Such qualified actions contribute to the operationalization of SDG 3, which provides for general hygiene and people's well-being.

One of the main goals in transforming organic waste in Ashaiman, Ghana, is energy production. The energy produced is characterized as clean and used to supply more than 500 families in Ghana. The power considered clean is added to the national electricity grid, compatible with what is recommended for reaching the goals recommended by the SDG 7.

The entire process of transformational production from organic waste requires human activities since it is not fully automated. According to the local policy, Safi Sana Ghana (2020), seeks to promote 90% of its workforce within the Ashaiman community. The company has as a goal the employability of 40% of female workers in its staff. Decent work brings economic relief and growth to people within the community. The economic growth resulting from the decent work offered to people in the municipality's community guarantees financial freedom, security, and stability, and this transformational change leads to SDG 8.

In the process of organic transformation, CH_4 and other gases are released in the AD (Ferdes et al. 2019), processed into biogas for electricity production. To minimize the emissions of CH_4 resulting from incomplete combustion, the biogas plants and processes must be operated effectively (Paolina et al. 2018). The operated biogas also reduces the emission of CO_2, Ammonia (NH_3), and other GHG, which are some of the contributing factors of climate change from SDG 13. The Safi Sana facility, ensures that the SDG13 goal is achieved by recovering slaughter and organic waste, other major factors of climate change. Organic waste's indiscriminate disposal becomes harmful to the environment when left to be decomposed, causing all kinds of pathogenic diseases which may be prevented through the AD process (Kasap et al. 2012).

The fertilizer produced by the transformation of organic waste is used to enrich the soil fertility (nutrient) and soil texture by increasing plant production in the community and reducing the use of excess land or big farmland for the small yield of plant or food (Al Seadi et al. 2018; Ma et al. 2021; Mezzullo et al. 2013). The organic fertilizer's texture or moisture content reduces soil erosion, ensures water conservation in farming land within the farming community and reduces the greenhouse effect. According to Brempong et al. (2019), organic fertilizer's moist content produced traps the temperature-raising carbon content in the soil, thus preventing the greenhouse effect for climate mitigation. The organic fertilizer produced is added to soil to prevent environmental degradation and promote the ecosystem's recovery by improving the soil's water quality. This activity enhances environmental restoration, vital for biodiversity. It is important to note that biogas digesters control odour, improve waste handling, and ensures that pathogens and worms are destroyed. The digesters also prevent leaching and thus safeguard underground water. A summary of the main environmental impacts of organic waste transformation within AD is presented in Table 1.

Table 1 Environmental impacts of organic waste transformation towards SDG in Ashaiman community, Ghana, adapted from Kubanza and Simateel (2020)

SDG	Action	Organic waste, positive environmental impacts in Ashaiman municipality
3	To ensure the health and well-being of people in the municipality	Promote good health and public hygiene through education
6	To ensure access to clean water (providing clean water) and sanitation	Promote and support clean water and environmental sanitation within the community through waste transformation and sustainability
7	To ensure access to affordable, reliable, sustainable, and modern clean energy for all	The biogas obtained from the organic transformation is a clean fuel powering home in the community, Ghana
8	To promote, sustain, and ensures decent work and economic growth	Some of the people in the communities are now employed through the activities of the waste transformation
13	To take urgent action and combat climate change and its impacts	In the organic waste transformation, biogas reduces CO_2, NH_3, and other GHG emissions, which impact climate change

6 Conclusions

Waste is a major problem in developing countries and Ghana is no exception. This is also justified by the high capital needed to invest in the construction and appropriate technology needed to transform waste. In Ashaiman communities, Ghana, organic waste transformation is essential due to the lack of engineered or inadequate landfills to manage waste and the huge volume of uncollected waste generated, specifically organic waste. Safi Sana company role in the community is presented as an example of a company contributing to sustainable development in Ghana, within the context of AD technology.

It is estimated that 127.1 tons of organic waste obtained from 205 tons of solid waste are generated daily in Ashaiman municipality, Ghana. The organic waste transformation activities within the municipality result in environmental sustainability, contributing to local economies, promoting hygiene and health. The education and training on hygienic conditions to the waste segregation and collectors ensure that the people's health and well-being in the Ashaiman localities are paramount by the Safi Sana operators towards achieving SDG 3.

The transformation of faecal and organic waste through the AD process reduces the negative impacts on public health and the environmental impact of sanitary waste in this community. These activities promote, support, and ensure clean water and environmental sanitation within the community to progress in SDG 6. The biogas produced during AD serves as a clean, renewable, and cheap energy source and is obtained from organic transformational activities. This electricity power used in the Ghanaian communities is affordable, reliable, sustainable, and clean, progress towards SDG 7.

The entire process of organic waste transformation for environmental sustainability creates jobs and enhances the people's economic growth, so important in developing countries. More than 90% of local people are employed in Ashaiman, Ghana, working in the process of organic valorisation, i.e., collection of organic waste, transportation, sorting, AD operation, and so on, a contribution to SDG 8, work for a decent living and economic opportunities. Through AD, the organic waste transformation in the Ashaiman locality reduces the emission of CH_4, CO_2, and other GHG released to the atmosphere for positive climatic change and environmental restoration towards SDG 13.

Apart from the organic fertilizer for farmers in crop yield and the energy for household electricity consumption obtained during the transformation of the organic waste, organic waste disposal at the landfills and GHG emission is also reduced because most of the organic wastes undergo AD.

Grounded on the organic waste transformation process, SDGs 3, 7, 8, and 13 have shown to be implemented in the Ashaiman community, Ghana.

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Justice Kofi Debrah is Ph.D. candidate in Ecology and Environmental Health at Faculty of Science and Technology, University Fernando Pessoa (UFP). His area of research interest is in Environmental waste management, medical waste management, environmental education, environmental sustainability and sustainable development.

Diogo Guedes Vidal is graduated in Sociology (2014) and M.Sc. in Sociology (2016) from the Faculty of Arts of the University of Porto (2016). He was research fellow in several projects financed by the Portuguese Foundation for Science and Technology (FCT, I.P.), in the area of public and environmental health, environmental sociology and sustainability (2014–2019). He is currently a Ph.D. research fellow with a project funded by FCT, I.P. to be developed at FP-ENAS/ University Fernando Pessoa in the area of Ecology and Environmental Health focused on urban green spaces. He also collaborates with several national and international research institutions, namely with the Bahiana School of Medicine and Public Health (Brazil), with the Local Health Unit of Matosinhos (Portugal) and with the Higher Institute of Social and Political Sciences of the University of Lisbon (Portugal). Also, he is a reviewer of several national and international indexed scientific journals in the areas of urban sustainability, public and environmental health and biostatistics.

Maria Alzira Pimenta Dinis Ph.D., M.Sc. and Associate Professor at University Fernando Pessoa (UFP), Porto, Portugal. Researcher at FP-ENAS, UFP Energy, Environment and Health Research Unit, Porto, Portugal. Her specialised expertise includes CO_2 geological storage, Reservoir modelling, Environmental science, Environmental education, Environmental and Human Health, Waste management, Sustainability and others. Editorial Advisory Board Member in Energy Sources, Part A: Recovery, Utilization, and Environmental Effects, Taylor & Francis, Editorial Board Member in Rudarsko-geološko-naftni zbornik (The Mining-Geological-Petroleum Engineering Bulletin), Faculty of Mining, Geology and Petroleum Engineering, University of Zagreb, Guest Editor in Sustainability, MDPI AG, Environmental Institutional Awareness in the Context of Sustainable Development and PUBLONS Academic Advisor. Author of numerous publications.

The Limits of Sustainability: Lessons from Past Societal Collapse and Transformation, for a Civilization Currently Defying Humanity's Safe Operating Space

João L. R. Abegão

1 Introduction

Twenty-First Century industrial society (hereafter, civilizational project) remains bound by the same constraints that brought about the collapse or transformation of past complex societies. However, the current anthropic impact and the degree of complexity are far apart from anything humanity has previously achieved. Indeed, a case can certainly be made that the biophysical limits that govern the safe operating space for humanity have or are being breached (Rees 2020; Rockström et al. 2009; McLaughlin 2018; Dasgupta 2021). Thus, concern over the potential fate of modern industrial society has been raised (Ehrlich and Ehrlich 2013; Gowdy 2020; Capon 2020); as ecosystems shift or collapse (Kareiva and Carranza 2018), non-human life declines or slips into extinction (McCauley et al. 2015; Dirzo et al. 2014); the climate is disrupted through anthropogenic action (Ripple et al. 2019), and deforestation and population grow unimpeded (Bologna and Aquino 2020; Bystroff 2021). As the fabric of human civilization is eroded (Convention on Biological Diversity 2020), the way humans can inhabit this Earth will be transformed (Halstead 2018; Steffen et al. 2018), with global catastrophic risks being elevated to an eminent concern (Carpenter and Bishop 2009; Kuhlemann 2019; Beard et al. 2021).

As a result, more than 250 scientists and academics have published a letter (Weyhenmeyer et al. 2020) alerting to the risk of societal collapse, where they affirmed:

> As scientists and scholars from around the world, we call on policymakers to engage with the risk of disruption and even collapse of societies […] Researchers in many areas consider societal collapse a credible scenario this century.

J. L. R. Abegão (✉)
Faculdade de Letras da Universidade de Lisboa, Alameda da Universidade, 1600-214 Lisboa, Portugal
e-mail: joao.abegao@edu.ulisboa.pt

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Many explanations have been advanced to make sense of the historical trends and sporadic events that have led to profound transformations or the collapse of past complex societies. 'Collapse' in itself has become a popular word, with its meaning dissolved. However, it is explicit that it relates to a political, demographic, economic, ecological cause or some sequence or amalgamation of these[1] (Johnson 2017; Middleton 2017; Bárta 2020). Under these circumstances, it is argued that the determinants that led to crises and protracted recovery or collapse of former complex societies do not just remain fully at work but are more significant than ever. This is linked to cumulative historical influence, changes to their severity (how bad the consequences can become), magnitude (how many people are affected), probability (likelihood of materialization), and loss of resilience (the capacity to absorb disturbances and rebound).

This chapter aims to re-examine the historical data and the evidence from contemporary biophysical/ecological trends. From these sources, it should be possible to establish whether the current debate on potential global civilization collapse is justifiable and whether governments, relevant institutions, and individuals should be debating vigorously and planning accordingly on that contingency. Expectations for innovation and development that intend to meet the goal of producing a sustainable and enduring civilization are not just being confronted by an expanding human enterprise[2] (Rees 2020) that endangers its safe operating space, but studies continue to emerge presenting evidence that the scale of anthropic impact is so grand that it has become hard to grasp its consequences, much less anticipate them fully. The condition of the earth—ergo human well-being—appears to be in a worse state than estimated (Bradshaw et al. 2021; Grinsted and Christensen 2021).

Under these circumstances, the significant elements proposed and analyzed here to be precipitating the likely collapse of the civilizational project are the combination of:

1. A Pollyanna view of reality and human nature, dominated by the fallacy of human exceptionalism and supremacy over the laws that govern biological lifeforms;
2. A swollen human enterprise consisting of growing human population already in substantial overshoot;
3. Lingering drivers more impactful than ever before;
4. A society of unmatched complexity;
5. A cornucopian myth of inexhaustibility;
6. Maladaptive socio-behavioral tendencies;
7. Loss of resilience, and lastly,
8. Social and political unwillingness to abandon the *status quo*.

[1] Guy D. Middleton's *Understanding Collapse—Ancient History and Modern Myths* (2017) offers an excellent overview of *what* collapse is, *why* it happens, and the different objects of study involved.

[2] Consisting of both the growth of the human population and economic activity.

By comparing these factors with what is known from the historical and archaeological records of past complex societies, discernible patterns materialize. Correspondingly, glaring differences also emerge, such as the progressive impracticality of one of the oldest resilience strategies employed by humanity, the capacity to migrate in search of sustainable environments when conditions are not suitable for life.

Lastly, this chapter accentuates the impacts of anthropogenic degradation of the ecosphere, past and present. However, it should be made clear that it is not the author's intention to minimize other disruptive forces—generally synchronous and synergistic to environmental and climatic phenomena—such as crises of economic and socio-political natures. To clarify, the thesis being advocated here upholds an interdependent concoction of factors that challenge biophysical limits. However, it is argued that the ones settled to galvanize our civilizational project are, for the most part, enhanced versions of the ones that impaired our antecedents.

2 Lessons from the Past

Humanity has achieved a remarkable milestone. The historical record attests to the ubiquity, cultural diversity, and innovation that have emerged throughout the ages of human expansion on Earth. Equally so, this chronicle of events also allows us to glimpse into the disasters, transformations, and occasionally, the collapses that past complex societies have experienced. As a result of such an examination, it becomes apparent that virtually every human collective [e.g., individual communities, political and cultural units, and populations (Middleton 2017)] has had to contend with either or both climate fluctuations and ecological boundaries in their struggle to erect resilient societies (McAnany and Yoffee 2009).

Among the most frequent problems faced by past complex societies were the loss of agricultural productivity (due to climatic fluctuations or environmental phenomena) or their populations' growth, which could outpace local or regional carrying capacity (Johnson 2017; Weiss 2017; Cooper et al. 2012). As a result, one of the most common strategies employed by previous societies was the conquest of territories and the relocation of the surplus population through internal migration, as with the historic example found in the colonization of Cyprus by the Ottoman Empire (White 2011; Gumuscu 2004). Alternatively, when conditions were not suitable for life, populations abandoned their territories in pursuit of others with more favorable conditions, as with the renunciation of areas in the American Southeast and Southwest between 1200 and 1500 CE (Cable 2020) or in Northern Mesopotamia during the 4.2 ka BP (Before Present) event (Carolin et al. 2019).

In a review article, Tainter (2006, p. 71) prominently asserted that "*there does not presently appear to be a confirmed archaeological case of overshoot, resource degradation, and collapse brought on by overpopulation and/or mass consumption.*" Assuming for the moment that Tainter's claim is accurate even though opposite claims have been made (e.g., Webster et al. 2005; Lima et al. 2020), a case

can certainly be made that a *direct* link between past societal collapse and the causes mentioned above has been a challenging endeavor to validate. However, it becomes difficult to dismiss the indirect implications of a growing population, pressing into the limits of a degraded and vulnerable ecology. That is precisely the scenario proposed by Sam White in *The Climate of Rebellion in the Early Modern Ottoman Empire* (2011).

White describes in thorough detail how the imperial ecology of the Ottoman Empire—one that was far-reaching and diverse but bounded by environmental and technological limitations—was severely disrupted by the synergetic effect of the onset of the "Little Ice Age" and unprecedented population growth during the sixteenth century (doubling and tripling populations in some regions). Because of such a rapid growth of the population, per-capita landholdings and agricultural harvests declined, creating an unequal land distribution. As a result, unrest was rife, as the conditions for a surge of 'landless, unmarried, and potentially dangerous men' (p. 76) in the face of the economic turmoil due to rising inflation were set.

When population pressure was combined with the Little Ice Age's climatic fluctuations (drought and freezing winters in Anatolia), regions ceased to meet the agricultural and livestock quotas and tributes (enhanced by wartime requisitions). Moreover, conflict escalated between settlers and nomadic tribes, as the former increasingly grew in numbers and moved into marginal land used for grazing; banditry rose unchallenged; famine was prevalent, and an exodus of refugees from the countryside amassed in cities due to insecurity, abandoning agricultural production and further accentuating the scarcity of resources. Accompanying these occurrences were the recurrent and deadly episodes of infectious diseases (affecting both humans and non-humans) that circulated through the weakened and overcrowded populations. Ultimately, this chain of events led to the Celali Rebellion (1595–1610), arguably the most significant crisis in Ottoman history. The empire plunged into disarray, as bandits organized into armies, plundering the countryside and disrupting the provisional system, a crucial economic strategy of the Ottomans, which allowed for the movement of essential resources throughout the extensive empire, supplying less productive territories.

Regardless, the Ottomans were not the only ones to grapple with challenges aggravated by environmental and climatic conditions, and we need to look no further than to the region known as the Near East[3] which encompassed most of the territory of the empire. Throughout human history, it is hard to find a more consequential region than the Near East. For one thing, this vast landscape accommodated the right conditions for the demographic pressure of foraging groups that are understood to have adopted a sedentary lifestyle and introduced cultivation in the Fertile Crescent at around 12,000–11,700 BP (Bar-Yosef and Bar-Matthews 2017). Secondly, it has also been subject to recurrent events of abrupt climatic changes that have punctuated ancient Near East civilizations. In detail, the 8.2, 4.2, 3.2 ka BP events, as well as the Late Antique Little Ice Age (LALIA), have been

[3] A transcontinental region comprising modern-day Western Asia, Turkey as well as Egypt.

linked with, respectively, the Neolithic dispersal (Weninger and Clare 2017), collapse, and transformation of Akkad and Egypt (Carolin et al. 2019; Bárta 2020), the LBA collapse (Kaniewski and Van Campo 2017) and the Beyşehir Occupation Phase (BOP)[4] that characterized the Byzantine Empire in the sixth and seventh centuries (Haldon 2016).

In any case, the mixture of rapid population growth and a volatile climate did not push the Ottoman Empire into a spiral of collapse, as it withstood the crisis and persisted until the twentieth century. Notwithstanding, this period of Ottoman history ought to serve as a cynosure for our civilizational project, as we face similar but amplified threats, as well as new challenges.

3 Defying the Safe Operating Space for Humanity

Our modern industrial society is contemplated to be the last in a long line of failed attempts by humanity to build an enduring civilization. However, several archetypical problems attest to the unsustainability and the likelihood of collapse of this civilizational project as well.

The myth of human exceptionalism and the Pollyanna worldview. The leading perception is that humanity has mostly managed to extricate itself from the hindrances that confined other past societies and that it has risen above the forces that bind other lifeforms, such as those of Malthusian nature. Under these circumstances, the prevailing narrative is that humans have transcended the forces of nature, particularly the ghost of Malthus and his positive checks (COVID-19 having given a harsh reality check). Moreover, continuous technological progress is expected to invalidate the inevitable reality of biophysical limits (Rees 2020) and ecological laws (Commoner 2020). Beliefs affirming the ingenuity and growing technological capacity of humanity are persistent, and they continue to be a foundation for economic thinking and political governance. Recent publications with social and political clout make the case that the human condition has improved beyond any point in the past and will continue to do so. These are especially prevalent in what concerns the human population's size and improving environmental conditions (Rosling et al. 2018; Pinker 2018), although these do not stand unchallenged (Monbiot 2018; Population Matters 2018). It remains to be seen if such undertakings, which can be regarded as the 'Darwinian dynamic of innovation and adaptation,' can stem the tide derived from the 'Malthusian dynamic of exponential growth' that underpins the trajectory of civilization, as Nekola et al. describe it (2013).

The human enterprise has grown beyond biophysical limits. The Earth is over-populated, and this is by no means a value-laden statement. Even at current

[4] Known to historians of the environment as a period of a sharp decline in anthropogenic activity due to climatic fluctuations.

global wealth and material levels, humanity still overshoots the biocapacity of 1.6 global average productive hectares (gha) per capita with roughly 2.8 gha per person (Global Footprint Network 2020). The human population keeps growing by more than 80 million/year, and all of these individuals will require, at the very least, a non-negligible subsistence level and a share of the global natural capital, while many others will strive to achieve higher wealth and material status, collectively participating in the degradation of the ecosphere[5] (Abegão 2019). The combined effect of a growing overpopulated species with global geographical range and an excessive material demand—global GDP has increased by over a factor of 100 since 1800 and per capita incomes, by 13 [(25 for the wealthiest countries) (Roser 2013)][6]—make the human enterprise a parasitic force on the ecosphere. By all means, the human enterprise is itself an agglomerate 'dissipative structure' whose preservation hinges on the entropic disheveling of the ecosphere (Rees 2020), resulting in a civilizational project which exhausts its ecological foundation in order to grow.

At the same time, a firm conviction is maintained that an increase in economic development leads to a decline in environmental degradation (after an initial burst of degradation as the economy starts growing) through the Environmental Kuznets Curve (EKC) (Beyene and Kotosz 2020). Given this, the proposition that "wealthier people care more about the environment" has been bolstered and continues to enjoy considerable public and political support, even though the EKC only appears to be applied to a small range of pollutants (Özokcu and Özdemir 2017), and evidence piles up pointing to its discrepancies, weaknesses or outright inapplicability (Aydin et al. 2019; Bradshaw and Di Minin 2019; Sarkodie and Strezov 2018). It is believed that in order to tackle environmental problems, people and nations everywhere must become more affluent to drive efficiency through technological progress. However, such growth (either in population or the economy) is anathema to the biophysical limits imposed on a finite planet, while absolute resource decoupling remains elusive (Parrique et al. 2019; Jackson and Victor 2019).

Lingering drivers have a cumulative historical essence, are more likely, consequential, and far-reaching today. The risks posed by lingering drivers have not remained unaltered through millennia. Human modifications of the environment have gradually been amassing [(e.g., on the climate change issue, when considering the pre-industrial baseline, an extra 0.2 °C of warming is added (Schurer et al. 2017) on top of the roughly 1 °C since 1880 (Earth Observatory, n.a.)]. The anthropogenic scale of impact and pace of change has also changed tremendously. As a result, one such driver today carries more weight than in former times, that is to say, their repercussions are more severe and momentous, as well as their probability of manifestation (Goss et al. 2020) [e.g., with Hurricane Harvey in 2017

[5] As the population increases, the biocapacity per capita will continue to decrease as environmental deterioration occurs during overshoot (e.g., Bystroff 2021).

[6] Hickel argues (2018) that *income* is intrinsically connected with a more significant ecological footprint (EF).

being attributed increased rainfall and likelihood of occurrence due to anthropic influence (Risser and Wehner 2017; Van Oldenborgh et al. 2017).

Furthermore, concurrent extreme events can combine and augment to produce more critical consequences through synergistic interactions (Yohe et al. 2020). It has been suggested to have occurred repeatedly to the past complex societies inhabiting the Andes (Moseley 1999). Equally important, there is the occurrence of a heightened geographical influence, one that was mostly local or regional in previous complex societies, to one, at present, that replicates those smaller-scale analogs of environmental modification but to a quasi-global extent [e.g., overfishing evolved from being mostly confined to near-shores and other waterbodies in the immediacy of past human societies (Jackson et al. 2001), to pervasive exploitation such that roughly ninety percent of the ocean is under intense human pressure (Jones et al. 2018)].

Population numbers also fit in this category. As illustrated in the previous section, the Ottoman empire grappled with rapid population growth, which produced many problems for that society. Recognizably, the global population has changed tremendously, ever since the sixteenth century-Ottoman empire, expanding from roughly 550 million people (United States Census Bureau, n.d.) to more than 7.8 billion today. It would be naïve not to consider such an enlargement of the global population as a risk, when reduced numbers—with a fraction of current footprints—beget such societal change.

Assuredly, lingering drivers have been present during the waxing and waning of past complex societies, and persist, nowadays, as an established threat gathering momentum, strengthened by anthropogenic reinforcement and enlarged area of effect. At the same time, a sober admission must be made that humanity today is equipped with problem-solving and awareness capabilities, international cooperation, technology beyond anything past complex societies ever achieved, as well as the advantage of forethought regarding the causes that led to their collapse.

A society of unprecedented complexity. Humanity has created a system of overwhelming complexity, an event unparalleled in the history of the species. This global/interdependent/integrated complex society has expanded in an interlinked manner, meaning that the system—comprised of many subsystems—responds by developing further complexity. The physicist Yaneer Bar-Yam, has fittingly described that "A networked society behaves like a multicellular organism" (quoted in Mackenzie 2008). Bar-Yam has argued that the more complex a given system evolves, the more indispensable each separate variable becomes to the whole system's fabric. Interdependencies are generated, and disruptions to an 'organ' ripple throughout the 'organism' (Servigne and Stevens 2020). Besides, Manheim (2020) has argued that latent instabilities may have developed within our civilizational project, magnifying the shocks imposed particularly by climate change, while Kemp (2019) reinforces the increased vulnerability of an intricate, interconnected single socio-economic system that came to depend on the functioning of some key states and industries that might falter leading to local perturbations that can reverberate around the globe.

In comparison, among the most thoroughly studied examples of collapse or profound transformations linked to interconnected susceptibility in past complex societies can be found in the Maya cultural unit (Middleton 2017), as well as in the Late Bronze Age (LBA) Collapse (c. 1200 BCE) (Cline 2021). In the former, the polities of the Northern Lowlands (which include the well-known Chichén Itzá) were less vulnerable to abrupt transitions such as megadrought, since they were less connected (and better adapted to dry conditions), and therefore less dependent on socio-political networks than their counterparts on the Central and Southern Lowlands (Kennett and Hodell 2017). In the latter, co-dependencies formed among many of the Mediterranean and Mesopotamia's key players during the LBA which contributed to either their contraction or collapse, and which has been increasingly linked to climatic fluctuations (Cline 2021; Kaniewski and Van Campo 2017).

The Cornucopian myth of inexhaustibility. Humanity is currently driven by a global myth of expansion in a world of neglected—although increasingly noticeable—limits. An expansionist myth intertwined with neoliberal economics that regards the economic system as unrestrained by ecological laws and divorced from the environmental system, is believed to be an infinite source of resources and a sink for waste. The prevailing economic rationale is linked with the belief system mentioned above that humans have acquired mastery over the natural world. Simultaneously, technology and free-market forces will pick and shift between an inexhaustible diversity of natural resources. Humans' ability to evade local resource shortages and population crash through trade, the movement of peoples from resource-depleted areas to more abounding ones, and their technological and innovative advantages have created a false sense of limitlessness. Even though, regarding the former, this was a successful strategy for most of humanity's history (Cooper and Sheets 2012; Cable 2020; Weiss 2017) before our species had become a global force with terraforming power. The dominant mantra overlooks the fact that the Earth is a closed system, and that the human enterprise's growth will inevitably demand the depletion of the ecosphere (Bystroff 2021). Correspondingly, the Cornucopian myth also overlaps with the Pollyanna worldview in the sense that patently optimistic attitudes towards the future (Simon and Kahn 1984; Reedy 2017) continue to embrace the model of continuous growth while overlooking facts and arguments about the constraints, limits, and boundaries of the planet. Similarly, they also consider the economy as growing in a nonphysical dimension, disconnected from thermodynamics and not as a subsystem of the finite and stationary biophysical system (Daly 2010).

Maladaptive behavior. Countless practices have persisted throughout human evolutionary history, which were favorable sometime in the past but have become detrimental, in a changed and unstable ecological setting. These maladaptive behaviors have bestowed a competitive advantage in securing the "natural capital" of the Earth (Rees 2002), consequently aiding in the current state of overshoot. In detail, these can range from economic policies to cultural norms or biological imperatives [e.g., the desire for a large family aggregate would have granted some utility in the past when child mortality was elevated but has now become an

egotistical action with collective harm, particularly in the overdeveloped world (Rieder 2016)].

Loss of resilience. The relatively amenable context of the Holocene [with occasional exceptions as in the form of megadroughts (Weiss 2017)], with functioning and rebounding ecosystems, has not just allowed for the emergence of past complex societies but has also sustained their recovery after tumultuous periods (McAnany and Yoffee 2009). However, the welcoming 'Long Summer' (Fagan 2005) that has characterized the Holocene is now in flux due to anthropogenic disruption, in conjunction with natural sinks that have either been overwhelmed or degraded to the point that they have become saturated (Nabuurs et al. 2013), resulting in a loss of resilience that further accentuates the vulnerability of our civilizational project (Beard et al. 2021). Furthermore, due to the near-ubiquity and expanding density of the human population, the ancient strategies adopted by our forebears of migration through urban abandonment, habitat tracking, and settlement dispersal are becoming increasingly harder to accommodate, while the numbers of people being internally displaced continue to steadily increase (Cazabat et al. 2020). Conjointly, as traditional environmental knowledge declines (Sheets 2012) and is replaced by the narratives mentioned of human exceptionalism, a Pollyanna worldview, and the myth of inexhaustibility, populations become more vulnerable (population growth also translates into an amassing at increasingly marginal and hazardous land) and are deprived of the capability to more effectively rebound when faced with crises.

Political intransigence and collective unwillingness to face harsh truths. Tying these issues together is the global inability to act on the threat of collapse, or at the very least, the inefficient ways that have been proposed to engage with humanity's predisposition to inhabit this planet in an unsustainable manner. Although it has been recognized for several decades that continued growth of the human enterprise would come into conflict with biophysical limits at the expense of the ecosphere and even the continued harmonious existence of *H. sapiens,* indicators of anthropogenic impact show no signs of abating, despite countless international treaties, conferences and proposed solutions. Given the seeming inevitability of collapse associated with future scenarios, compounded by all the complex societies confined to the historical record, it remains to be established if a 'controlled descent,' spearheaded by both voluntary economic and population reductions, could be viable approaches or just different roads to the same destination. In any case, there is virtually no public support for the necessary scaling down policies to target both the population and the economic system since these would constrict rights, liberties, and freedoms that people have acquired and now relish and are unwilling to relinquish. Equally so, since constituents expect their well-being to increase, or at the very least, not decrease, politicians will perpetuate growth-based policies in the expectation of swelling their electorate. Consequently, politicians remain committed to the *status quo* seeing that the vast majority of their constituency endorses such positions.

4 What Lies Ahead

Despite our ambitions concerning technology, innovation, and development, humanity faces a conundrum (Servigne and Stevens 2020). Suppose humans strive to pursue material and energetic growth (intrinsically dependent on fossil fuels) to maintain this civilizational project and its bloated human population. In that case, the earth-systems will be degraded even further, and climatic changes will be expedited. On the other hand, if humanity were to choose to preserve the biosphere, the human enterprise would have to be intentionally constricted [as a matter of example, a contraction of 7–8%/year of global GDP observed during the Covid-19 '*anthropause*'[7] would be required for the next ten years to have a 66% likelihood of limiting warming to less than 1.5 °C above pre-industrial temperatures (Gabbatiss 2020)], amounting to a deliberate social and economic collapse. Alternatively, a massive investment in current alternatives to reduce GHG emissions would require a transition away from fossil fuels which are still an underlying factor sustaining this society and the immense human population reliant on their energetic output. Renouncing those too quickly would engender inevitable energy shortages, food insecurity, and once again, an economic contraction and massive increases in death rates (e.g., Sers and Victor 2018). Not excluding the inherent difficulties from rebound effects (Biewendt et al. 2020) and other socio-technological cognitive and behavioral obstacles (Gifford 2011; Unruh and Carrillo-Hermosilla 2006), concerns over the ecological impacts of 'green growth' and a 'green transition' are emerging (Hickel and Kallis 2020; Gibson et al. 2017), on top of the interwoven threats from our 'human predicament'[8] (MAHB, n.a.).

5 Conclusion

From humble beginnings and through the ebb and flow of history, humanity has erected a civilization with no precedent. However, in exchange for leaving an indelible mark in the annals of humankind, *H. sapiens* literally became a species with terraforming potential, capable of anthropomorphizing the planet, impairing their safe operating space, and exhausting the foundation sustaining their project.

Overall, it can be argued that the forces that have undermined past complex societies remain bounded to our civilizational project, albeit with a heightened influence. Like our ancestors before us, through innovation and technology, we can

[7] A term related to the COVID-19 shock that stifled human activity and allowed wildlife to flourish (Stokstad 2020). It is a useful term that is applied here to the general slowdown of the human enterprise.

[8] Including ocean acidification, land use degradation, global toxification, resource wars, threats to human health, land use change, social and environmental injustice, inequity, and a fragile financial system.

better adapt to unstable conditions, although the decisive differences are the acquired, accumulated knowledge of past events and the development of a mature and global scientific establishment that have granted this civilization *Promethean* powers of prescience. Regrettably, so far, such insight has been overtly misused, as the current blueprint to assemble a lasting civilization relies on strategies that erode the bedrock supporting it. It follows that more effective communication of the credible and plausible threat of societal collapse is crucial to displace some of the prevailing complacency and misplaced optimism.

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The Role of Social Capital on Innovation with Environmental Benefits: The European Case

Jorge Cerdeira, Cristina Parente, and Teresa Cunha Alegre

1 Introduction

The new millennium has been marked by a process of profound questioning of the capitalist economic system since the mid-1970s with the first oil crises. The 4th industrial revolution, characterized by virtual space, brought us the liberating greatness of a globalized and borderless life, very promising in terms of economic growth. However, the ambivalent aspects of growth continue to be felt. The first warnings of depletion of environmental resources appeared in 1972 by the United Nations Environment Program (UNEP), which seeks to promote planet sustainability. As stakeholders of the new societal project, companies integrate environmental concerns in the innovation agenda. For instance, in 1996, ISO launched its

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J. Cerdeira (✉) · C. Parente · T. C. Alegre
Institute of Sociology (IS-UP), University of Porto - Via Panorâmica, s/n, 4150-564 Porto, Portugal
e-mail: jcerdeira@letras.up.pt

C. Parente
e-mail: cparente@letras.up.pt

J. Cerdeira · C. Parente · T. C. Alegre
Faculty of Arts and Humanities, University of Porto - Via Panorâmica, s/n, 4150-564 Porto, Portugal

J. Cerdeira
School of Economics and Management, University of Minho - Campus de Gualtar, 4710-057 Braga, Portugal

J. Cerdeira
Centre for Organizational and Social Studies (CEOS.PP), Porto Accounting and Business School, Polytechnic Institute of Porto - Rua Jaime Lopes Amorim, s/n São Mamede de Infesta, 4465-004 Porto, Portugal

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environmental management system standard, ISO 14001, which helps firms and organizations to identify and control their environmental impact. Nowadays, the United Nations considers, in its 2030 Agenda for Sustainable Development, the importance of innovation on employment and growth (Goal 9) and the need for climate action in order to provide a more sustainable planet for future generations (Goal 13). Innovations with environmental benefits are relevant to achieve these goals.

Innovations with environmental impacts were first heard, at European level, in 2014, in a business inquiry instrument that we intend to analyze in this article. This is the most recent and only information made available by EUROSTAT for a scientific approach to innovation with environmental benefits. This article aims to analyze the importance of these innovations relating them to social capital. The main objective is to understand how, in the new paradigm of the networked company, belonging to a social relations network can be decisive for innovation with environmental benefits.

The article is organized as follows: in Sect. 2, the heuristic potential of the concept of social capital is discussed and its relationship with business approaches, namely environmental innovation is demonstrated; in Sect. 3, the data and methodological choices are discussed, as well as the proxies used to assess the influence of social capital on innovation with environmental benefits; in Sect. 4, the main results are presented, distinguishing the role of social capital in the various types of innovation with environmental impact. The article ends with a discussion of the limitations of the study and suggestions for future research.

2 Social Capital and Innovation

2.1 Networked Company and Social Capital: Theoretical Tool for the Analysis of Innovation

The business world has undergone profound changes over the course of different industrial revolutions and their technical–economic paradigms. The networked company and the corresponding cooperation paradigm is one major organizational transformation that justifies the use of the concept of social capital in the business world (Bowey and Easton 2007).

According to Castells (2010), a network (or net) is a "set of interconnected nodes" (p. 501) and the type of node depends on the network, the latter being an open, highly dynamic and innovative structure that is able to expand without limits. However, the author points out that communication in and between networks is only possible if the same codes, such as values or performance forms are used (Castells 2010).

Also referring to the emergence of a new economy as a result of the globalization process, the author points out that the network is "organized around global

networks of capital, management, and information, whose access to technological know-how is at the roots of productivity and competitiveness" (Castells 2010, p. 502). Thus, the work process is increasingly "reintegrated through a multiplicity of interconnected tasks in different sites, ushering in a new division of labor based on the attributes/capacities of each worker" (Castells 2010, p. 502).

Interconnection strategies bring flexibility to the system and the company itself works internally as a network. According to the author, this is the model of the "horizontal corporation" that gains from the decentralization and autonomy of its units, even allowing their internal competition within the scope of a common general strategy (Castells 1996, p. 193). This network transformation of companies takes on different internationalization strategies. The most basic one is investment in the international market and the most advanced one is participation in transnational networks. At the higher internationalization level, companies relate to different markets and exchange information on them, and foreign direct investment gives place to "a set of relationships between companies located in different institutional contexts" (Castells 1996, p. 193). According to Castells, this transnational structure allows small and medium-sized companies to link up to larger companies, forming networks capable of innovating and adapting. The operating units are now the business projects and the information circulates and is processed between companies due to the experience acquired in each field. The challenge of the horizontal company is coordination and flexibility in a context of rapid change.

Taking into account the paradigm of cooperation and coordination of the networked company, we seek to relate the ability of companies to innovate from an environmental point of view to the concept of social capital.

The notion of social capital implies the recognition of the importance of social relations as a mediator of collective achievements.

We will begin by the classic approach to social capital whose forerunner is Coleman (1988). This author sees this form of capital as an available resource to be mobilized by actors in their actions. He identifies three different forms of social capital: obligations and expectations, information channels, and social norms. The analytical reference is that of rational action in which the actor plays with the means and ends, social capital being a part of action resources. Social capital is raised through its function of mediation between subject and structure: it facilitates action taking the environment into account. Coleman considers that relationships of proximity and trust allow objectives to be more effectively achieved by facilitating action and cooperation with a view to mutual benefit. It is the mediation of social capital that explains cooperation between individuals, each one of them trying to reach his/her own private interests. Social capital would be a special type of public good since it is actualized in an intersubjective way and enhances relationships of trust and reciprocity.

Bourdieu (1980) defines social capital as the "actual or potential set of resources related to the ownership of a durable network of more or less institutionalized relations of inter-knowledge and recognition" (p. 2). The social capital that an individual has and mobilizes depends directly on the networks s/he is part of.

Although for Bourdieu (1989) social capital is economic at its root, it is expressed through symbolic power and has an intangible character. Social capital consists of resources derived from the individual's association to social groups. The amount of social capital accessible to a private agent varies according to the extent of his/her social relations network and the capital flow within the group. The gains derived from belonging to a group sustain relationships of reciprocity within it. In this sense, we can see social capital as an important business asset.

For Granovetter (1985), the question is to know how economic behavior and institutions are affected by their involving social relations. Economic behavior is usually considered to be based on social relationships in traditional societies and as autonomous in modern societies. In other words, in the traditional model, the market is ruled by social relations while in the modern model, the market coordinates social relations. Granovetter stands out from these visions and sees the rooting of economic practices as a historical constant that evolves *pari passu* with the dynamics of social relations. The search for well-reputed economic partners in the market shows that it is networks that validate exchanges between social actors. The key point is that trust relationships can reduce uncertainties regarding reciprocal behavior and this favors the construction of stable relationships, which is promising to several business components, namely the one that concerns us here—environmental innovation.

In short, social capital refers to a network of social relationships in which social agents can obtain benefits that would otherwise be inaccessible (Vale et al. 2006).

> As Teramoto and Jurčys (2017) point out in a crucial article, "Accumulation of trust between members of a society (a kind of social capital) significantly contributes to sharing of ideas and enhances cooperation.[...] In designing a trust-based innovation ecosystem, it is first of all important to identify the relevant stakeholders and their main interests. […] Higher level of trust between various stakeholders of ecosystem contributes to sharing, collaboration, dissemination of information and innovation" (Teramoto and Jurčys 2017, p.129).

2.2 Social Capital, Innovation and Environment

We conducted a bibliometric analysis on the relationship between social capital, innovation and environment. It includes, for the time period 2000–2021, (i) 2310 publications containing the terms *social capital* and *innovation* and (ii) 278 publications containing the terms *social capital* and *innovation* and *environment.*[1]

[1] This search at the Web of Knowledge (BETA version, available at https://www.webofscience.com/wos/woscc/basic-search) was carried out in March 2021. It included all types of publication between January 2000 and March 2021 that included these concepts at least in one of all possible fields (title, abstract, keywords, text, etc.). Quotation marks were used before and after each concept to narrow down the number of publications that specifically correspond to the subject.

In the beginning of the 21st Century, the theoretical emphasis was placed on the network theory (Castells 1996). It demonstrated the importance of social capital in business contexts (e.g. MacLeod 2000), namely for fostering innovation (e.g. Senge et al. 2001), creating and developing personal and formal networks, clusters and business communities (e.g. Ashton 2001; Carayannis et al. 2000; Mao et al. 2002), but also for internal skills in terms of human resources (e.g. Yli-Renko et al. 2001; Lee et al. 2001).

More recently, studies regarding *social capital* and *innovation* focus on diverse and current topics such as artificial intelligence (e.g. Tubadji et al. 2021), the sustainable local or regional development of communities, and cooperation (e.g. Salla and Caesar 2021; Schuch et al. 2021), immigration, gender studies (e.g. Fatemi et al. 2021), etc. Nevertheless, some publications began to focus also on environmental matters—be it the implementation of environmental solutions in communities or in the market and industries—and on the importance of social capital for managerial competences (Mehta and Ali 2021), business contexts (Khan et al. 2020), green innovation (e.g. Zhao et al. 2021), or societal future trends (e.g. Kashima et al. 2021).

Considering the concept of *environment*, it is possible to identify the emergence of some publications focusing on the relationship between social capital and environment. They either reflect on the impacts of social capital when environment is considered, or on how social capital (translated into resources or networks) affects environmental innovation (Chen and Luo 2011; Halme and Korpela 2014; Liao 2018).

This analysis led us to consider the interrelation between *social capital* and *innovation*, as well as its interdependence with competitive regions and competitive performances not only at the economic, but also social level (Xi et al. 2017).

It is also possible to understand the growing importance ascribed to climate and environmental actions in business and innovation contexts when considering social capital as a resource. As early as 2001, Senge et al. (2001) suggested that, in the next industrial revolution, an integrated vision of systems—combining social and environmental principles—would be necessary for innovative organizations since it would allow them to reach long-term profitability and financial sustainability. Later on, Liao (2018) analyzed the relationship between social capital (divided into structural, relational and cognitive capitals) and environmental innovation in the manufacturing industry, concluding that the structural and relational social capitals had a positive effect on environmental innovation. Halme and Korpela (2014) suggest that environmentally and socially responsible innovations by small and medium enterprises (SMEs) need a resource combination that "comprises equity, research and development cooperation, networks, industry knowledge and reputation" and that "Environmental technology innovations call for more abundant resource combinations" (p. 547).

3 Data and Methods

The Community Innovation Survey (CIS) is a survey which is part of the European Union [EU] science and technology statistics and includes firm level data on innovation activities by EU members. Surveys are voluntarily implemented in several EU member countries every two years. Given that EU member countries compile the information in CIS on a voluntary basis, each CIS wave may include different countries. In a given year (or wave), companies are questioned about their innovation activities: whether they have introduced an innovation in the period under analysis, the type of innovation, whether they have had access to public funding, among other variables. The CIS also includes variables that provide a general characterization of the company, such as economic sector, turnover and percentage of employees with a tertiary degree (Eurostat 2020a).

In this study, we use the CIS to analyze the impact of social capital on innovation with environmental benefits. We start from the following hypothesis: companies that co-operate with other companies or organizations, regardless of the purpose, build relationships of proximity and trust that benefit them both in terms of information and knowledge sharing, and the challenges they face, responding to these more positively than isolated companies. We consider that these companies are more likely to dedicate themselves to innovations, namely innovations with environmental benefits. These refer to a relatively secondary intervention area for companies (as illustrated in the bibliometric analysis, they are mentioned only in 278 out of a total of 2310 publications). Within the latter, belonging to a social relations network can be decisive for considering this area of innovation, including its importance for businesses bearing in mind the excesses of capitalism over the environment. These are influencing factors that can be associated with what Coleman (1988) calls the closure of a social network as a "self-help system" in which dense groups are more able to mobilize resources among themselves to achieve their goals.

The last available CIS wave corresponds to surveys implemented in 2014 [CIS2014]. In addition to variables regarding innovation in general, CIS2014 also gathers information regarding innovations with environmental benefits. Thus, our database includes information for 2014 from companies of 13 countries: Bulgaria, Cyprus, Czech Republic, Germany, Estonia, Greece, Croatia, Hungary, Lithuania, Latvia, Portugal, Romania and Slovakia.[2] Each company corresponds to one observation, with a total of 26,509 observations.[3] Considering the statistical classification of economic activities in the European Community (NACE Rev. 2), each company is included in one of the following 9 sectors (Eurostat 2020b): manufacturing and other industry; construction; wholesale and retail trade, transportation and storage, accommodation and food level service activities; information and communication; financial and insurance activities; real estate activities; professional, scientific,

[2] CIS2014 also includes data for Spain and Norway, but these countries were dropped out from our study as data regarding innovations with environmental benefits is missing.

[3] See Table 5 in the annex for a list of the number of observations per country.

technical, administration and support service activities; public administration, defense, education, human health and social work activities; other services.

The database gathers information on the companies' innovations with environmental benefits, recording whether the firm has introduced such an innovation and distinguishing it by type—product, process, organizational or marketing innovation—and occurrence—during production (e.g., reduction in material or water use per unit of output; reduction in CO_2 production or pollution; replacement of materials or fossil energy by less polluting substitutes or renewable energy sources; recycling of waste, water, or materials) or during product/ service consumption by the final user (e.g., reduction in energy use or CO_2 'footprint'; reduction in pollution or easement of product recycling after use; extension of product life through longer-lasting, more durable products), as stated in Eurostat (2020a). As such, we consider in our analysis 7 (binary) dependent variables: the introduction of an innovation with environmental benefits (variable *Innovation*); the introduction of an innovation with environmental benefits within the company (variable *Within*); the introduction of an innovation with environmental benefits during the consumption or use of a good or service by the end user (variable *End_user*); the introduction of a product innovation with environmental benefits (variable *Product*); the introduction of a process innovation with environmental benefits (variable *Process*); the introduction of an organizational innovation with environmental benefits (variable *Organizational*); and the introduction of a marketing innovation with environmental benefits (variable *Marketing*).

As for independent variables, we use two alternative proxies to evaluate the role of social capital: company engagement in external knowledge, as the company may acquire other organizations' knowledge and use it as an input to introduce an innovation (variable *Engagement*); whether the company cooperated on any innovation activity with suppliers, clients, or competitors (variable *Cooperation*). Several other variables are considered in our study to characterize the company: whether it is part of a business group (variable *Group*); whether it sold goods/ services in international markets (variable *International*); its size proxied by the company's turnover (variable *Turnover*); the employees' level of education measured by a binary variable for the percentage of employees with a tertiary degree equal to or greater than 25% (variable *Education*); whether it benefitted from any public funding for innovation activities (variable *Funding*). Table 1 describes the variables and presents some descriptive statistics.

The analysis of Table 1 allows us to conclude that 69.2% of the firms in our sample introduced an innovation with environmental benefits during the period under analysis. While 43.3% of them introduced an innovation with environmental benefits within the company, only 30.7% of the companies introduced an innovation with environmental benefits during the consumption or use of a good or service by the end user. Interestingly, the percentage of companies that engaged in process innovation (43.2%) is higher than the corresponding percentage for product (33.8%), organizational (25.7%) or marketing (11.9%) innovations.

As for social capital, 19.9% of the companies acquired knowledge from other organizations for the introduction of an innovation, although a more significant

Table 1 Variables and descriptive statistics

	Variable	Description	Mean	Std. dev	Min	Max
Indicators of innovation with environmental benefits	Innovation	Binary variable equal to 1 if the company introduced an innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.692	0.462	0	1
Dependent variables	Within	Binary variable equal to 1 if the company introduced an innovation with environmental benefits within the company between 2012 and 2014; 0 otherwise	0.433	0.495	0	1
	End user	Binary variable equal to 1 if the company has introduced an innovation with environmental benefits during the consumption or use of a good or service by the end user between 2012 and 2014; 0 otherwise	0.307	0.461	0	1
	Product	Binary variable equal to 1 if the company introduced a product innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.338	0.473	0	1
	Process	Binary variable equal to 1 if the company introduced a process innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.432	0.495	0	1
	Organizational	Binary variable equal to 1 if the company introduced an organizational innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.257	0.437	0	1
	Marketing	Binary variable equal to 1 if the company introduced a marketing innovation with environmental benefits between 2012 and 2014; 0 otherwise	0.119	0.324	0	1

(continued)

Table 1 (continued)

	Variable	Description	Mean	Std. dev	Min	Max
Social capital indicators	Engagement	Binary variable equal to 1 if the company acquired knowledge from other companies or organizations for the introduction of an innovation between 2012 and 2014; zero otherwise	0.199	0.399	0	1
Explanatory variables	Cooperation	Binary variable equal to 1 if the company cooperated on any innovation activity with suppliers, clients or competitors between 2012 and 2014; 0 otherwise	0.935	0.246	0	1
Characterization indicators of companies	Group	Binary variable equal to 1 if the company was part of a business group in 2014; 0 otherwise	0.379	0.485	0	1
Contextual variables	International	Binary variable equal to 1 if the company sold goods and/or services in international markets between 2012 and 2014; 0 otherwise	0.653	0.476	0	1
	Turnover	Natural log of the company total turnover (thousands of euros) for 2014	13.752	4.666	0	23.101
	Education	Binary variable equal to 1 if the percentage of the company's employees with a tertiary degree in 2014 was equal to or greater than 25%; 0 otherwise	0.450	0.498	0	1
	Funding	Binary variable equal to 1 if the company received any public funding for innovation activities between 2012 and 2014; 0 otherwise	0.324	0.468	0	1

share of them (93.5%) cooperated on any innovation activity with suppliers, clients or competitors. The descriptive statistics for control variables suggest that there is some heterogeneity among companies in our sample as 37.9% of them were part of a business group and 65.3% sold their products in foreign markets. There is also some variability in company turnover, showing that the database includes companies with different sizes. Table 1 also reveals that 45% of the companies in the sample had a percentage of employees with a tertiary degree equal to or greater than 25 and that 32.4% of them received public funding for innovation activities.

We want to analyze the role of social capital on innovations with environmental benefits. Given the available data and the variables put forward, we resort to a regression analysis taking into account the nature of the data, i.e., the fact that we have survey data. As all dependent variables are binary, assuming only the values of zero and one, we rule out the possibility of adopting Ordinary Least Squares [OLS] as an estimation method, given that the latter assumes that the dependent variable is continuous and not truncated or restricted to a given set of values (Gujarati and Porter 2008). Instead, we use the probit model for survey data (see, e.g., Wooldridge 2010), which explicitly assumes survey data and that the dependent variable is binary. The probit model assumes that since the dependent variable can be equal to one or zero, the probability of it being equal to one depends on a function of the independent variables as follows:

$$Probability(Y_i = 1) = F(\alpha + \beta X_i),$$

where Y_i is the dependent variable of the model (each one of the 7 dependent variables in Table 1), X_i is the vector of independent and control variables included in the model (see Table 1), α is the constant coefficient of the model, β the vector of coefficients associated to each independent and control variable, and $F(.)$ is the cumulative distribution function for the normal distribution. We estimate separate regressions for each one of the 7 dependent variables presented in Table 1 and include in all regressions sector and country fixed effects, as well as robust standard errors for heteroskedasticity.

4 Results and Discussion

With data from 26,509 companies of 13 European countries in 2014, we estimate the probit model separately for each dependent variable presented in the previous section. As we consider two alternative proxies for social capital—variables Engagement and Cooperation—we present results using each proxy in order to check the robustness of the results.

Table 2 displays our estimates using Engagement as a proxy for social capital. Our outcomes show that social capital has a positive impact on innovations with environmental benefits as the associated coefficient is positive and statistically significant at the usual significance levels. It is worth mentioning that this result holds regardless of the type of innovation considered in the analysis—product, process, organizational or marketing innovation—or its occurrence—within the company or during consumption by the end user.

We also found that belonging to a business group has a positive impact on innovations with environmental benefits within the company—though there is no significant effect on the other dependent variables—which may be related to intra-group knowledge that flows from one company to another, as well as to

Table 2 Estimation results with Engagement

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Engagement	0.196*** (0.071)	0.365*** (0.047)	0.376*** (0.045)	0.346*** (0.060)	0.233*** (0.059)	0.323*** (0.061)	0.327*** (0.072)
Group	0.062 (0.065)	0.097** (0.044)	0.060 (0.044)	0.077 (0.060)	0.024 (0.060)	–0.002 (0.061)	-0.005 (0.075)
International	–0.060 (0.069)	–0.030 (0.043)	0.026 (0.044)	0.061 (0.064)	–0.054 (0.061)	0.029 (0.066)	-0.034 (0.077)
Turnover	0.058*** (0.019)	0.054*** (0.013)	0.032** (0.013)	–0.005 (0.017)	0.089*** (0.016)	0.066*** (0.016)	-0.007 (0.025)
Education	0.165** (0.079)	0.007 (0.048)	0.039 (0.048)	0.253*** (0.068)	–0.051 (0.065)	0.034 (0.068)	0.073 (0.078)
Funding	0.187*** (0.058)	0.255*** (0.038)	0.155*** (0.037)	0.150*** (0.051)	0.182*** (0.050)	0.085 (0.054)	0.000 (0.062)
Constant	–0.167 (0.303)	–1.438*** (0.180)	–1.422*** (0.178)	–0.066 (0.245)	–1.128*** (0.231)	–1.494*** (0.234)	-0.969*** (0.362)
Observations	8900	17,640	17,622	9997	9999	10,000	9,998

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

pressure or guidelines from the group that create an incentive for innovation (Dunning and Lundan 2008).

Interestingly, selling in international markets has no statistical effect on innovation when compared to companies operating only in the domestic market. This result may be due to market globalization since companies have both domestic and foreign competitors and, therefore, even those selling their products exclusively in national markets are motivated to innovate in order to survive in the long run. In fact, globalization allows for technology diffusion around the globe and fosters innovation in domestic companies (Feng et al. 2019).

As expected, company size (proxied by variable Turnover) has a positive effect on innovation (the exceptions being product and marketing innovations). Larger companies have more human and financial resources that can be channeled to innovation activities, bear higher sunk costs of innovation, and benefit from economies of scale and scope in innovation development (Symeonidis 1996).

Regarding Education, our findings suggest that companies with educated employees are more capable of developing product innovations with environmental benefits, which is in line with research on the link between human capital and company innovation (e.g., Organisation for Economic Co-operation and Development [OECD] 2011). However, there is no significant influence of Education on process, organizational or marketing innovations. While this is somewhat surprising, the dataset does not include additional information to examine this relationship in detail.

As for public funding, Table 2 reveals its positive and statistically significant effect on innovation with environmental benefits (except for organizational and marketing innovations). Public funding may have an additional effect on private investment—allowing companies to get hold of financial resources required by innovation—and stimulates private research and development expenditures, boosting innovation outcomes (Ebersberger 2005; Bai et al. 2019).

Table 3 presents our findings using Cooperation as a proxy for social capital, which corroborates the results presented above for variable Engagement: social capital has a positive and statistically significant influence on innovations with environmental benefits no matter the type of innovation considered (product, process, organizational or marketing innovation) or its occurrence (within the company or during product consumption by the end user). Comparing the estimates displayed in Tables 2 and 3, which consider different proxies for social capital, there is evidence of the positive role of social capital on innovation with environmental benefits.

As for the other variables, conclusions are similar to those drawn from the inclusion of variable Engagement: all variables that were significant in each regression in Table 2 remain significant except for Funding, which no longer has a significant impact on variables Innovation and End user.

Since we estimated parameters of non-linear regressions, estimates in Tables 2 and 3 allow us to analyze the significance—and to distinguish the positive or negative effect—of each variable, but not its marginal effect, i.e., the variation of the conditional mean of the dependent variable due to a unitary change in the independent variable. Thus, we present, in Table 4, the marginal effects for both proxies of social capital, variables Engagement and Cooperation.

Table 3 Estimation results with Cooperation

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Cooperation	0.282** (0.140)	0.342*** (0.121)	0.260** (0.117)	0.214* (0.115)	0.336*** (0.129)	0.254** (0.126)	0.470*** (0.177)
Group	–0.024 (0.111)	0.144* (0.078)	–0.039 (0.074)	0.103 (0.096)	–0.003 (0.101)	–0.017 (0.090)	0.069 (0.104)
International	–0.167 (0.115)	–0.038 (0.083)	0.071 (0.082)	0.092 (0.104)	–0.079 (0.105)	0.022 (0.102)	0.013 (0.114)
Turnover	0.054* (0.028)	0.059** (0.026)	0.048** (0.025)	–0.015 (0.027)	0.083*** (0.027)	0.082*** (0.022)	-0.038 (0.042)
Education	0.302** (0.122)	0.049 (0.085)	0.131 (0.081)	0.270*** (0.102)	–0.042 (0.105)	0.005 (0.100)	0.115 (0.114)
Funding	0.038 (0.086)	0.146** (0.066)	0.092 (0.063)	0.140* (0.075)	0.134* (0.078)	0.107 (0.080)	0.052 (0.090)
Constant	–0.098 (0.484)	–1.342*** (0.387)	–1.458*** (0.372)	0.092 (0.425)	–1.079*** (0.416)	–1.873*** (0.372)	-0.904 (0.662)
Observations	5465	8027	8017	5811	5811	5811	5,771

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

Table 4 Marginal effects for Engagement and Cooperation

	Innovation	Within	End user	Product	Process	Organizational	Marketing
Engagement	0.065*** (0.023)	0.134*** (0.017)	0.135*** (0.016)	0.118*** (0.020)	0.089*** (0.022)	0.093*** (0.017)	0.060*** (0.013)
Cooperation	0.072** (0.036)	0.121*** (0.043)	0.098** (0.044)	0.075* (0.040)	0.124*** (0.047)	0.074** (0.037)	0.100*** (0.038)

Notes *** (**) [*] statistically significant at 1% (5%) [10%]. Robust standard errors in parentheses

According to the computed marginal effects, social capital increases the probability of a company introducing an innovation with environmental benefits by approximately 7 percentage points (pp), as Table 4 reports an impact of 6.5 pp if we consider the Engagement proxy and 7.2 pp using the Cooperation proxy. As for the other innovation variables, the effect of social capital is somewhat different for both proxies: social capital increments the probability of the company developing an innovation with environmental benefits internally by around 13 pp (12 pp with variable Cooperation) and during consumption or use of a product by the end user by almost 14 pp (10 pp with variable Cooperation).

While the probability of developing a product innovation is boosted by around 12 pp (8 pp with variable Cooperation), social capital expands the corresponding value for process innovation by 9 pp (12 pp with variable Cooperation). Also, social capital raises the probability of generating an organizational innovation by about 9 pp (7 pp with variable Cooperation) with a corresponding value for marketing innovation around 6 pp (10 pp with variable Cooperation).

Thus, this discussion allows us to affirm that social capital has a positive and significant impact on innovations with environmental benefits, boosting the probability of introducing such innovations by between 6 and 14 pp depending on innovation type and occurrence, as well as the proxy for social capital under consideration.

5 Conclusion

In this paper, we used the concept of social capital to analyze its relevance in promoting innovations with environmental benefits. We use data from the European Community Innovation Survey of 13 European countries for 2014 and resort to two alternative proxies of social capital to explore its role on innovations with environmental benefits. Our results suggest that social capital—measured by variables Engagement and Cooperation—has a significant and positive influence on innovations with environmental benefits, boosting the probability of introducing these innovations by between 6 and 14 pp regardless of innovation type (product, process, organizational or marketing) and occurrence (within the company or during the consumption or use of the product by the end user).

This positive relationship between social capital and innovations with environmental benefits may be particularly relevant nowadays, given that the former may be a way to boost the latter. This is crucial to meet the UN 2030 Agenda for Sustainable Development, as it underlines the importance of innovation on employment and growth (Goal 9) and the need for climate action in order to ensure a sustainable future for the next generations and the planet (Goal 13).

Since the literature on social capital and environment is relatively new and only a small number of studies has considered this issue, this article contributes to the analysis of the European case. However, it has some limitations. Our database only includes 13 European countries, leaving aside relevant nations such as France or

Italy, among others; on the other hand, we only have information for one year (2014) and include two proxies for social capital in our analysis.

For future research, it would be interesting to have richer data on a larger set of countries and periods of time, allowing for comparisons among regions and across time. The inclusion of more variables to proxy social capital would further consolidate the study.

Annex

See Table 5.

Table 5 Number of observations per country

Country code	Country name	Observations	Percentage
BG	Bulgaria	3725	14.05
CY	Cyprus	1346	5.08
CZ	Czech Republic	2364	8.92
DE	Germany	4818	18.17
EE	Estonia	1627	6.14
EL	Greece	1456	5.49
HR	Croatia	1332	5.02
HU	Hungary	2012	7.59
LT	Lithuania	1297	4.89
LV	Latvia	505	1.91
PT	Portugal	4167	15.72
RO	Romania	1114	4.20
SK	Slovakia	746	2.81

Note Total number of observations in the dataset = 26,509

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Bringing Meaning Back to Our Lives: Well-Being and Healthy Individuals in Sustainable Organizations

Carla Fonte and Cristina Pimentão

1 Introduction

The 193 Member States of the United Nations (UN) in 2015 embraced the 2030 Agenda for Sustainable Development and its Sustainable Development Goals (SDGs). This agenda introduces a global call for engagement to, care for the planet, to end poverty and ensure that all citizens benefit from peace and prosperity. It was defined 17 SDGs and 169 targets that are interconnected and universal across three dimensions: social, environmental, and economic. Health is a major result, of sustainable development (Sweileh 2020).Concretely, the SDG 3 is devoted to health and well-being for all at all ages, and is organized in 13 targets that includes several goals, for instance: zero hunger and poverty, clean water and sanitation, affordable and clean energy, gender equality and quality in education, reduction of inequalities, decent work and economic growth, industry, innovation and infrastructure; sustainable cities, communities, production and consumption; climate action, life below water and on land, peace and governance (United Nations 2015; Menne et al. 2020).

In this chapter we defend that health and well-being are both requirements and results of sustainable development, because without 'good health and well-being for all', achieving the SDGs will be very difficult. Methodologically this examination is expanded in according to the literature that focuses this topic, but also on the basis of a larger research project where we are collecting empirical data on life meaning, mental health and work. Also, at the same time, health and well-being are dependent on the accomplishment of other SDGs. These goals highlight the significance of growing opportunities for development of individuals, families, and communities to guarantee sustainable development and global progress. This is especially true

C. Fonte (✉) · C. Pimentão
University Fernando Pessoa, Praça 9 de abril, 349, 4249-009 Porto, Portugal
e-mail: cfonte@ufp.edu.pt

C. Pimentão
e-mail: pimentao@ufp.edu.pt

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also for organizations. In summary we consider that sustainability can be analyzed not only in terms of social and ecological environment, but also in terms of fostering well-being of individuals and organizations.

2 Health and Well-Being as Sustainable and Development Goals

2.1 Health and Well-Being Definition

The World Health Organization (WHO) defines health as 'a state of complete physical, mental and social well-being and not merely the absence of disease or disease' (WHO 2008). In scientific literature we can find several definitions and perspectives on what we are talking about when well-being is analyzed. A robust body of theoretical-empirical knowledge states that well-being includes the existence of positive emotions (e.g., joy, happiness), the lack of negative emotions (e.g., anxiety, depression), but also, satisfaction with life, fulfillment, and positive functioning (Diener 2000).

Scientists from various fields have study different aspects of well-being in terms of physical, social, economic, emotional, and psychological well-being (Larsen et al. 2008). The Centers for Disease Control and Prevention (CDC 2013) considers that well-being is a positive result that is significant for individuals and groups, in different domains of humanity. Numerous studies have demonstrated that there are several determinants of well-being. For instance, the access to basic needs, for example a shelter, food, and income, but also good health and positive social relationships are important predictors of person's well-being (CDC 2013). Specifically, one of the most central determinants for well-being is to experience that we have supportive relationships. Moreover, results from different studies find that well-being is linked with healthy behaviors; self-perceived health; longevity; decreased risk of disease and better immune functioning (Diener and Seligman, 2004; Frederickson and Levenson 1998; Lyubomirsky et al. 2005).

The relationship between work and well-being is complex but in general, associations between income and well-being are stronger for those at lower or higher economic levels (Argyle 2003). But, in generally, people with high levels of well-being are more productive at work and are more likely to contribute to their communities (Pressman and Cohen 2005). Literature indicates that, for one hand, work is important to individual's well-being because it allows access to resources, fostering meaning, purpose and satisfaction. On other hand, unemployment is negatively related to well-being (Warr 2003).

Several literatures have argued that organizations need to look on workers well-being, people's talents to realize high performance. This movement emphasizes the value of a positive work environment in promoting employee health, well-being, and performance (Di Fabio 2017b). Focusing on the well-being

promotion, sustainable development can be seen therefore as a new approach for organizations and all the society. We discuss this idea in the next section.

2.2 *Health and Well-Being as Preconditions and Outcomes of Sustainable Development*

To guarantee healthy lives and promote well-being for all people is one of the purposes presented on the SDGs, concretely number 3, regarding the association between health, well-being and sustainable development. In accordance to Nunes et al. (2016) sustainable development refers to the orientation of institutional, financial and technological investments in a way that resources used do not compromise the health and well-being of future generations (Buse and Hawkes 2015). As health is widely determined by environmental, economic and social conditions, is also connected with other domains as education, poverty, gender equality being thus vital for sustainable development (Nunes et al. 2016).

The 2030 Agenda for Sustainable Development defends that a global and incorporated approach is needed, integrating the goal of better health and well-being for all. In this agenda one of the principles asserts that 'human beings are at the center of concerns for sustainable development. They are entitled to a healthy and productive life in harmony with nature', highlighting the association that we need to achieve between health and sustainable development (Menne et al. 2020), so that health and well-being become central to sustainable development as discussed. In this context the United Nations, have clearly focused at the relationship among health and sustainable development including the idea that health can be a provider, a beneficiary and a focus to calculate success in accomplishing sustainable development (United Nations 2015).

Strengthening the resources of individuals is vital to global development. For example, Di Fabio (2017a) argues that the sustainability of a project from a psychological perspective includes vertical and horizontal axes of analysis. The vertical axis refers to the question "where I come from" proves consciousness of "where I am," and continues to "where I will go." The horizontal axis refers to the change from a narcissistic, self-centered position to a new unselfish attitude centered on the promotion of shared flourish, namely gain for others and gain for the self. Emerging perception of this fact is especially helpful in relation to the person but also in relation to the groups and the organizations. This new consciousness is really important, so that we can find a balance between "me," "we," "organization," "people," and "the world", for the twenty-first century organizations (Di Fabio 2017a).

So, we defend that sustainable development can nurture well-being in organizations at individual and group levels. This involves designing and constructing development and well-being in organizational contexts in everyday life. In the next point we present healthy organizations, culture, climate, and good practices that

produce an atmosphere that can encourage worker health as well as organizational effectiveness, emphasizing the solid relation among organizational practices and workers' well-being.

3 Sustainable Organizations for Well-Being and Healthy Individuals

3.1 Psychological Insalubrity in Organizations and Its Antidote

Despite the changes introduced in people management practices in organizations over time resulting from the expansion of knowledge about, for example, satisfaction and leadership we continue to observe in many demotivation, low productivity and turnover. As we are dealing today with what some call a VUCA world characterized by volatility, uncertainty, complexity, and ambiguity the organizational dynamic and the well-being of people can be even more stressed and damage and so in need of a more close and deep approach and understanding. In the article 'Creating authentizotic organizations: Well-functioning individuals in vibrant companies', Kets de Vries (2001) states: "Moving into the twenty-first century, it becomes the challenge of organizational leadership to create corporations that possess these authentizotic qualities. Working in such organizations will be an antidote to stress, provide a healthier existence, increase the imagination, and contribute to a more fulfilling life. These will be the kinds of organizations that help their employees maintain an effective balance between personal and organizational life. These are the organizations we need to hope for. To quote an Arab proverb, 'he who has health has hope, and he who has hope has everything!'" (p. 110).

We consider that in other for an organization to be sustainable it is necessary to actively contribute, daily, to the well-being and health of its employees. In healthy organizations, is created an internal environment that leads to employee health and safety and organizational effectiveness (Di Fabio 2017b). And a healthy organization conducts to a successful business (De Smet et al. 2007; Grawitch and Ballard 2016), showing this clear link between organizational relevant outcomes and workers' well-being. Many variables can contribute to psychological insalubrity or unhealthiness like dysfunctional leadership whether in its direct exercise through, for example, impoverished communication or even the absence of communication with employees, or indirectly, for example, through people management practices that do not promote equity and justice and/or the development of employees. To combat this scenario of psychological unhealthiness, Kets de Vries (2001) proposes as an antidotethe creation of authentizotic organizations. The term authentizotic-traduces a neologism resulting from two Greek words: authenteekos, defines the organization is authentic, it is worthy of trust; and zoteekos, the organization is vital for people, providing meaning to their lives. And this issue of proving meaning is

fundamental since we spend a significant amount time of our life in preparation and updating for work and working. With the increase in average life expectancy, we will need to work for a longer period until we retire. In Portugal, for example, the retirement age is currently 66 years and 6 months. And work, if carried out in a climate of psychological healthiness, provides us with a set of extremely valuable counterparts. Effectively, work has several psychological and sociological functions in our life (Salanova et al. 1996) and, in this sense, it is essential that the experience of doing it is pleasant and enriching for employees and produce relevant outcomes for organizations. The authors present a set of functions that work plays and one of them, crucial in our understanding, is the integrative or meaningful function that work provides to the extent that it allows people to fulfil themselves personally through it. According to the authors, work can be a source of self-esteem and personal fulfilment. Through work people can fulfil themselves, give purpose to their life and be creative. Work naturally fulfils this function when it is intrinsically satisfying.

A series of investigations have been conducted to analyze the extent to which authentizotic features of companies explain the attitudes and behaviors of employees (Rego et al. 2003; Rego and Souto 2004). One of these investigations (Rego et al. 2003) aimed to analyse the degree to which the respondent's organization presented the 6 authentizotic characteristics, that are: leaders' credibility and trustworthy; open and honest communication with the superior; development and learning opportunities; equity and justice; work-family balance; and camaraderie spirit. At the same time, it was intended to analyze the impact that those variables had on the degree to which the employee intended or not to leave the organization and the commitment he had with his organization. This variable reflects the psychological bond that characterizes the employee's connection to the organization and reduces the likelihood that he will abandon it. The results found allow us to verify that people who feel that they work in authentizotic organizations manifest less intention to leave the organization and develop stronger emotional ties with them (Rego et al. 2003). In this virtuous scenario, they tend to develop higher levels of performance that contribute more clearly to the success of organizations.

Faced with this challenge of creating organizations with authentic characteristics, leaders need renewed skills. But also, to improve skills that they may have, but are not using in the work context due to the tendency to follow the classic and conservative modus operandi in the way, for example, how to solve problems and how to manage people in the work context.

3.2 Creative Leadership to Promote Well-Being

Leadership is an individual's ability to influence, motivate and enable others to contribute to the effectiveness and success of the organizations (House et al. 2002). According to Ketz de Vries (2004), one of the challenges for twenty-first century leadership is to create authentizotic organizations where it is recognized that

employees' minds are like a parachute that only work when they open. One of the causes that we pointed out previously that contributes to psychological unhealthiness in organizations is the existence of dysfunctional leadership. For leaders to fulfil their mission, they need to possess and develop various skills. One of these skills is creative thinking that is so often negated by the tendency to perform tasks "by the book(s)". Richard Denny (cited in Almeida 1996) when studying leadership failure, identified several factors that influence it. Among these factors is the absence of creative thinking. According to the author, the failure of many leaders results from the fact that they are not very creative, but also because they do not accept, often, the creativity of their employees, often due to selfish motivations or disbelief in the skills of their employees. It is important that the leader realizes that his value and importance as such is operationalized by the quality of his team's performance and not necessarily by the quality of his ideas. Naturally, that to have well-trained and competent leaders, we need them to be well-trained from an ethical and human point of view before they even enter the work context and face the challenge of managing others.

Tsai (2012), when analyzing the literature on creative leadership, notes that leaders play a key role in facilitating creativity in individuals and groups, in organizational settings, with relevance in dealing with turbulence and with rapidly changing environments (VUCA context). A central value in creative leadership is giving others permission to be creative. In this way, we are empowering people to develop and show their creativity and to trust their abilities. Leaders need a set of complex creative thinking skills to solve problems and to interact with their followers to stimulate their creativity. Cunha et al. (2007) suggest, for the promotion of the virtues of leadership, that leaders create "conditions so that their collaborators can put their imagination, creativity and their own gifts at the service of the organization" (p. 470). In the research carried out by Bagulho (2014), which aimed to understand how the leader can enhance the creativity of his team members, the results found suggested that emotional leadership, centered on autonomy, on the apprehended support of the leader and in the sense, potency intrinsic motivation and creativity.

But what is creativity and how can we define it? In the research carried out by Bagulho (2014), the author identifies the definition given by Lubart (2003, cited in Bagulho 2014, p. 27) that defines creativity as "the ability to carry out a production that is at the same time new and adapted to the context in which it manifests itself". In this way, the creative act implies work and intentionality, which translates into "the development of a new product, idea or solution to a problem". Creativity is like a "kaleidoscop thinking" in which reality is just a temporary arrangement and the whole creative act is a way of playing with ideas (Kanter 1986 cited in Tsai 2012). In other to promote the leader's creativity for an authentic leadership, traduced in more healthy employees and companies, we think it is necessary to bring meaning to the equation. We subscribe Di Fabio (2017a) perspective that a new consciousness is mandatory in organizational settings to promote healthy atmospheres and that this intention calls for acknowledging the importance of relationships and meaning. Di Fabio and Peiró (2018) formed a new combined structure of human

capital sustainability leadership and this leadership style aims to achieve higher integration of the four dimensions of leadership, including servant, mindful, sustainable, and ethical leadership.

4 Creating Healthy Individuals and Organizations in the 21 Century: The Meaning Paradigm

Interestingly the meaning of 'purpose', and its psychological operationalization, has been gaining attention by researchers, but also by individuals and organizations. For those who were born, for example, in the 70s of the 20th Century possibly still register the recommendations of their grandparents and their parents regarding the need to find a job for life and assuring security. In the Era of classical industrialization, the idea of the 'homo economicus' prevailed, so the individual was mainly motivated by extrinsic material reinforcement. Perhaps for many workers and most likely for many companies, the idea of the work providing intrinsic realization or being connected with something greater than its instrumental outcomes was of non-major relevance. We strongly believe that in the first decades of the twentieth century we already had companies with a different vision, as has always happened throughout History. In other words, it is mandatory to be aware of the status quo of the moment in History that is happing. Still in that Era, the experiments carried out at the Western Electric Company, in Hawthorne, in the 20s and 30s of the 20th Century, on the effect of lighting on the productivity of workers and those that followed, revealed that the workers are also motivated by psychological and social reinforcement. At that time, workers as today (if they are not experimenting a kind of learned organizational dismay) react favorably to the attention, concern that is given to them. At the Western Electric, workers productivity increased when lighting increased or decreased and in the control group where no changes on the lighting were made.

Today in the twenty-first century, year 2021, experiencing fulfilment at work is for many of us beyond the realization of the financial need, the working conditions, and the status of the job. All these environmental factors are important and even more, probably, in the context of the pandemic crisis that we have been experiencing since the beginning of 2020. However, some workers are also driven by the need to carry out meaningful work, in line with a broader life purpose. So, in addition to the company having the goal of creating relevant outcomes for the company owner or stakeholders, it is equally important that these goals also include a genuine purpose that touches employees, that mobilizes them for action, for the fulfilment of the company's mission and vision. In a study conducted by Lysova et al. (2019) points that to enable individuals to construct their sense of meaningful work, organizations should construct and dynamize a work environment characterized by: quality jobs; facilitative leaders and high-quality relationships, and access to decent work. It seems that we are discovering something innovative and

cutting edge, but this fact is a kind of Holy Grail of people management that has always been available and that should have been included in organizational dynamics a long time ago. As the cycles of History seem, at times, to repeat themselves, today as we did 100 years ago, we are plunged into a depression from which to get out and empower ourselves it is necessary to bet on individual, collective and organizational development of awareness.

The existence of a purpose not only impacts favorably on individuals, in their life outside the context of work, but the existence of a purpose mobilizes people in organizations. In (2016) LinkedIn and consulting firm Imperative conducted a study of 26,151 LinkedIn members about the impact of purpose on organizations. On the report made after, Reid Hoffman, Executive Chairman, and co-founder LinkedIn states: "Companies that understand the increasing emphasis of purpose in today's professional landscape improve their ability to attract such employees and also their ability to retain them for longer periods of time." (2016). In this report, the authors refer to the purpose as the process of "finding work that matters to each person and connecting those people to companies where they can drive meaningful impact." (p. 4).

We believe that purpose can be sought and found in various contexts and life events. The work context can provide the discovery of a life purpose or its redesign; but a particular work and/or its context of performance can be chosen so that it is aligned with a previously defined or designed life purpose. Some interesting results highlight on the report: 37% of LinkedIn members globally are purpose oriented (persons who understand work as individual fulfillment and helping other persons); the 5 most purpose-oriented countries are Sweden (53%); Germany (50%); Netherlands (50%); Belgium (49%); and Poland (48%); the U.S. workforce showed up near the middle of the pack (40%), just over the global average (37%). The authors suggest that leaders can nurture the perception of purpose in workers, allowing more productive, satisfaction and more realized workers that likely to stay longer on the organization. We believe that if people are increasing and fostering their awareness and renovated search for meaning or they have already found a meaning, they will increasingly look for jobs that give them personal fulfilment. It also appears that a few businesses are seeing that purpose-oriented workers are more productive and successful. That can happen since they have aligned the work territory with their life outside work. Naturally, those who can influence and manage talent have a relevant roll in this process.

In this approach, the meaningfulness of the project (at organizational and individual level) plays a vital role in its real sustainability. Individual and organizational projects are more sustainable if they are categorized by belonging, coherence and significance. In this point we propose, as Di Fabio (2017a) states "the passage from the motivational paradigm to the meaning paradigm". The motivational paradigm refers to intrinsic and extrinsic motivation, that highlights aspects like doing a job to increase satisfaction and get recompense or keep away from negative consequences. The meaning paradigm focus on how individuals can find meaningful lives and work experiences during challenging moments. The sustainability of a life-work project needs to be anchored to a meaningful construction that increases the chances

of well-being and success (Di Fabio 2017b). Research shows that people who say their work is meaningful report better well-being and psychological adjustment, greater job satisfaction and work unit cohesion and at the same time hold potentials that are necessary to organizations (Steger et al. 2012). Work represents a significant position in people's health and the effect of perceptions that work is meaningful on work-related variables and wellbeing is an area of increasing importance to researchers, leaders and organizations. Although some authors have claimed that developing meaning from life experiences is crucial for health and well-being further investigation of these construct is warranted for drawing attention to the specific sources of meaning people identify in their lives. Research on well-being has considers how events in life areas performing impact on well-being (Steger and Dik 2009). One outgrowth of this research has been the acknowledgment that the work area is extremely important to how individuals produce conclusions about well-being in their lives (Deci et al. 2001).

Regarding sustainable life-work projects we need management practices that acknowledge and recognize the value of relations in organizational contexts for the workers' well-being. A new organizational awareness is necessary to stimulate and guarantee sustainable development in "liquid" organizations in uncertain and ever-changing conditions. A managerial approach and new styles of leadership that display consciousness of the constructing positive narratives in organizational contexts is the key to activating energy, managing challenges that achieves sustainable development and the well-being of individuals in organizations.

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Carla Fonte is an assistant professor at Fernando Pessoa University, Porto, Portugal. Has a PhD and a degree in Psychology from Minho University, a master's degree from Porto University. Her main research interests are positive mental health in clinical and non-clinical populations, well-being, happiness and optimal experience (flow) studied in different life contexts through the lens of Positive Psychology. She is also a licensed Psychologist, specialist in Clinical and Health Psychology and Psychotherapy.

Cristina Pimentão has been an assistant professor at Fernando Pessoa University, Porto, Portugal, since 2001. Has a PhD in Psychology from University of A Coruña and a master and graduate degrees in Psychology from University of Porto. She is a licensed psychologist, specialist in Work and Organizational Psychology and also coach certified by I Have The Power—Solfut, Consultoria e Formação, Lda. Her field of work is within the scope of Work and Organizational Psychology and coaching. Her main research interests are life and executive coaching and the relationship between life purpose and work.

Preparing the Future: The Transformation of Public Administration for the Anthropocene Era

Ricardo Cunha Dias and Paulo Castro Seixas

1 Introduction

The environmental crisis has been described as the greatest challenge of our time, changing our conception of the world (Beck 2016). This change was well evidenced with the proposal of the Anthropocene (Crutzen and Stoermer 2000): a new era of human influence on the environment on a planetary scale. Such influence poses a broad and complex set of governance problems at a global level (Seixas 2014). Our future depends on the ability of a dialogue between decision-making and science as to integrate human and Earth system histories (Trischler 2016). Nonetheless, preparing the future in Anthropocene era poses a difficult task for national governance systems to transform their institutions to cooperate globally (Franchini et al. 2017). These difficulties have been visible in efforts to achieve the Sustainable Development Goals (SDGs) embodied in the United Nations 2030 Agenda (United Nations 2015). The implementation of this agenda has shown that the lack of network cooperation between different actors and interorganizacional entities at different levels of government is an obstacle to the integration of cross-cutting issues such as environmental sustainability (Kapucu and Beaude 2020).

The integration of a cross-cutting issue is generally understood "as a strategy to make a problem an integral dimension of the design, implementation, monitoring and evaluation of the organization of development policies and programs" (Organisation for Economic Co-operation and Development [OECD] 2014, p. 7). This definition makes clear the importance of the Public Administration (PA), being the main instrument of states for the implementation of public policies (Molenveld

R. C. Dias (✉) · P. C. Seixas
Administration and Public Policy Center (CAPP), Institute of Social and Political Sciences (ISCSP), University of Lisboa, Campus Universitário do Alto da Ajuda, Rua Almerindo Lessa, 1300-663 Lisboa, Portugal
e-mail: rdias@iscsp.ulisboa.pt

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et al. 2020). Aspiring for greater integration, PA has sought to reform its traditional forms of action, organized hierarchically and by silos, to new governance practices: more horizontal and networked (Marques and Ferraz 2015). However, PA are still predominantly bureaucratic organizations that operate in an environment of great institutional fragmentation shaped by the clash between new management and governance models and administrative traditions (Biesbroek et al. 2018). Hence, changes to an integrated governance paradigm in the PA remain largely to be done.

This text proposes that there is a tension within the simultaneously disciplinary and applied character of the PA field that have constrained such changes. At the heart of this tension is the old dichotomy between the Political and the Administrative spheres (Wilson 1887), founder of this field. This dichotomy defends the separation between the political sphere of decision-making and the administrative sphere, restricted to its rational and technical operationalization. To overcome this dichotomy is fundamental to prepare the future in the Anthropocene era. It is the dialogue between the Political and Administrative spheres that allows integrating cross-cutting issues, translating global commitments at the level of practices. Nevertheless, PA theory has struggled with its own theoretical and epistemological traditions. Meanwhile, PA practices face the need to plan the change in their organizations and overcome the constraints posed by their political-administrative traditions. This process is being mediated by the use of what we propose in this text as "concepts of future": normative and, therefore, inherently political concepts that seek to create desired futures (utopias), scientifically supported, as opposed to unwanted futures (dystopias).

The purpose of this text is to reflect on the use of these concepts in the transformations to be carried out in the PA to respond to the Anthropocene era. The objective is to discuss the commutative transfer processes between theoretical and applied knowledges (scientific, political and practical) in the PA and its influence on the institutional change associated with governance learning. For this purpose, the first section of the article contextualizes the notion of change in the framework of the evolution of PA models. In a second section, the inadequacies of positivist theories and administrative methodologies that underlie and block changes in PA values and practices are detailed. In a final section, an alternative interpretative epistemology is proposed, assuming Communities of Practice and the use of Learning Cases as forms of governance of learning and facilitators of transformation in PA.

2 Models and Dynamics of Change in the Public Administration

Sustainability governance has already been defended as the conceptual focus for change in the PA field in the coming decades (Fiorino 2010). Change is a recent topic in the PA field, appearing mainly associated with the various "reform"

movements that have been taking place in recent decades (Temizel 2015). In the literature on the subject, it is common to distinguish between "planned change" and "emergent change" (Kuipers et al. 2014). The first is generally associated with more radical reforms from Traditional Administration to New Public Management (NPM); and the second with the upward adoption of New Public Governance values and practices. Discussing the transformation of PA implies knowing how each of these models envisaged change management and the planning of the future, as well as the relationship between the Political and Administrative spheres in sustainability governance.

The PA field emerged at the end of the 19th century from the recognition that an applied science was needed to control the discretion of political power. It was in this context that Wilson (1887) proposed the famous "political-administration dichotomy", initiating a long discussion on the best way to protect public service from its inherent instrumental dependence on the political power. In this dichotomy, the role of the Politician must be restricted to the definition of the objectives of the policies and that of the Administrative as executor of those same policies. As an applied scientific field (which was mainly supported by economics and law), it was therefore up to the science of administration to create a conceptual and methodological universe that would guarantee the PA political neutrality and objectivity.

These objectives were at the basis of the organization model of the so-called Traditional Administration that was affirmed throughout the 20th century. In this model, the first theories in the field, such as the Scientific Administration of F. Taylor, the Bureaucratic Theory of M. Weber and the Classical Theory of Administration of H. Fayol, focused essentially on rational action shaped by the departmentalized organizational structure and the vision of *homo economicus*. By aiming at the pursuit of maximum efficiency, these theories did not question the social role of PA in planning the future, assuming PA from a technical and procedural perspective as separated from decision-making. This separation is contextualized in a broader debate headed by Weber (1979 [1919]) who attributed to science the role of knowledge production, by its exemption from ideological values; and to politics, the decision to apply it.

However, in the second half of the 20th century, the bureaucratic model of Traditional Administration failed to respond to the new social realities and citizens demands (Temizel 2015). Such a gap has become clearer, especially with the intensification of globalization and its consequences since the 1980s. On one hand, the increase of economic interdependence has shaken the institutional foundations of the nation-state model; and, on other hand, the neoliberal policies adopted have brought the PA closer to the management model of the private sector. This movement became known as NPM and led administrations around the world to operate a set of reforms that sought to bring flexibility and a reduction in hierarchies, increasing autonomy for managers and the ability to innovate through market-based mechanisms (Hood 1991).

The defenders of this movement believed that these reforms would liberate the functions of the Administrative from the Politician sphere (Bilhim 2013). But as a result, there was an increase in the transfer of state functions to other sectors, such

as the private and voluntary, which emphasized the need for more control and coordination, generating inconsistencies and contradictions in the functioning of public services and in the process of public policy. Consequently, the NPM model would end up showing several problems of fragmentation and institutional coordination, leading some authors to question the idea of "governance without government" as a dominant pattern of this model (Rhodes 1996; Peters and Pierre 1998).

Such problems were felt in the Anglo-Saxon administrative tradition, culturally closer to private management, and even more complex in the countries of Continental Europe with Napoleonic legal tradition (Bilhim 2014). This reformist, decentralizing character, focused on objectives and results brought strategic planning as one of the principles of the PA, closely associated with the management of change or/and reform processes. But the perverse effects (wickedness) that resulted from this translation, and accumulation of cultures, values and principles, also reflected the absence of a planning culture in the countries of Continental Europe tradition. Likewise, they took the focus away from the separation between the Political and the Administrative to put it in a new dichotomy between management and bureaucratic administration.

An answer to the wicked problems created by NGP reforms came with a new movement known as Joined up Government/Whole of Government (JuG/WoG) (Christensen and Lægreid 2007). Aspiring for greater integration and coordination of the public sector, this movement emerged in the second half of the 1990s associated with digital government programs. These programs evidenced a transformational effort by government organizations through ICT to enable greater efficiency, transparency and a citizen-centred approach in the public sector. Alongside, the search for more holistic approaches to increase government (re)integration has turn governance into a global trend (Dunleavy et al. 2005).

The emergence of the concept of "governance" was twofold: it started to be used as a normative model (good governance) for the development of society disseminated by international institutions; and afterwards as a critique to the NGP by highlighting the processes of self-government and loss of a protagonist role of the State (Rhodes 1996; Peters and Pierre 1998). Later, at the turn of the 2000s, the understanding of governance expanded to encompass the potential for digital transformation of the state governability processes by facilitating new forms of interaction with society, as well as the citizen co-creation of public value.

It is in this context that Stoker (2006) proposes network governance as a new paradigm of "public value management", and that Osborne (2006, 2010) speaks of a "New Public Governance" as a more comprehensive, participatory and citizen-centred public management model. Similar ideas lead Denhardt and Denhardt (2003) to question the dichotomy between bureaucratic and management administration, by associating governance as a New Public Service (NSP), assuming that the role of the PA is to establish partnerships between management, companies and citizens, to solve their problems. As consequence, this paradigmatic change is no longer understood as the loss of the centrality of the State, ratter as

new functions of regulation and coordination of networks, as an activator that triggers and coordinates other actors to produce public value with it.

In the changes to this new paradigm, sustainability appears as a central value. On the one hand, there is an increasing awareness that the principles of sustainable development can be applied to much of the work of the public sector (Leuenberger 2006). On the other hand, the challenge of governance, and therefore of PA, is to maintain a balance between each of the systems involved in sustainability: the environmental, the economic and the political/social. As will be shown in the next section, the governance of these systems implies complementarity between the political and administrative spheres. By integrating the study of the environmental system with the traditional competence of the political/social and economic systems, the Administrative sphere can contribute to sustain the political decision on a more theoretically and empirically valid basis (Fiorino 2010). The absence of this complementarity is the reason why we have failed to deal adequately with the governance of complex problems of the Anthropocene era, preventing us from seeing the integrating elements in such complexity.

3 Governance and Concepts of Future: From the Nation-State to Globalization and the Anthropocene

The term governance gained the expression of "multilevel" when it was used to characterize the new system of balance of world power post-Westphalia that established the dilution of the power of nation-states with the emergence of intergovernmental entities. At the global level, political developments driven by concepts like "sustainable development" have accompanied and guide this process of political-institutional transformation towards a governance paradigm (Dias et al. 2020). As we have seen, these changes first appeared in response to the intensification of globalization and economic competition. Currently, however, it is the recognition of the Anthropocene, as a new era of global environmental crisis, and the integration of cross-cutting policies issues to respond to it, which calls for new forms of cooperation.

The "Anthropocene" is defined as a "scientific event" that opened a debate "about the meaning and impacts of the current situation in which humanity has become a 'geomorphic' agent, increasingly influencing the functioning and evolution of the planet's Earth biophysical systems" (Ferrão 2017, p. 207). There are two major perspectives in this debate: the "bad" Anthropocene, which highlights a period of impending catastrophe that can lead to the collapse of the terrestrial system and life; and the "good" Anthropocene, which underlies the possibility of a paradigmatic transformation at the scientific, political and societal levels that avoid such a collapse. The difference between these positions is not in the degree of change, more incremental or more radical, but in the transformational objectives and the different visions in terms of the approaches (scientific and ethical

conceptions), the objectives (ends) and the conditions (means) associated (Ferrão 2017).

A set of structuring ideas on the basis of these transformational objectives were (Ferrão 2017): (i) the need for a paradigmatic change at the scientific level that overcomes and replaces the disciplinary cuts typical of modernity, by holistic approaches of coevolution; (ii) the idea that this change must be associated with a set of ethical values indispensable to transformative societal changes; (iii) the defence that the complex problems raised by the Anthropocene demand new forms of global coordination and planetary governance; (iv) the conviction that new forms of transformational governance can be developed through the added multiplier effect of local experimentation initiatives based on learning and sharing of good practices; and (v) the affirmation that only through an adequate combination of a new policy by the States and societal changes will it be possible to build new future contexts for humanity.

These transformational principles are inherent in the use of what we propose as "concepts of future". There are several of these concepts: good governance, place-based policies, smart cities, sustainable development, ecological modernization, among many others. One way to recognize them is in their use in political discourse to scientifically support decision-making in relation to the future. Such concepts are characterized by being normative, and therefore inherently political, that seek to create desired futures (utopias), scientifically supported, as opposed to unwanted futures (dystopias). Unlike conventional concepts that result from the abstraction of existing phenomena or realities, the "concepts of future" reveal dynamics of realities that are intended to promote/activate and/or to avoid scenarios.

These concepts have been disseminated and used by international institutions, especially since the 1980s, to guide political action in a context of growing uncertainty caused by globalization and a reflexive approach to modernity as an alternative to the postmodern discourses (without limits to deconstruction). Although the use of these concepts can be discussed as a political instrumentation of science within a framework of systemic risks and uncertainties (Dias et al. 2020), they also reveal the aspiration for greater openness and dialogue between political, scientific and practical/lay knowledges. The theoretical and practical seduction of such concepts rely in the high cognitive and reflexive value to design and implement "transformational plans", that is, a planned change (top-down), aligned with an emerging change (bottom-up).

In the PA field, the use of these concepts become clear with the JuG/WoG movement, which in Portuguese was translated as Integrated Governance (GovInt) (Marques and Ferraz 2015). GovInt has been proposed as an approach to wicked or complex social problems, such as the environment, health, poverty and others. Such problems are characterized by overcoming the artificial divisions imposed by political-administrative jurisdictions (parishes, municipalities, etc.), geographic barriers (countries and regions), legal forms (public, private, for-profit and non-profit institutions), among others. Its degree of complexity refers to the level of knowledge necessary to understand the environment, generally presenting a defined

number of variables, though difficult of calculating/measuring (Nanita et al. 2018). These problems are considered "wicked", precisely because typical/conventional solutions, organized by sector or by administrative silos, generate even more complexity and new problems.

As wicked problems are problems without a clear definition or solution, the interaction of different actors is necessary to understand and cross-cut multiple world views in an attempt to find a possible delimitation (Nanita et al. 2018). The recognition of wicked problems in PA, as well as the use of "concepts of future" to tackle them, reveals an awareness of the complementarity of the Political and Administrative spheres: it is the PA that has to implement the solutions and these always imply uncertainties and risks and, as a result, more problems. These are, therefore, cross-cutting issues that, due to their complexity, prevent any organization from being able to individually respond to the needs imposed by the challenges that arise.

GovInt presents itself as an approach to achieve collaborative governance to answer wicked problems, implying interorganizacional networks in which the Political and the Administrative spheres complement each other in the planning and implementation of cooperation and coordination mechanisms. These mechanisms provide governance and management both at the system level and at the individual level of the organizations. The main challenges to build such networks are the definition, planning and management of a vision and sharing agenda, in which the translation of "concepts of future" become core.

At the theoretical level, the transdisciplinary approach inherent in these challenges has, however, fragmented and delayed the processes of production and return of knowledge about what and how the practical application of these new concepts takes place. Even though, when we relate GovInt approach with the concept of change in PA, the following common aspects come to the fore into the application of the "concepts of future": (a) a scenarization that seeks to identify wicked problems and innovative responses to them; (b) a continuous planning that uses interorganizacional networks as a form of innovation and integrated governance of such responses; (c) a prospective rational that attributes to the use of ICTs a potential to put citizens into the core of decision-making and to enable institutional changes (UN 2016); and (d) a reflexive learning based on the identification and sharing of good practices.

4 Theory of Practice: The Centrality of Interpretivism in Learning Governance

Governance lexicon implies rethinking government, politics and PA against the backdrop of a broad set of changing social processes. Generally, the relationship between these transformations and the government crisis is discussed under the labels of "Risk Society" (Beck 2015), "reflexive modernization" (Beck et al. 1997)

and "Network Society" (Castells 2005). The tendency, therefore, is to describe change in macro sociological terms, using technological developments, globalization, individualization and emancipation of citizens to explain the erosion of state power and politics in general. However, the repercussions of these macro sociological changes are often more affirmed than discussed (Hajer and Wagenaar 2003).

Much of the governing process is still carried out by traditional hierarchical government institutions. But these institutions have now to live with ad hoc and variable geometry arrangements, which demonstrate a better ability to respond to wicked problems in the same circumstances in which the former failed, creating opportunities for learning and change (Rhodes 2000). The effects of these new network governance practices are not limited to how decision-making is conducted and implemented. In a governance framework, the issues of power and interests are redefined and reallocated, generating tensions and conflicts related both to the intended political change and to the administrative reforms necessary to enable more democratic institutional arrangements (Hajer and Wagenaar 2003).

Such a lexicon should, therefore, help academics and practitioners to unlearn the intellectual reflexes rooted in disciplinary and administrative traditions. Nonetheless, involvement in change tends to induce myopia: understanding new governance arrangements is often not based on an analysis of what exactly is "new" in relation to the previous reality. Governance tends to be seen as an "umbrella" that encompasses several centrifugal trends of change without really showing the mechanisms by which they are evident (Hajer and Wagenaar 2003). At this level, the Academy, as an institution, is "path dependent" in its theoretical and empirical traditions, which often makes it difficult to recognize the subtle but profound changes underway (Peters and Pierre 1998).

Professionals and decision-makers, on the contrary, were forced to be more directly involved in these changes, facing a dilemma between the degree of transformation they can achieve and the likelihood of a reform being successful (Peters and Pierre 1998). Given the path dependence of the administrative systems, this dilemma arises because the reforms that aim to change the normative structure and the practices of the PA can bring dissonances of translation, confusion and conflict between the expectations of the actors and the reality of organizational culture. To deal with this complexity and uncertainty, the actors in such situations tell stories and formulate arguments from their own worldview (Hajer and Wagenaar 2003). Its feasibility and legitimacy are assessed in "Communities of Practices" in which the actors are aware of the problem and restrictions at stake, overcoming the abstract elaborations created by the academics.

One way to reducing conceptual dissonances and increase the degree and success of changes is to bring three types of knowledge (political, scientific and practical/lay) into an "ecology of knowledges" (Santos 2007). However, translation among these knowledges depends on the existence of channels for dialogue, cooperation and partnership. Its creation is a challenge to the practices and procedures established in the PA. As a consequence, thinking about institutional planning and design requires a micro sociological contribution, centred on the interpretative analysis of good governance and institutional practices of change.

Deliberative policy analysis shows that epistemological beliefs consciously or unconsciously have normative consequences (Fisher and Forester 1993; Hajer and Wagenaar 2003), being an important approach in the analysis of global environmental governance (Stevenson 2016). What counts as justified belief and valid knowledge establishes acceptable limits for continuity and for the type and degree of desired changes.

Accepting this, the language and scientific concepts used in politics and PA have a strong influence on the way in which decision-making processes are conducted and in what is considered a legitimate political argument and/or administrative practice, taking into account the type of society in which we imagine ourselves to live (Hajer and Wagenaar 2003). If the positivist epistemology tried to separate the scientific procedure from the political organization, that is, the Administrative from the Political, an interpretative epistemology addresses this relationship in terms of adequacy ("to fit" or "to match"). On one side of this equation is the conception of science and knowledge of the PA and on the other side the new forms of political organization. The link between the two is the way in which a particular purpose and methods of PA simultaneously allows and limits opportunities for research and knowledge growth and transfer and, therefore, enhance practical solutions to wicked problems and ways of more democratic governance (Hajer and Wagenaar 2003).

The use of "concepts of future" in political language not only reflects the desired reality, but actively paves the way for its understanding and legitimation, creating new ontologies. However, this raises questions of value, distortion and influence between PA scientific knowledge and practices. The normative discourse creates ontologies that are incorporated and analysed by science (concepts of future). These ontologies are consequently confronted with practices, generating among its gaps new ones. This is important because ontologies generate theories about what can be known (epistemology), how knowledge can be produced (methodology) and which research practices can be employed (methods) (Raadschelders 2011).

This looping between the paradigmatic and the pragmatic in which reality is built implies a reflexive approach oriented to practice and its interpretation as an alternative to postmodern discourses. In concrete everyday situations, individuals attribute meanings to institutions based on their behavioural dispositions or participating in practices (Fischer and Forester 1993). These behavioural dispositions are composed by the set of narratives underlying the individual's worldview (ontology). Participation in "Communities of Practices" is what prevents extreme relativism in determining the semantic meaning of institutional language.

The "Communities of Practices" are forms of socialization for the values and practices of a given community that guide its members towards the construction of a shared identity, through participation in networks (Lave and Wenger 1991). Thus, a governance network is always a Community of Practices, interpretive of "concepts of future" and guiding action, configuring a political arena in which such concepts and futures are negotiated, judged and adjusted by the actors to realities and concrete problems. These communities have an important role in opening governance to citizen participation and involvement in deliberating on such

problems, with a view to creating and improving the collective capacity for decision-making and self-transformation. One way to accelerate these processes of openness, learning and institutional change is through the sharing of good practices as learning cases.

5 Challenges to the Future of Public Administration Study and Practice: Learning Cases as a Methodology for Teaching Governance

The Academy is the context *par excellence* in which theory and practice prepare its meeting ground, being in this context that future specialists and practitioners are socialized. Therefore, each PA course is in itself a Community of Practices, led by academics. The challenges that arise from the complex problems faced on a day-to-day basis by the professionals of the PA highlighted the need to rethink the quality and training in this area worldwide. However, it is not clear what PA academics recognize as "challenges" and what the implications for learned knowledge and skills and curriculum changes in the field (Wessels 2019).

A perspective on the challenges to the future of PA study and practice was presented by Raadschelders (2011), from his experience as editor-in-chief of the Public Administration Review (PAR) journal. For the author, the advance in the study of PA lies in providing an understanding of the wicked and complex social problems that public officials and managers have to deal with. The author argues that the acquisition of technical skills in academic curricula should be complemented with interdisciplinary perspectives on modern civilization and the development of the State and society through changes in the relationship between government and citizens. Hence, a first challenge arises from the fact that the majority of the academics of the PA is focusing on a reality that they consider objective, static and permanent. This is the dominant way in which the PA has been studied and means that this is also the type of PA knowledge that is read, learned and used by professionals (Raadschelders 2011).

Related to this, a second challenge is to articulate analyses at the micro (individual, group), meso (organization) and macro (society) levels, as a way of investigating the consequences of the great questions of modern society on practice. However, not all of these questions can be answered only through measurement and quantification, especially when it comes to respond complex problems, creating a third challenge. A fourth and final challenge is related to the trend towards a PA focused on developing technical skills and becoming an evidence-based science. This positivist and technical theoretical focus on the acquisition of "hard" skills turns out, paradoxically, to be justified by macro sociological worldviews on the transformation of the State and society that demand more comprehensive and less specialized knowledge (Raadschelders 2011).

In turn, Wessels (2019) showed the consequences of how the notion of "challenges" in PA has been used in the context of curriculum revision to characterize tasks associated with the wickedness of complex problems and the capacities of public officials and managers necessary for its accomplishment. One of these consequences referred is the obsolescence of PA curricula oriented towards the traditional competencies formulated in the language of technical rationality (selection of means according to ends). Such competencies work to perform simple and routine tasks, but not to identify the perversities of complex problems or to create consensus on how to deal with them. According to the author, this consequence implies a reformulation and continuous redesign of the PA curricula that provides future specialists practical governance skills to prepare for the future, such as: (i) reflexivity (dealing with the various possible contexts); (ii) resilience (adjusting actions to uncertain changes); (iii) responsiveness (responding to changes in agendas and expectations); and (vi) revitalization (unlocking).

In view of the great diversity of perspectives and possible configurations within a normative framework, this shift to an approach of governance capacities is based on the expectation that valuing individual well-being and freedom allowing professionals to have autonomy to do what they are effectively capable of and what they value the most. In order for curricula to include these capabilities, Wessels (2019) suggests that their reformulation should be geared towards continually rethinking the facilitation of learning, using different methods and techniques that encourage creative and critical thinking as essential capabilities of PA programs. One of these methods of continuous learning facilitation is learning cases based on problem solving.

The "learning cases" have their origin in the areas of Law and Management, bringing to the academic discussion the evidence of cases of good and bad practices. Recently, this methodology has also started to be used in the policymaking process to innovate based on the problem solving experience adopted in similar cases (Dotti 2018). The use of learning cases in PA is understood as a way of preparing the future, stimulating the building of partnerships and creating an innovation context for transformational change. This type of methodology is not new at the level of international entities such as the UN, in which the sharing of good practices around "concepts of future" is recurrent as a way to strengthen the capacity of their governments and respective PA, both domestically and throughout global collaboration.

The use of learning cases is suggested by the UN (Williams et al. 2020) to improve the implementation of the UN 2030 Agenda, especially the involvement and participation of stakeholders. Some of the most recent approaches have focused specifically on sharing the best cases of using strategic foresight methodologies, such as horizon scanning, megatrend analysis, scenarization and vision and back-casting (UN 2016). However, is scarce the research in the field of PA that adopts this type of methodologies. Without their use, the "concepts of future" end up generating biases of translation, especially when their application does not take into account differences in context.

As we have seen, Political Science has already managed to take a step forward, recognizing the need for an interpretative epistemology that allows, simultaneously, the understanding of the practices and worldviews (ontologies) that underlie it. However, qualitative work continues to represent a very small percentage of the published research in the PA field (Ospina et al. 2017). What we did in these last sections was to propose that the study and practice of PA can also advance, following this same approach. For this purpose, PA academics and practitioners must be "facilitators of transformation", dialoguing on the interpretation of "concepts of future", to promote not merely a normative science, but an interventional one, which may help to prepare networks of actors in the field, responding to wicked problems and at the same time preparing the future.

6 Conclusion

The UN Agenda 2030 states governments' determination to "take the bold and transformative steps that are urgently needed to take the world on a sustainable and resilient path" (UN 2015, p. 1). Achieving this transformation in Anthropocene era requires a change from sectoral policies to cross-cutting policies. PA has an important role to play, being the main instrument of governments to implement public policies. Nonetheless, the integration of cross-cutting policy areas is in itself a complex and wicked problem in PA given the tension between simultaneously scientific and applied focus in the field. Since its foundation, the science of administration has been built on a conceptual and methodological universe based on the separation from political decision-making. This shaped the way the commutative knowledge sharing between PA theory and practice is done, becoming a constraint to change to a governance paradigm. Administrative traditions and national government cultures overlap with a PA that must be part of a global governance system under construction.

This text proposed that the "concepts of future" disseminated by international institutions and used in the political rhetoric to sustain the decision-making to prepare the future imply a greater complementarity between this sphere and the administrative one. The normative character of these concepts implies that the design and implementation of public policies are aligned with a worldview shared by all stakeholders. But the construction of this worldview is plural: each individual has his own conception of the world (ontology) that results from the intersection between institutional interpretation and his field of experiences. The great challenge of integrated governance is to bring scientific, political and practical/lay knowledge into contact so that these worldviews can converge and become shared. Only when this dialogue becomes possible, a globalized collective action may be triggered beyond the administrative traditions of national scopes.

PA is the space for excellence in which citizens and governments relate. It is therefore in PA that the transformation of government must first take place. Communities of Practices are central spaces for transformation in the PA, enabling

individuals to socialize for change and a shared, problem-oriented worldview. The academy is an important Community of Practices where governance can be lectured and learned and put into practice. Learning governance implies a theoretical challenge and a practical challenge: an interpretative epistemological orientation and greater autonomy for PA professionals achieved through the development of soft skills. The use of Learning Cases is a way to reconcile these challenges. Knowing which good and bad practices and which histories and processes encompasses them, are perhaps the best way to prepare for the future and facilitate transformation.

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Tourist Complex and Its Environmental Effects: The Case of "Marina Isla De Valdecañas" (Spain)

Julián Mora Aliseda, Yonatan Cáceres Escudero, Consuelo Mora, and Jacinto Garrido Velarde

1 Introduction

Regarding the background scientific and technical, it should be noted that throughout the world, protected natural areas (PNA) or included in the Natura 2000 network has suffered for decades losses in local and natural heritage (European Commission 2017). These areas are characterized by being relevant habitats concerning the Birds Directive 2009/147/CE and the Habitats Directive 92/43/CEE. (European Commission 2016a, b), and cultural landscapes that were extracted from the millennial interaction between humanity and the environment (Moreira et al. 2011; Semeraro et al. 2016).

Specifically, many regions of Spain, especially Extremadura, face strong impacts and pressures due to their geographical, demographic, and economic disadvantages (Moreira et al. 2011; Aretano et al. 2015; Semeraro et al. 2016; Mora et al. 2018).

J. M. Aliseda
Department of Art and Territorial Sciences, Universidad de Extremadura, 10003 Cáceres, Spain
e-mail: jmora@unex.es

Y. C. Escudero
Forest Research Group, Universidad de Extremadura, 10600 Plasencia, Spain
e-mail: ycaceres@unex.es

C. Mora
Fundicotex, 10910 Cáceres, Spain

J. G. Velarde (✉)
Department of Social Sciences, Languages and Literatures, University of Extremadura, 06071 Badajoz, Spain
e-mail: jgvelarde@unex.es

J. G. Velarde
University Research Institute for Sustainable Territorial Development (INTERRA), University of Extremadura, 06006 Badajoz, Spain

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Along with current situations, the concept of PNA has changed over several decades (Brundtland Commission 1987; Cumbre de Rio de Janeiro 1994; López-Rodríguez and Rosado 2017). Although at the beginning of the twentieth century, with the establishment of the first natural parks, conservation had a more specific nuance, less interaction, and much more protectionism in the face of changes, since the end of the 1980s, with the appearance of the Bruntland report (1989) In the early 1990s, with the Rio Summit (1992), the changes in the study of these spaces have been evident.

Both the national and international bibliography presents a wide variety of studies that show the incidence of protected areas in the rural economy, that is, in the areas of socioeconomic incidence that surround them (Cuff and Rayment 1997; Sunyer and Manteiga 1998; Mora et al. 2020a, b). These studies, which seem to be more up-to-date on the international scene than on the national scene, where recent research is less numerous, differ greatly depending on the case study discussed. For example, if in Spain the main concern is the legislative analysis and its application by each Autonomous Community (from which derives another of the great legislative difficulties: the regulatory treatment and the range of protection figures that is frequently detected in neighboring territories or trans-regional with similar geoenvironmental conditioning factors), with few specific case studies (Hoyos et al. 2012). For example, as in the Netherlands the main concern is how the excessive protected area can affect the implementation of new activities or beneficial infrastructures over development (Port of Rotterdam) (Palerm 2006; Beunen et al. 2013); in Austria, like conservation policy, it can affect regional economic development (Getzner and Jungmeier 2002); in the UK, submission to these policies can often be seen as a temporary patch of major conflicts (Morris 2011); or in Poland, the negative perception of the protection of the entire municipal area in communities whose main dedication is agriculture (Peitrzyk-Kaszynska et al. 2012).

He aim of this article is to analyze the socio-economic and demographic impacts of a singular initiative, such as the construction of a Tourist Complex in rural areas, taking advantage of the resource, perhaps most characteristic of Extremadura, the reservoirs, in which this region houses a third of the freshwater stored in Spain, with more than 1500 km of inland fresh coast. This water resource, until now, has had irrigation and electricity production as a priority destination, totally neglecting other immense exploitation potentials to generate employment and wealth in deeply depressed areas, such as 90% of the Extremadura territory where practically all municipalities less than 10,000 inhabitants (96% of a total of 388) inevitably lose population, the most valuable element for their future development and also for the conservation of spaces with environmental values, which cannot be understood without human presence.[1]

[1] Although the legislation typifies the denomination of "natural spaces", it is convenient to point out that in Extremadura, they are not pristine spaces without human intervention, but are transformed spaces, such as the Dehesa, so it would be more correct to define them as "well-preserved cultural spaces", Which without the human presence and their traditional activities would not be understood or maintained as such, with all their biodiversity.

We start from the hypothesis that any project that is respectful of the environment will serve as an incentive to consolidate the populations, as well as a model for future actions in the "artificial lake" environments that make up the Great Reservoirs built in the last 60 years in Extremadura. and that can become a complementary alternative to the new functions that a rural world must assume (as recommended by the European Territorial Strategy) that is no longer agricultural, given that its majority workforce is not employed in the agro-livestock and forestry sector. We wanted to contrast the statistical data from official sources to verify their behavior in the municipalities most directly affected by the Isla Marina de Valdecañas Complex: El Gordo and Berrocalejo. This will allow us to know in detail the social, economic, and demographic dynamics of both nuclei which, logically, given their size and structure, are doomed to disappear.

2 Methodology

The changes in land use show the transformations in the configuration of the landscape and the effects on the typology of the uses prior to urbanization when the judicial stoppage and afterwards.

The methodology we use has already been contrasted in studies carried out by some members of the Department of Territorial Sciences on Extremadura and the Spanish-Portuguese border, the results of which appear in specialized publications on these matters (Jaraíz et al. 2012, 2018).

In this work, we are going to verify that the changes made to the municipalities that are affected by the ZEPA (Special Bird Protection Zone) of Valdecañas have been very positive from the environmental point of view (Fig. 1).

Therefore, any other disturbance of the complex is comfortably offset by the increase between 2006 and 2018 in the forest and shrub area in the 14 municipalities that share the protected area: Valdelacasa de Tajo, Almaraz, Peraleda de San Román, Valdecañas de Tajo, Bohonal de Ibor, Mesas de Ibor, Belvis de Monroy, Valdehúncar, El Gordo, Peraleda de la Mata, Villar de Pedroso, Berrocalejo, Campillo de Deleitosa and Fresnedoso de Ibor (Fig. 2).

2.1 Use of the Corine Land Cover 2006, 2012, 2018

As they are covers that represent the entire national territory, the ArcGis 10 © Software was used for their treatment, to obtain the evolution maps of land use of the terms affected by the Valdecañas ZEPA.

The classification of land uses used is that stipulated by the Corine Land Cover for categorizing the land surface into different units according to its biophysical properties, such as urban area, cultivation, forest trees, etc.

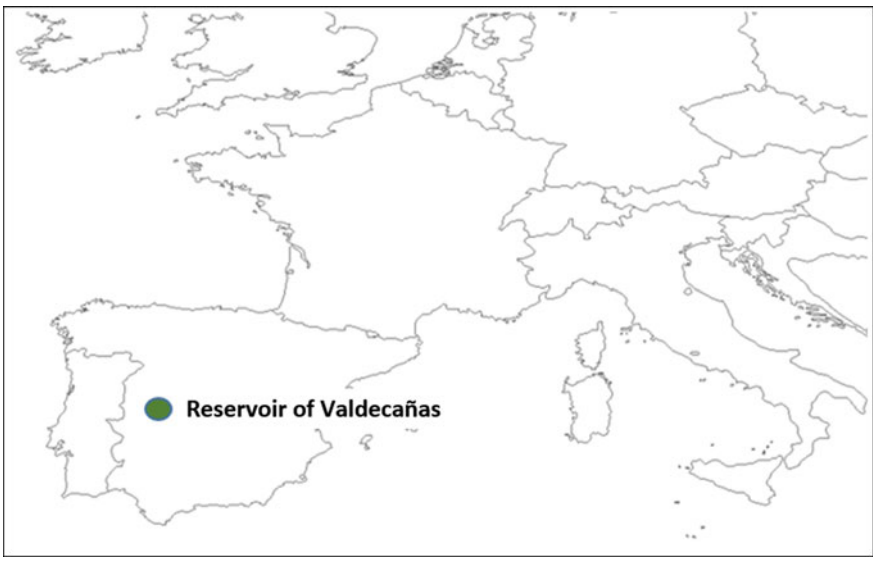


Fig. 1 Location of the analysis area. *Source* Own elaboration based on data from the National Geographic Institute

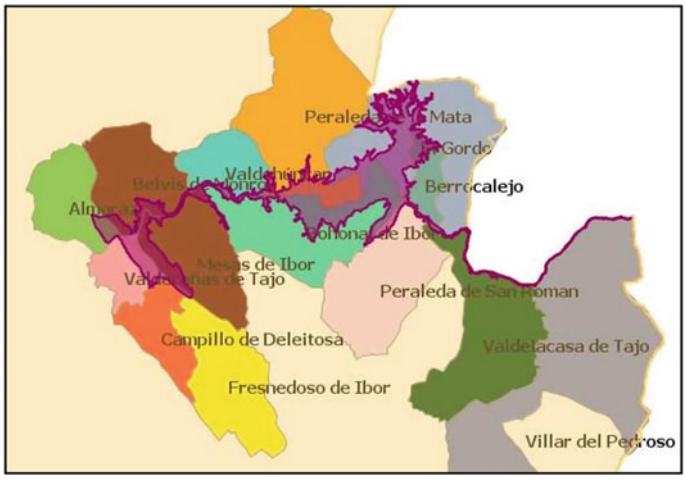


Fig. 2 Municipalities that make up the Valdecañas ZEPA. *Source* http://extremambiente.juntaex.es/

The area of analysis is located in the northeast of the province of Cáceres (Fig. 1). In this sense, the work scale was 1: 100,000 and the minimum cartographic unit is 25 ha. Also, the geometric precision is always greater than 100 m. The representation of land uses made using polygonal graphic entities. Polygons are

associated with a land-use code to which they refer. For this reason, a specific coding is developed in three levels of detail. Therefore, there are 44 classes at level 3, with the highest degree of detail (Table 1).

First, the geodatabases were made appropriately for each year of study (2006, 2012, and 2018). Subsequently, they were downloaded from the municipalities listed in this study previously (Fig. 3).

In order to obtain the representative polygons of the changes in land use for each year, we confront them with the administrative limits, through a geoprocess.

Finally, the extent ratio for each land use is calculated using the percentage, which is determined using Structured Query Language (SQL). The procedure was repeated for each year analyzed.

2.2 *Analysis of the Corine Land Cover Images*

Previously and to serve as a comparative reference on the traditional uses of the land before the construction of the reservoir, we used the Orthophoto of the American flight of 1956/1957, with a flight scale 1/32,000 in Black and white, which is very illustrative of the existing uses before eventually and ephemerally becoming an "island" the space object of the conflict (Fig. 4). And taking a leap in time, the 5 decades that elapse until the beginning of the construction of the Complex "Marina Isla de Valdecañas", after the abandonment of dry land and its repopulation of eucalyptus, we come to the year 2006 which is the one that we are interested in knowing in order to know how the landscape[2] of the municipalities affected by the ZEPA was configured and its evolution until now (Fig. 4).

To do this, we proceed to analyze the information provided by the images of the Corine Land Cover, in order to verify the change in Land Uses. After a meticulous study of the territorial dynamics in the 2006–2012–2018 period, corresponding to the initial moment of the works, the stoppage of the works, and the present moment, we have verified that the surface destined to "Forest" and "Shrub and Herbaceous Vegetation" have increased considerably (Table 2).

During the construction of the "Marina Isla de Valdecañas" tourist complex, there was an abandonment of the "heterogeneous agricultural areas" of lower productivity due to employment in construction sites, much better paid than agricultural work (Figs. 5, 6 and 7).

With the data on the Changes in Land Use, it is concluded that the Impact of Marina Isla de Valdecañas has been very positive for the Natural Regeneration of the ZEPA and its immediate surroundings, as shown in the increase of 15,785 ha of surface destined to "Forests" and "Shrub vegetation", between 2006 and 2012.

[2] According to the European Landscape Convention (Florence, 2020), "landscape" shall mean any part of the territory as perceived by the population, whose character is the result of the action and interaction of natural and/or human factors.

Table 1 Corine land cover nomenclature

Level 1	Level 2	Level 3
1. Artificial surfaces	1.1 Urban fabric	1.1.1 Continuous urban fabric
		1.1.2 Discontinuous urban fabric
	1.2 Industrial, commercial and transport units	1.2.1 Industrial or commercial units
		1.2.2 Road and rail networks and associated land
		1.2.3 Port areas
		1.2.4 Airports
	1.3 Mine, dump and construction sites	1.3.1 Mineral extraction sites
		1.3.2 Dump sites
		1.3.3 Construction sites
	1.4 Artificial, non-agricultural vegetated areas	1.4.1 Green urban areas
		1.4.2 Sport and leisure facilities
2. Agricultural areas	2.1 Arable land	2.1.1 Non-irrigated arable land
		2.1.2 Permanently irrigated land
		2.1.3 Rice fields
	2.2 Permanent crops	2.2.1 Vineyards
		2.2.2 Fruit trees and berry plantations
		2.2.3 Olive groves
	2.3 Pastures	2.3.1 Pastures
	2.4 Heterogeneous agricultural areas	2.4.1 Annual crops associated with permanent crops
		2.4.2 Complex cultivation patterns
		2.4.3 Land principally occupied by agriculture, with significant areas of natural vegetation
		2.4.4 Agro-forestry areas
3. Forest and semi-natural areas	3.1 Forests	3.1.1 Broad-leaved forest
		3.1.2 Coniferous forest
		3.1.3 Mixed forest
	3.2 Scrub and/or herbaceous vegetation associations	3.2.1 Natural grasslands
		3.2.2 Moors and heathland
		3.2.3 Sclerophyllous vegetation
		3.2.4 Transitional woodland-shrub
	3.3 Open spaces with little or no vegetation	3.3.1 Beaches, dunes, sands
		3.3.2 Bare rocks
		3.3.3 Sparsely vegetated areas
		3.3.4 Burnt areas
		3.3.5 Glaciers and perpetual snow

(continued)

Table 1 (continued)

Level 1	Level 2	Level 3
4.. Wetlands	4.1 Inland wetlands	4.1.1 Inland marshes
		4.1.2 Peat bogs
	4.2 Maritime wetlands	4.2.1 Salt marshes
		4.2.2 Saline
		4.2.3 Intertidal flats
5.. Water bodies	5.1 Inland waters	5.1.1 Water courses
		5.1.2 Water bodies
	5.2 Marine waters	5.2.1 Coastal lagoons
		5.2.2 Estuaries
		5.2.3 Sea and ocean

Source https://www.eea.europa.eu/publications/COR0-landcover

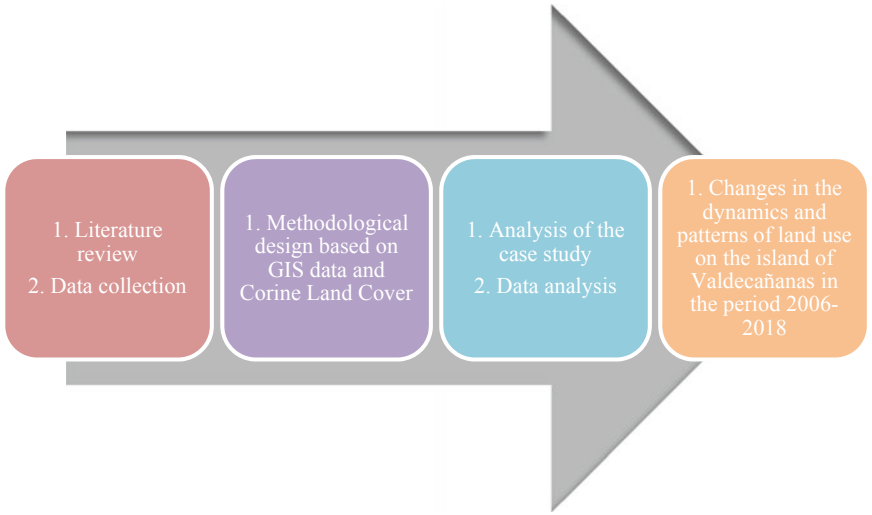


Fig. 3 Methodological Scheme

This wooded and scrub surface has decreased slightly since the work stopped between 2012 and 2018, with the consequent increase in "tilled lands", due to the return of some inhabitants to agricultural activity (Figs. 5, 6, and 7).

En resumen, el impacto positivo se refleja actualmente (2018) en un incremento del espacio "regenerado" que alcanza las 12.418 hectáreas con respecto al tiempo anterior (2006) a las obras del Complejo, casi duplicando la extensión a la propia ZEPA (7.459,17 ha). That is, the 133 ha, corresponding to the promontory whose buildings are planned to be demolished, have contributed during the construction phase to multiply the "natural regeneration" of the municipalities affected by the Valdecañas ZEPA by almost 100 times (93.3) times (Table 2).

Fig. 4 Evolution of land uses from 1945 to 2020, in the Valdecañas Reservoir study area. *Source* https://www.ideex.es/IDEEXVisor/

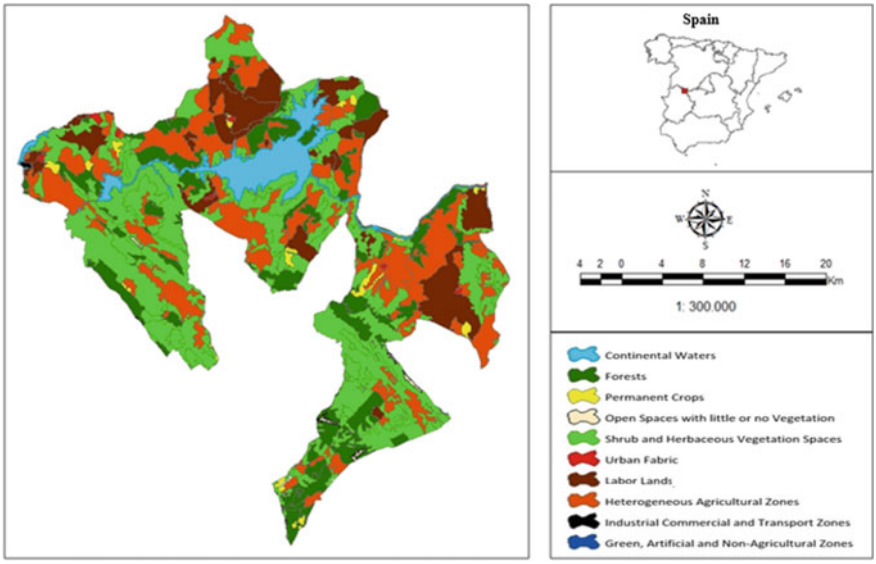


Fig. 5 Positive vegetation changes in the municipalities of the Valdecañas ZEPA Zone (Corine Land Cover 2006). *Source* Own elaboration based on data from the Corine Land Cover 2006

Table 2 Increase in the area under natural regeneration in the municipalities of the Valdecañas SPA (2006–2012–2018)

	Percentage (%)	Surface (ha)
2006		
Forest	8.14	16.120
Shrub vegetation	29.11	57.650
Total area "natural"	37.25	73.770
2012		
Forest	12.39	24.537
Shrub vegetation	32.83	65.018
Total area "natural"	45.22	89.555
		(+15.785 ha, de 2006–2012)
2018		
Forest	11.01	21.982
Shrub vegetation	32.42	65.018
Total area "natural"	43.43	86.188
		(+12.418 ha de 2006–2018)

Percentage of land uses, the reference year 2018 (total 198,045 ha)
Source Own elaboration based on data from the Corine Land Cover 2006, 2012, 2018

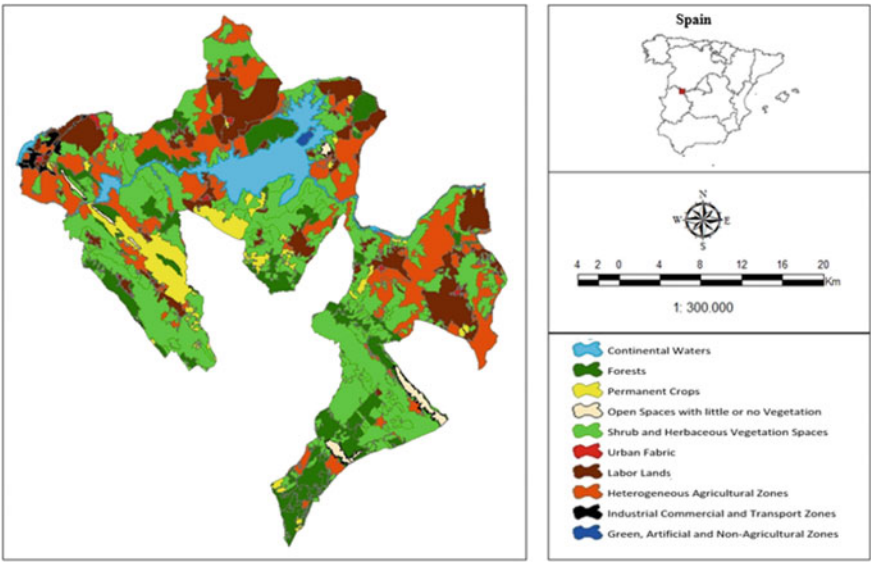


Fig. 6 Positive Vegetation Changes in the Municipalities of the Valdecañas ZEPA Zone (Corine Land Cover 2012). *Source* Own elaboration based on data from the Corine Land Cover 2012

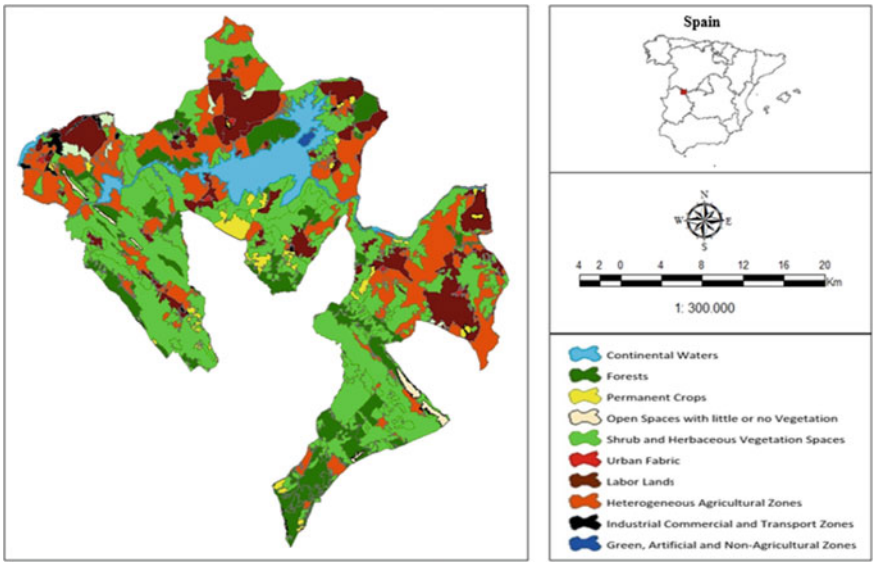


Fig. 7 Positive Vegetation Changes in the Municipalities of the Valdecañas ZEPA Zone (Corine Land Cover 2018). *Source* Own elaboration based on data from the Corine Land Cover 2018

For this reason, the presence of protected species has increased and the entire agro-system of the 14 municipalities affected by the ZEPA de Valdecañas has substantially improved (Table 2).

3 Economic Resources Analysis by Sectors

3.1 Primary Sector

In the following tables (Tables 3, 4, 5, 6, 7 and 8), we will check the evolution that this structure of ownership and holdings has been following. But before contemplating them, we must know some essential concepts to better understand these topics that we are going to discuss:

- *Tilled lands*: are those that receive care regardless of their use and the date on which they have been carried out within the year of the census. These cares are those that are carried out with a hoe, plow, harrow, cultivator …, the tasks of spreading fertilizer, replanting, cutting …, practiced, for example, in permanent meadows do not fall into this category. The following types of crops exist in these lands: herbaceous, woody, and fallow.
- *Uncultivated land*: includes uncultivated lands proper, in addition to also referring to lands cultivated for forestry purposes. And within these, the

Table 3 Total area of the agricultural holdings surveyed

Year	Tilled land	Land for permanent pastures	Other lands	Total
Berrocalejo				
2009	213.61	1037.26	155.33	1406.2
%	15.19	73.76	11.05	100
El Gordo				
2009	1706.28	2812.89	195.14	4714.31
%	36.19	59.67	4.14	100

Source Agrarian Census 2009. Own elaboration

Table 4 Number of farms and area in hectares

Agrarian Census 2009 (ha)	Berrocalejo		El Gordo	
	Surface ha	Number of farms	Surface ha	Number of farms
1–2	10.78	8	1.36	1
2–3	2.68	1	–	–
3–4	4.5	2	5	1
5–10	–	–	7.49	1
10–20	12.17	2	11	1
30–50	30	1	342.78	5
70–100	79.19	1	177.65	2
Más de 200	1111.55	3	4049.75	5

Source Agrarian Census 2009. Own elaboration

Table 5 The total area of the farms surveyed according to the tenure system

Year	Property ha	Lease ha	Sharecropping or other regimes ha	Area of farms census
Berrocalejo				
2009	510.3	700.98	39.59	1250.87
%	40.80	56.04	3.16	100
El Gordo				
2009	3769.9	699.57	49.7	4519.17
%	83.42	15.48	1.10	100

Source Agrarian Census 2009. Own elaboration

following groups are considered: meadows, permanent meadows and pastures; forest tree species; and others.

- *Permanent meadows or meadows*: permanently dedicated to the production of grass and whose priority use is carried out by mowing. They can receive some care such as reseeding, fertilizing, roller passes, etc. Herbaceous crops are excluded here.

Table 6 Use of tilled lands

Año	Herbaceous ha	Olivar ha	Vineyard ha	Fruit trees ha	Other tilled lands ha	Total ha
Berrocalejo						
2009	162.27	51.29	0	0	155.33	368.89
%	43.99	13.90	0	0	42.11	100
El Gordo						
2009	1673.84	31.9	0	0.5	195.1	1901.34
%	88.03	1.68	0	0.03	10.26	100

Source Agrarian Census 2009. Own elaboration

Table 7 Livestock livestock units (UG)

Año	Bovino	Ovino	Caprino	Porcino	Equino	Aves	Colmenas	Total (UG)
Berrocalejo								
2009	0	1027	0	0	1	6	425	1459
%	0	70.04	0	0	0.1	0.4	29.1	100
El Gordo								
2009	721	3288	0	0	1	3	0	4013
%	17.97	81.93	0	0	0.02	0.07	0	100

Source Agrarian Census 2009. Own elaboration

Table 8 Number of natural person holders by age groups and main occupation

Año	25 to 44 years	45 to 54 years	55 to 64 years	65 and more years	Total
Berrocalejo					
2009	2	2	3	10	17
%	11.76	11.76	17.65	58.82	100
El Gordo					
2009	3	2	5	6	16
%	18.75	12.5	31.25	37.5	100

Source Agrarian Census 2009. Own elaboration

- *Pasture*: pasture land normally utilized to tooth for cattle and not often receive care.
- *Forest tree species*: are the areas covered by forest trees, dedicated to obtaining wood, firewood or other products or to the conservation of the environment. Leafy, resinous and mixed species (a mixture of the first two) are distinguished here. The areas temporarily cleared by cutting or burning are also included, as well as the repopulated areas and forest nurseries.
- *Other uncultivated lands*: within these, in turn, we can find those classified as wasteland or pastures (uncultivated lands accidentally dedicated to pasture, characterized by their low yield and that have not received any type of labor),

scrub (land populated with a predominance of spontaneous shrub species such as rockrose, heather, broom, thyme, etc., regardless of whether or not it is susceptible to grazing) and other areas (including areas belonging to farms occupied by wasteland, water, buildings, eras, roads, quarries, rocky areas …, which are not susceptible to appreciable plant use).

According to the 2009 Agrarian Census in both localities, most of the agricultural holdings correspond to land for permanent pastures, the highest percentage being in the town of Berrocalejo with 73.76% and in El Gordo with 59.67%. This is followed by cultivated lands wherein El Gordo represents an important percentage of 36.19% while in Berrocalejo it only reaches 15.19% (Table 3).

Number of farms and area

In Table 4 we can see that in Berrocalejo the largest number of farms has a surface area between 1 and 2 ha, bringing together a total of 8 farms. In the locality, most of the farms are smallholdings, on the other hand, latifundium farms we can find 3 that are those that gather the largest number of hectares 1111.55 ha.

In El Gordo, the number of farms with less than 20 ha is 4, while those with 20–50 ha are a total of 5, as is the case with the large estates that are the ones with the most hectares, a total of 4049.75 ha with 5 farms (Table 4).

Farm tenure regime

The Tenure Regime (legal form under which the entrepreneur acts in the agricultural exploitation), both for its total number and for the agricultural area used, but first we will expose the meaning of each of the categories into which this is divided regime, as they are (Table 5).

- Owned lands are those lands over which the entrepreneur has the right to property, with or without written title, and those that have been exploited peacefully and uninterruptedly by the entrepreneur for at least thirty years and without payment of rent. Also included in this heading are the usufructs of the land and the lands ceded to third parties, also considering as such the communal ones given in "lots" or leases.
- Leased land: are those in which the employer enjoys the use of the same by paying a fee or rent, regardless of the results of the exploitation, either in cash, in-kind, or with both at the same time.
- Sharecropping lands: are those owned by a third person temporarily transferred to the sharecropper by paying a percentage of the product obtained or its equivalent in cash. The amount of this part depends on local conditions, the type of business, and the contribution of the owner.
- Land in other tenure regimes: this section includes those not included in any of the previous regimes: those exploited in trust, in litigation, in precarious, census, forums, etc.

As we can see in Table 5, in the town of Berrocalejo, most of the total area of the farms (56.04%) is under the lease, while the owned farms represent 40.80%. On the

contrary, in El Gordo, it is the opposite since 83.42% of the farms are owned compared to the 15.48% that are under lease.

Use of tilled lands

Table 6 shows the evolution of Crops in the agricultural tilled lands of both municipalities.

As we have been pointing out, in the case of cultivated lands, the following crops are considered:

- Herbaceous crops: are those plants whose aerial part has a herbaceous consistency (cereals, legumes, potatoes, cotton, beets, vegetables, etc.), including fallows. If a farm is dedicated in whole or in part to a seedbed, each crop is included in its corresponding section.
- Woody crops: are the species that occupy the land for long periods, such as fruit trees, vines, and olive trees, and do not need to be replanted after each harvest. Forest trees and their nurseries are excluded from this group.
- Fallow land: these are the lands that have remained in rest during the course of the campaign, not supporting any crops and receiving some work. This includes dry-land fallow land and irrigated land not occupied for any reason; Those lands that are being transformed into irrigated land and that have not had any cultivation during the campaign will also be considered. Land sown for green manure is also included.

As shown in Table 6, in Berrocalejo the highest percentage of land use corresponds to the herbaceous group (43.99%) with crops such as barley, oats, cereals, peas, among others. While 42.11% corresponds to other cultivated lands and, to a lesser extent, the remaining 13.90% corresponds to olive groves.

In the case of El Gordo, herbaceous crops represent 88.03% with crops such as wheat, rye, barley, among others. It is followed by the other cultivated lands that represent 10.26%, followed by the olive grove with 1.68% and, to a lesser extent, the fruit trees with 0.03%.

Cattle raising

El Gordo has a greater number of livestock units (4013) compared to Berrocalejo (1,459). In Berrocalejo, the highest livestock weight corresponds to sheep, since it represents 70.04% of its livestock herd, followed by beekeeping with 29.1%. With respect to El Gordo, the greatest weight also corresponds to the sheep sector with 81.93% followed by the cattle with 17.97%, and to a lesser extent with the equine and poultry sector (Table 7).

Agricultural entrepreneurs

In Berrocalejo, the age group with the highest proportion of ownership of the farms corresponds to people aged 65 and over with 58.82% followed by 17.65% of people aged between 55 and 64 years, which shows the high aging that exists in the agricultural sector, due to the fact that younger people have traditionally chosen to emigrate or work in the service sector (Table 8).

In the case of El Gordo, practically the same occurs, although with lower percentages, since 37.5% of the agrarian holders are 65 and over followed by 31.25% with ages ranging from 55 to 64 years.

3.2 Secondary Sector

The secondary sector is the one with the least economic weight in both municipalities since according to the December 2007 data provided by Caja España in the town of Berrocalejo there were no industrial or construction companies as well as no employees. On the other hand, in El Gordo, 3 of the 10 companies that exist are dedicated to construction with a total of 17 workers, which represents 28% of all employees in the municipality (Figs. 8 and 9).

3.3 Third Sector

According to data from Caja España for December 2007, at the beginning of the works, the service sector is the engine of the economy of both localities, since in Berrocalejo it represents 72.7% of all workers and 80% of companies, while in El Gordo services comprise 46.7% of workers and 60% of companies (Fig. 10). As of 2011, we found 2 retail stores in Berrocalejo, one of which is dedicated to tobacco and smoking products and the other is a mixed retail business. There are also 6 cafes and bars in the town. On the other hand, in El Gordo there are 3 retail stores which are one for food products and beverages in general, another for pharmaceutical products, drugstore, perfumery, and cosmetics, and another of mixed commerce. In the case of basic equipment, there is more offer than in Berrocalejo since we find 2 hotels and motels, 1 hostel or pension, 3 restaurants, 1 cafeteria, and 3 cafes and bars.

In the time period from 2007 to 2013 in both locations, thanks to the funds received via taxes from the Isla Marina de Valdecañas Complex, the number of social facilities available to the City Councils has increased to broadly satisfy the needs of their populations.

In the case of El Gordo, a nursery has been built; a pool; a multipurpose hall, where social and cultural events are held; a pensioner's home; a residence for the elderly that will soon open; a reading agency; the expansion of the medical center (co-financed) and the purchase of a car that provides services to the City Council.

Local budgets

The local budgets of both towns have been strongly benefited in recent years since they have grown notably since 2006 until reaching its economic zenith in 2009 where Berrocalejo had a budget of 556,865 euros, while that of El Gordo was 3,269,337 euros.

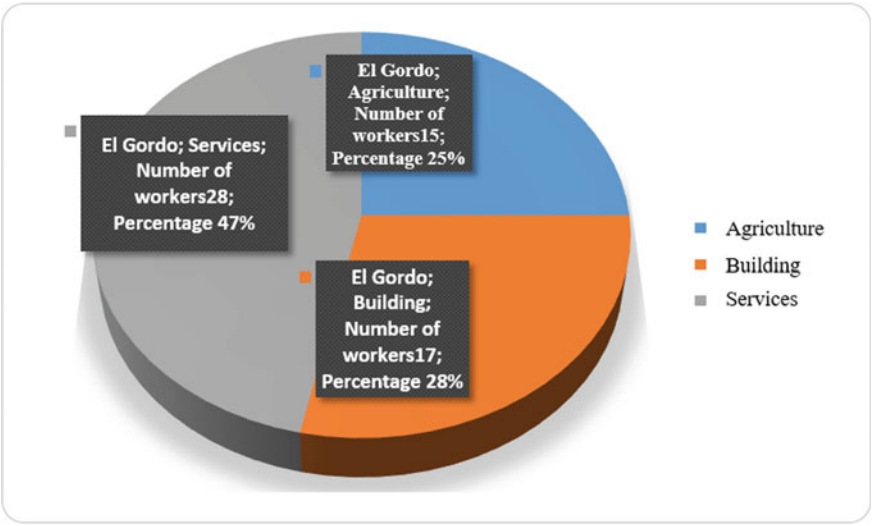


Fig. 8 Percentage of workers by economic sector in El Gordo 2007. *Source* Caja España. Own elaboration

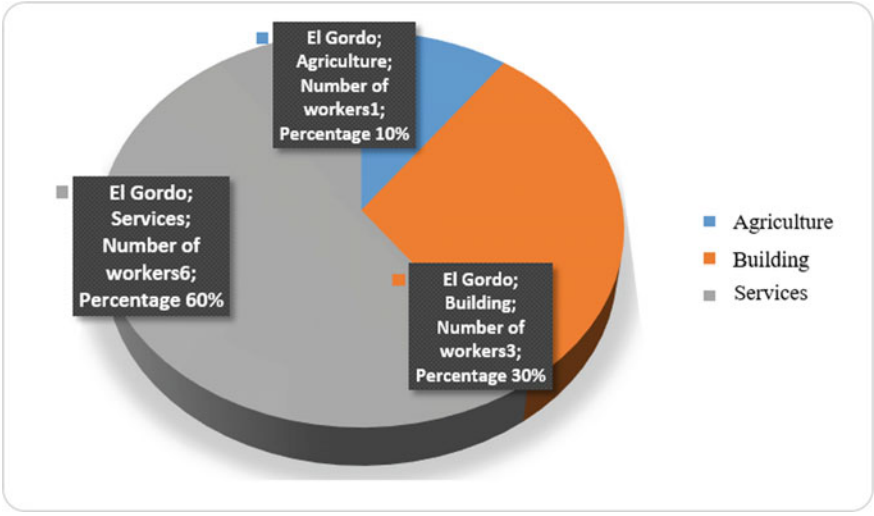


Fig. 9 Percentage of companies by economic sector in El Gordo. *Source* Caja España. Own elaboration

This rise in public coffers is what has allowed the City Councils to expand social services to their respective populations as well as the fact that by private initiative there are more premises open today than before 2007 (Figs. 11 and 12).

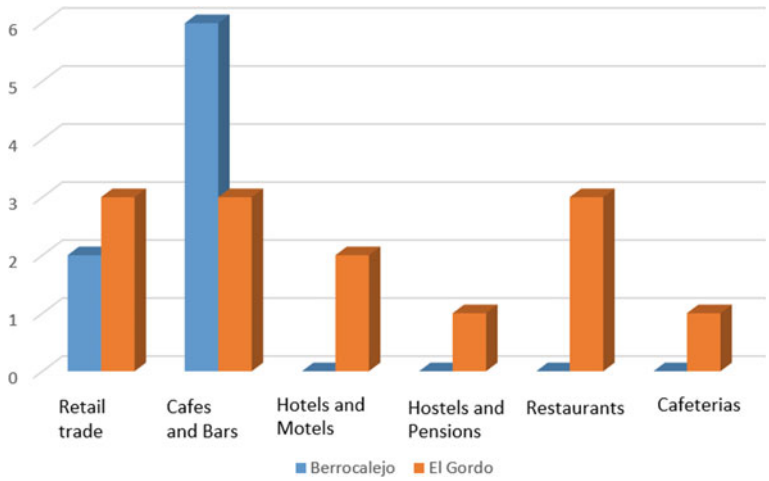


Fig. 10 Establishments in the service sector in Berrocalejo and El Gordo (2011). *Source* Caja España. Own elaboration

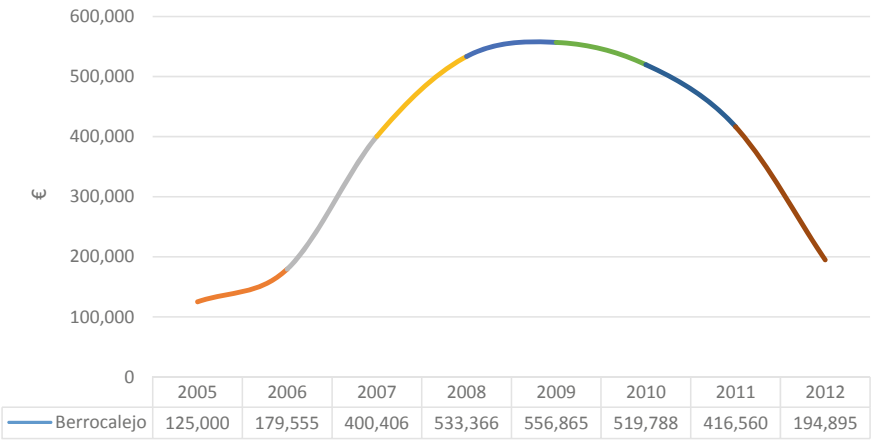
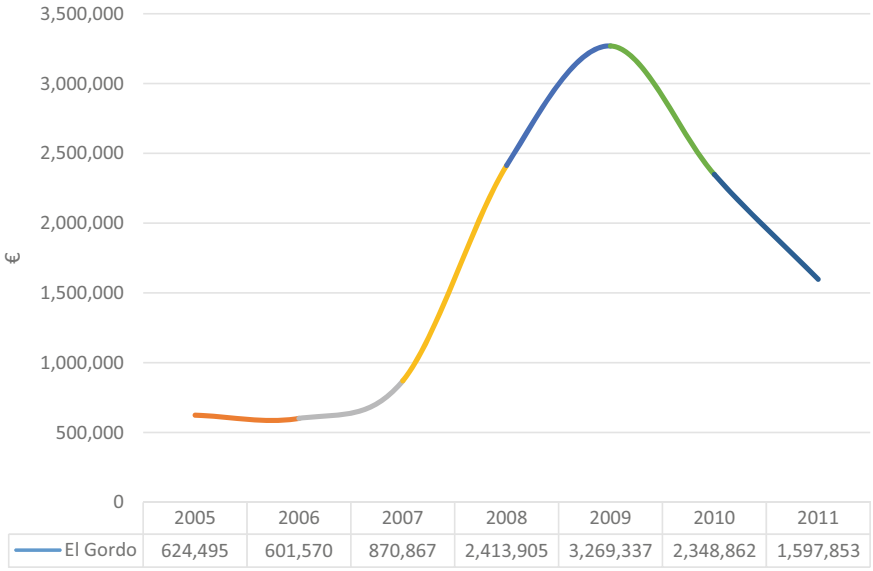


Fig. 11 Evolution of local budgets in Berrocalejo. *Source* Own elaboration

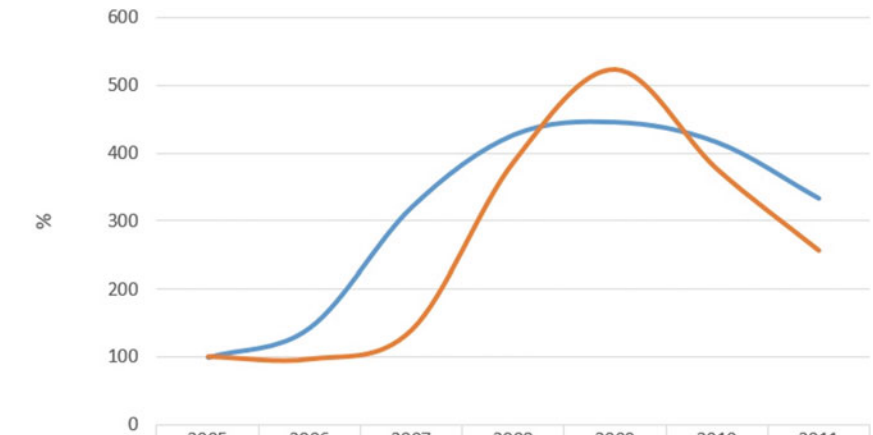
As can be seen in Fig. 13, the rise in municipal budgets has been spectacular in recent years, since Berrocalejo's budget grew by 445.5% in 2009 compared to 2005, while that of El Gordo rose 523.5% in 2009 compared to 2005. However, since 2009 and with respect to 2011, Berrocalejo's budget has decreased by –25.20% and that of El Gordo by –51.13%.

All this has resulted in an improvement in the quality of life of the citizens residing in the area, to the point that this development model based on the new functionalities of the rural world, linked to the rational exploitation of its huge



	2005	2006	2007	2008	2009	2010	2011
El Gordo	624,495	601,570	870,867	2,413,905	3,269,337	2,348,862	1,597,853

Fig. 12 Evolution of local budgets in El Gordo. *Source* Own elaboration



	2005	2006	2007	2008	2009	2010	2011
Berrocalejo	100	143.6	320.3	426.7	445.5	415.8	333.2
El Gordo	100	96.3	139.5	386.5	523.5	376.1	255.9

Fig. 13 Percentage evolution of the budgets of Berrocalejo and El Gordo. *Source* Own elaboration

tourist resources (water and landscaping, in this case), has been extremely successful, and incomparably more efficient than any of the traditional measures to use developed with European funds to fix rural population. Consequently, the initiative

as "Marina Isla de Valdecañas" is part of the Compatible Development policies recommended in the Final Document of the Rio de Janerio Conference, 2012 (Rio + 20), entitled "The Future We Want", as well as that it proposes the symbiosis between socio-economic development and environmental conservation, as is also included in the document "Transforming our world: the 2030 Agenda for Sustainable Development" (UN 2015) and the European Territorial Strategy of Postdam and the Millennium Development Goals.

3.4 Socio-economic Impact of the Judgment of Stoppage of Works on the Geographic Area of Influence

The loss of population entails the closure of activities and the next disappearance of the towns, which is negative for the environment due to the absence of traditional activities, in addition to the decrease in income from IBI of both municipalities and the provision of services.

Likewise, if we analyze the effect of the Complex on the nearby area of influence (20 km radius, established by the CSIC), it is observed, however, how the area had been decreasing between 2005 and 2007, including the Navalmoral de la Mata city, start to grow significantly between 2007 (start of works) and 2011 (Judgment of the Extremadura Court of Justice).

The area referred to in the study reverses its regressive demographic trend to increase the population by 600 people, when throughout the rural world of Extremadura and nearby Castilian-La Mancha (outside of that 20 km radius) the dynamics are totally recessive.

This demographic increase between 2007 and 2011 corresponds to the same lost number of inhabitants between 2012 and 2018.

Since 2011, after the Judgment of the Extremadura Court of Justice, the population drop in the area of influence is notorious, despite being in a "rich" area such as Campo Arañuelo and with the city of Navalmoral de la Mata acting as regional head. Here we observe the negative trend after the stoppage of the works, in the two largest nuclei that acted as poles of attraction, because they had Institutes of Secondary Education, Professional Training, health centers, and Hospital and commercial and leisure dynamics, which attracted Complex workers to stay with their families in these closest urban centers (Table 9).

Table 9 Demographic Impact of the PIR Valdecañas in the county seat and neighboring municipality of Castilla-La Mancha

Municipalities	2007	2008	2009	2010	2011	2007–11	2018	2011–18
Navalmoral de la Mata	16.931	17.103	17.228	17.309	17.386	+455 (+2.7%)	17.170	–216 (–1.2%)
Oropesa	2.870	2.940	2.937	2.942	2.977	+107 (+3.7%)	2.658	–212 (–7.1%)

Source Own elaboration based on data from the National Institute of Statistics (INE)

4 Discussion

The evolution of the population, between 2007 and 2011, not only in the municipalities of El Gordo and Berrocalejo but also in the entire area of influence within a radius of 20 km, has a positive impact, which breaks the regressive trends that were coming. suffering from decades past. However, after the stoppage of the works of the Complex, the positive dynamics have been broken and the surrounding nuclei are again in regression, including the county seats of Navalmoral de la Mata and Oropesa, which between 2007 and 2011 had increased their residents (Table 13).

It should be remembered that Berrocalejo, goes from being the municipality that proportionally grows the most in Extremadura (+45%), from 2007 to 2011; to be the municipality that loses the most population (–35.6%) of the entire region, between 2012 and 2018, due to the judicial stoppage of activities in the urbanization.

Throughout this study, the notorious positive impact that, on two small rural municipalities and, to a lesser extent, on others close to the province of Toledo, has had the construction of a Tourist Complex, such as Marina Isla de Valdecañas, in the interior of an eminently rural region (Deep Rural, according to the methodology applied by the European Commission for Extremadura).

Berrocalejo, between 2007 and 2011, with a spectacular increase in their demographic numbers, in the midst of the economic crisis, of more than 40%, contrasts with the generalized decline of the rural world in Spain and Extremadura. Well, while the small Spanish municipalities remain bloodless, despite all the subsidies received via European Community funds (EAFRD) and national funds (Proder) have not managed to reverse their regressive situation, El Gordo and Berrocalejo have substantially improved in all the variables considered.

Consequently, the Territorial Strategy based on initiatives such as "Marina Isla de Valdecañas" is framed within the Compatible Development policies recommended in the Final Document of the Rio de Janerio Conference, 2012 (Rio + 20), entitled "The future we want", which proposes the symbiosis between socio-economic development and environmental conservation.

5 Conclusions

Throughout this study, the notorious positive impact that on the two small rural municipalities directly affected (El Gordo and Berrocalejo), as well as on other nearby municipalities, especially the county seat, Navalmoral de la Mata, which increases its population by 455 inhabitants (+2.7%) between 2007 and 2011 (after a previous regression), and the Castilian-La Mancha nucleus of Oropesa that increased its inhabitants by a total of 107 (+3.7%). From 2011 to today, both returned to the phase of demographic recession in which they were immersed: Navalmoral (–1.2%) and Oropesa (–7.2%).

Not only has the number of jobs increased throughout the area and new business activities, but the affected municipalities have had more and better social facilities (swimming pools, nurseries, cultural and health facilities, nursing homes, etc.) thanks to the outstanding increase in their budgets derived from the exploitation of the new taxes associated with the aforementioned urbanization.

As can be seen in Fig. 13, the rise in municipal budgets has been spectacular in recent years, since Berrocalejo's budget grew by 445.5% in 2009 compared to 2005, while that of El Gordo rose by 523.5% in 2009 compared to 2005. However, since 2009 and compared to 2011, Berrocalejo's budget has decreased by –25.20% and El Gordo's by –51.13%.

All this has resulted in an improvement in the quality of life of the citizens residing in the area, to the point that this development model based on the new functionalities of the rural world, linked to the rational exploitation of its huge tourist resources (water and landscaping, in this case), has been extremely successful, and incomparably more efficient than any of the traditional measures to use developed with European funds to fix rural population.

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Yonatan Cáceres Escudero Researcher at GIF (Forest Research Group) of the University of Extremadura and member of INDEHESA (Institute for Dehesa Research). Activity focussed on plant ecology, biodiversityand agroforestry sciences.

Consuelo Mora Fundicotex. Degree in Anthropology and a Masters in Local Development. Research Support Technician. University of Extremadura.

Jacinto Garrido Velarde Lecturer at the Department of Social Sciences, Languages and Literatures, University of Extremadura and member of the University Research Institute for Sustainable Territorial Development (INTERRA). Some of the subjects or research areas implemented at the University of Extremadura have been or are the following: Spatial Planning, Urbanism, Sustainable Development, Strategic Planning, and Cross Border Cooperation, etc.

Best Management Practices for Controlling the Urban Surface Runoff in Coastal Zones: A Case Study in Guarujá, State of São Paulo, Brazil

Vinicius Roveri, Luciana Lopes Guimarães, and Alberto Teodorico Correia

1 Introduction

Currently 40% of the world's population (estimated at 7.2 billion people) lives in about 2100 coastal cities (Pelling and Blackburn 2013; United Nations Department of Economic and Social Affairs [Undesa] 2017; Blackburn et al. 2019). According to a geographic delimitation criterion, coastal cities can be considered those located up to 100 km from the coast and up to 50 m in altitude (Barragán and Andrés 2015; Undesa 2017; Blackburn et al. 2019). The high concentration of population in the coastal cities raises some concern because there are many people living in this small

V. Roveri
Faculdade de Ciência e Tecnologia da, Universidade Fernando Pessoa (FCT-UFP), Praça 9 de Abril 349, 4249-004 Porto, Portugal
e-mail: viniciusroveri@bol.com.br

V. Roveri
Universidade Metropolitana de Santos (UNIMES), Avenida Conselheiro Nébias, 536 - Encruzilhada, 11045-002 Santos, São Paulo, Brasil

V. Roveri · A. T. Correia (✉)
Centro Interdisciplinar de Investigação Marinha e Ambiental (CIIMAR/CIMAR), Avenida General Norton de Matos S/N, 4450-208 Matosinhos, Portugal
e-mail: atcorreia.ciimar@gmail.com

L. L. Guimarães
Laboratório de Pesquisa em Produtos Naturais, Universidade Santa Cecília, Rua Cesário Mota 8, 83A, 11045-040 Santos, São Paulo, Brasil

A. T. Correia
Faculdade de Ciências da Saúde da Universidade Fernando Pessoa (FCS-UFP), Rua Carlos da Maia 296, 4200-150 Porto, Portugal

A. T. Correia
Instituto de Ciências Biomédicas Abel Salazar da Universidade do Porto (ICBAS-UP), Rua de Jorge Viterbo Ferreira 228, 4050-313 Porto, Portugal

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area of the world's land surface (estimated at between 4 and 8%), thus causing an intensive anthropic use of the narrow coastal areas (Barragán and Andrés 2015; Undesa 2017; Blackburn et al. 2019). As a consequence, countless human activities, mainly related to port, industry, transportation, civil construction and tourism, cause several economic and socio-environmental conflicts, with direct consequences on the coastal aquatic ecosystems (Lusk and Toor 2016; Yang and Toor 2017; United Nations [UN] 2018).

Many of the coastal occupation processes observed worldwide are closely related with the rate of population growth in developing countries, such as Brazil (Von Glasow et al. 2012; Barragán and Andrés 2015; Blackburn et al. 2019). Brazil is the largest country in South America, whose territory occupies almost half of the South American continent (47.3%), with an area that exceeds 8.5 million km^2 (Brazilian Institute of Geography and Statistics [Ibge] 2018). In the latest census, Ibge estimated its population around 210 million inhabitants, 26.6% of which inhabit the coastal area of the country (about 8500 km of coastline) (São Paulo State Secretariat for the Environment/Planning and Environmental Education Coordination [SMA/CPLEA] 2005; São Paulo State Secretariat for the Environment/Environmental Planning Coordination [SMA/CPLA] 2012; Ibge 2018). One the most important Brazilian coastal regions is the Metropolitan Region of Baixada Santista (MRBS) located in the State of São Paulo. MRBS has a total area of 2422 km^2, and about 245 km of coastline which covers nine municipalities (about 2.0 million inhabitants), including the Guarujá city. Due to its natural richness, beautiful beaches and historical constructions, Guarujá is considered one of the main Brazilian tourist destinations (SMA/CPLEA 2005; SMA/CPLA 2012; Roveri 2019). Moreover, Guarujá has a geographic strategic position, serving as a link between the Port Complex of Santos-Guarujá (the largest in Latin America), and the city of São Paulo (the state capital, and the country's main economic centre) (SMA/CPLEA 2005; SMA/CPLA 2012; Ibge 2018).

However, because of its economic and socio-environmental importance, since the end of the twentieth century, Guarujá sub-basin is under strong anthropic pressure. This occurs because, although it has a drainage area of approximately 143 km^2, about 107 km^2 are environmentally protected areas and, therefore, currently about 316,000 inhabitants are concentrated in a small territorial fraction (corresponding to 36 km^2) (SMA/CPLEA 2005; SMA/CPLA 2012; Ibge 2018). The scenario is worsened during the summer, when tourism intensifies, and the population almost doubles (SMA/CPLA 2012; Ibge 2018; Roveri 2019). As a result of this high-population density, jointly with the non-existence of urban planning, Guarujá has suffered for decades from socio-environmental and urban infrastructure problems, mainly because more than 64,000 residents live in poor communities (locally named "*favelas*", mainly in the hill of Enseada and in the Beach waterfront of Perequê, and therefore do not have basic sanitation facilities (SMA/CPLA 2012; Trata Brazil Institute 2018; Roveri 2019). Thus, although the municipal sewage collection and treatment network is sized for a population of 450,000 inhabitants, the destination of clandestine sewage from the "*favelas*" ends up on the 43 artificial urban drainage channels, and a complex mixture (composed of domestic sewage

and urban diffuse load) flows directly to the beaches of the municipality and, therefore, may compromise the public and environmental health of Guarujá (SMA/CPLA 2012; Trata Brazil Institute 2018; Roveri 2019).

According to the UN, the diffuse loads flowing into the worldwide coastal areas have been viewed with concern in the last decade, because is difficult to monitor (UN 2018). Several studies conducted in coastal cities of Mexico (Curiel-Ayala 2012), China (Zhang et al. 2013), Cuba (Larrea-Murreal et al. 2013), Colombia (Botero et al. 2015), United States (Tilburg et al. 2015) and Italy (Federigi et al. 2016), have warned that urban runoff is a potential threat to the public and environmental health, as it is responsible for introducing chemical and biological pollutants directly into estuaries and oceans (areas of intense human recreation) (Tilburg et al. 2015; Federigi et al. 2016; UN 2018). In this context, recently, some studies demonstrated that the urban surface runoff of Guarujá, is also responsible for introducing a mixture of conventional and emerging pollutants into the tourist beaches, resulting from numerous anthropic activities that take place along this hydrographic basin (Roveri et al. 2020a, b, c, d). According to these studies, the channels of Enseada and Perequê beaches are considered to be the most impacted in the city, since they receive the clandestine domestic sewage from regular and irregular occupations along these beaches, mainly during the Brazilian summer (period of greatest tourist affluence). Of the 231 physical, chemical and microbiological analyses performed on these channels, only 34–43% were in compliance with the current Brazilian legislation (Roveri et al. 2020a). Moreover, these channels were identified as a potential threat to the public health, as they are responsible for the introduction of allochthonous pathogenic microorganisms, related to disease outbreaks, in areas of intense human recreation (Roveri et al. 2020a, b). For instance, the concentrations of bacteria (*Escherichia coli* and *Enterococci*) and the viral loads (species HAdV-C, D and F) detected in these two channels are alarming, as they are higher than the maximum concentrations detected in different coastal areas around the world (Roveri et al. 2020a, b). In addition, these waters are eutrophic, and excess of surfactants and nutrients, such as phosphorus, phosphates and ammonia, were reported (Roveri et al. 2020a). Consequently, benthic macrofauna taxa, tolerant to organic pollution, were inventoried in the sediment adjacent to these channels (e.g., Oligochaeta, Ceratopogonidae, Chironomidae and *Chironomus*) (Roveri et al. 2020c). Regarding emerging pollutants, a total of sixteen pharmaceuticals of various therapeutic classes (among them: caffeine, acetaminophen, diclofenac, losartan and valsartan) and illicit drugs (cocaine and its metabolite benzoylecgonine), were also detected in these channels, and indicated a moderate to high ecological risks to algae, crustaceans and/or fish (Roveri et al. 2020d).

In an attempt to solve the historic disorderly growth of the municipality, the city government implemented in 2010 the "Guarujá Waterfront Project", as result of a joint action between the Ministry of Urban Development and Environment [Brazil] (Brazil 2006), and the Guarujá city hall [Guarujá] (Guarujá 2013, 2019). This project was conceived based on surveys about the current conditions of the land use and occupation of the city's waterfront and integrates strategic tools such as the Economic Ecological Zoning of Baixada Santista [São Paulo] (State Decree No

58.996/2013) (São Paulo 2013), besides the Guarujá Master Plan and the respective criteria regarding the land use and occupation of the city (Complementary Law No 156/2013) (2013, 2019). The "Guarujá Waterfront Project" establishes guidelines to prevent, correct and/or mitigate the impacts on the natural environment caused by the human intervention, generally disorganized, illegal, or improper, having as consequences the launching of untreated sewers and pollution to watercourses (Guarujá 2013, 2019). Moreover, it also aims to contribute to the reduction of conflicts related to the land use and occupation of the coastline, establishing strategies to rescue the attractiveness of this space as a democratic place of leisure (Guarujá 2013, 2019).

However, despite its socioeconomic and environmental importance, the "Guarujá Waterfront Project" still lacks effective strategies to controlling the urban surface runoff which occur in the tourist beaches of the Guarujá (Guarujá 2013, 2019; Roveri et al. 2020a, b, c, d). An effective strategy would be to adopt a "Best Management Practices" (BMP) program, which are a combination of social-environmental practices used to prevent, correct and/or mitigate non-point source pollution (Roveri et al. 2020a, b, c, d), which during the last few decades, has been successfully adopted by several developed countries, such as Canada (Greater Vancouver Sewerage and Drainage District [GVS and DD] 1999), New Zealand (New Zealand Water Environment Research Foundation [NZWERF] 2004) and, particularly, United States (North Carolina Department of Environment and Natural Resources [NCDENR] 2007); and (Urban Drainage and Flood Control District [UDFCD] 2016).

In this context, the aim of this work is to suggest BMP for controlling the urban surface runoff which occurs in two tourist beaches of the Guarujá, namely Enseada and Perequê. On a local scale, the dataset from this work will subsidize action plans for the "Guarujá Waterfront Project", and therefore, will allow Guarujá to reaches the sixth Sustainable Development Goal (SDG) from UN. SDG nº6 seeks to "ensure sustainable management of water and sanitation for all" (UN 2018). In a regional scale, the results from this study will contribute to the Environmental Agency of the State of São Paulo [Cetesb] adopt BMP throughout the MRBS. In São Paulo coastal zone, there are 600 urban drainage channels (registered by Cetesb and with characteristics similar to those of Guarujá), whose diffuse loads flow to 290 tourist beaches (Cetesb 2020). Moreover, at a global scale, the major findings from this work will help stakeholders (civil society, public authorities and environmental agencies) to adopt BMP in different coastal zones worldwide, namely in developing countries.

2 Material and Methods

2.1 Study Area

This study took place in Guarujá city, MRBS, São Paulo, Brazil (23° 59′ 18″ S 46° 14′ 32″ W), which is considered the third largest coastal island in São Paulo

coast, with an area of 143 km^2. Guarujá has a tropical climate, characterized by a mean annual precipitation and temperature of 3000 mm and 22 °C, respectively. Two main seasons are observed in the region: a rainy (November to March) and a dry (April to October) period (SMA/CPLEA 2005; SMA/SPLA 2012). Favoured by these climate conditions, and endowed by an ecosystem diversity, it is possible to find along its coastal area mangroves, rocky shorelines, sandbanks and estuaries, besides 26 beaches providing good conditions for tourism throughout the year (SMA/CPLEA 2005; SMA/CPLA 2012; Ribeiro and Oliveira 2015).

Among these 26 beaches, two were selected to apply the BMP, namely Enseada and Perequê. For the selection of both beaches were established some criteria, such as:

(a) Different characteristics regarding land use and occupation: The beach of Enseada has a high tourist visitation (Ribeiro and Oliveira 2015). Moreover, the system of oceanic disposal of sanitary sewage of the municipality of Guarujá—Sewage Pre-Conditioning Station (SPS) of Vila Zilda—is located on this beach (Cetesb 2020). Although it has medium and high standard hotels and residences, this beach contrasts with the presence of favelas (sanitation deficiency) on the slope of Enseada's hill (Ribeiro and Oliveira 2015). The Perequê is located in a region with sanitation deficit, that hosts the largest fishing community in Guarujá (about 10,000 residents), which settled illegally along the edge of the beach in an environmentally protected area (Ribeiro and Oliveira 2015).
(b) Representativeness of these two beaches in the "Guarujá Waterfront Project": among the six study sectors, delimited by the City Hall for the "Guarujá Waterfront Project", the Enseada is located in sector 3, and the Perequê in sector 4 (Brazil 2006; São Paulo 2013; Guarujá 2013, 2019).
(c) Potential threat to public and environmental health: Guarujá has 26 beaches, and since 2005, 8 are regularly monitored by Cetesb, including Enseada and Perequê. This choice took into consideration the levels of urbanization, the physiography of beaches, the frequency of bathers and the risks of pollution. Historically, between 2009 and 2019, the beach of Enseada presented a water quality classification between "regular and bad", and the Perequê, obtained a systematically "terrible" classification (Cetesb 2020). Moreover, recently studies conducted in the urban drainage channels of Enseada and Perequê have already identified the urban surface runoff as a potential threat to public and environmental health, as it is responsible for introducing a complex mixture of pollutants (physical, chemical and microbiological) directly into the tourist beaches (areas of intense human recreation) (Roveri et al. 2020a, b, c, d).

For more information about the main characteristics regarding the land use and occupation of these beaches, see Fig. 1.

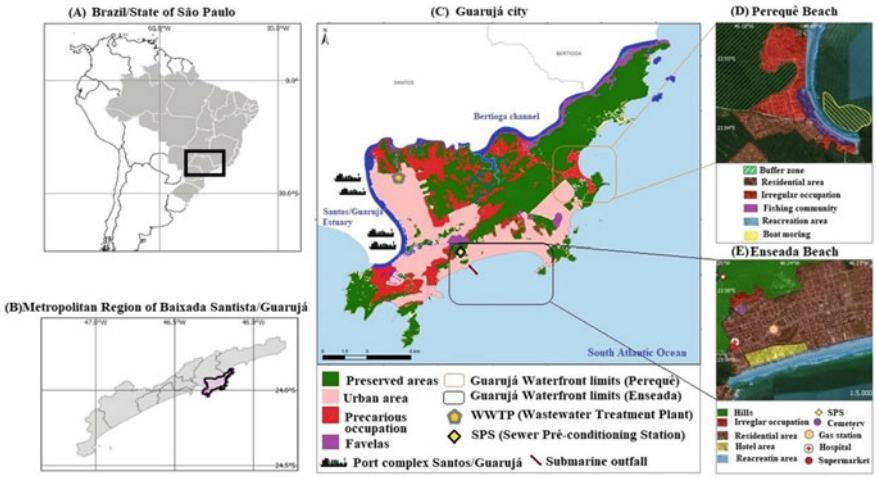

Fig. 1 Brazil, State of São Paulo (**a**), Metropolitan Region of Baixada Santista (**b**), Guarujá: boundaries of the "Guarujá Waterfront Project" and the respective locations of Enseada and Perequê Beaches; and main characteristics regarding the land use and occupation of these beaches (**c**). Detail for occupations in favela areas at Perequê beach (**d**) and precarious occupations at Enseada beach (**e**) (adapted from SMA/CPLA 2012)

2.2 Selection of Best Management Practices

This study was based on the BMP for controlling the urban surface runoff, which were successfully adopted in Canada (GVS and DD 1999), New Zealand (NZWERF 2004) and in United States (NCDENR 2007; UDFCD 2016). In Canada, the Environmental Agency has adopted the GVS and DD program (GVS and DD 1999). In New Zealand, the Environmental Water Research Foundation followed the program On-site Stormwater Management (OSM) (NZWERF 2004). In the United States, the Environmental Agency has adopted two programs: Best Management Practices (BMP) and Low Impact Development (LID) (NCDENR 2007; UDFCD 2016). All these programs are based on holistic practices and therefore adopt a "non-structural" and "structural" management measures (GVS and DD 1999; Novotny 2003; NZWERF 2004; UDFCD 2016). The "non-structural" measures are related to community education programs, e.g., recycling actions; maintenance practices; control of pollutants at source; planning of land use and occupation; control of the waste disposal; urban cleaning; maintenance of public roads and drainage systems; and control of irregular sewage connections, among other practices. The "structural" measures are related to engineering works and other physical interventions related to the control of water flow in urban channels, e.g., adoption of porous paving; installation of infiltration wells; installation of infiltration and/or retention basins, among others (GVS and DD 1999; Novotny 2003; NZWERF 2004; UDFCD 2016).

2.3 Current Brazilian Legislation

In addition to the best management practices previously reported, such as the GVS and DD, OSM, BMP and LID programs, this study was also supported by the current Brazilian legislation. The legal basis relies on a framework of infra-constitutional rules, both at the federal and municipal levels. At the federal level, six laws: (i) Federal Law No 9,605/1998, which provides for criminal and administrative sanctions resulting from conducts and activities harmful to the environment (Brazil 1998); (ii) Federal Law No 9,966/2000, which provides for the prevention, control and inspection of pollution caused by oil spills and other harmful or dangerous substances in waters under jurisdiction national (Brazil 2000); (iii) Federal Law No 12,305/2010, which institutes the National Solid Waste Policy (Brazil 2010); (iv) Federal Law No 430/2011, which provides conditions and standards for discharge of effluents in Brazil (Brazil 2011); (v) Brazilian Technical Standards Association [ABNT] standard No 16457/2016, which provides for procedures for Reverse logistics of expired and/or out-of-use medicines for human use (ABNT 2016); and (vi) Federal Law No 13.465/2017, which provides for urban land regularization (Brazil 2017). At the municipal level, the Complementary Law No 44/1998, which provides for Code of Guarujá Positions (Guarujá 1998), was take into account.

3 Results and Discussion

The following recommendations are based on the GVS and DD, OSM, BMP and LID programs and supported by the current Brazilian legislation, which can subsidize some plan actions for the "Guarujá Waterfront Project".

3.1 Environmental Education Programs

Firstly, it is recommended that the city hall of Guarujá, through the Secretariats of Environment and Public Health, promotes environmental information programs oriented to the community, discussing the problems related to the environmental and public health due to improper disposal of urban solid waste (USW) in the environment. Previous studies aiming to analyse the water quality of the Enseada and Perequê channels (Roveri et al. 2020a, b, c, d) reported inadequate USW disposal in the streets, drainage channels and beaches through the year, which can be transported to the sea (especially during the rainy season). As provided in the Complementary Law No 44/1998—articles: 62 to 66; 67 to 72 and 95 to 99, the irregular disposal of USW on beaches and other public roads of the municipality is prohibited (Guarujá 1998). In addition, it is important to stress that the irregular

Fig. 2 Irregular garbage disposal at Enseada beach, Guarujá, São Paulo coastal zone, Brazil. In the foreground of the image, a child lying along the urban runoff of that beach. *Source* Personal archive

disposal of waste on beaches and public roads is considered an environmental crime, according to the Federal Law No 9,605/1998—Article 54 (Brazil 1998). In addition, a program of public awareness, in loco, targeted to the beach users (mainly during the summer tourist season) should be pondered. Again, during the fieldwork of previous published studies (Roveri et al. 2020a, b, c, d), it was possible to observe that people constantly come into contact with the waters of these channels, demonstrating total ignorance about the potential health risks due to this behaviour. For more details, see Fig. 2.

3.2 Awareness Program on the Collection of Drug Residues

A total of sixteen pharmaceuticals of various therapeutic classes, including illicit drugs, were detected for the first time in the channels of Enseada and Perequê, suggesting a moderate to high ecological risks to algae, crustaceans and/or fish (Roveri et al. 2020d). Although the untreated discharge of domestic sewage containing pharmaceuticals and illicit drugs in its original, metabolised or conjugated forms jointly with human and/or animal excrements, is the main route by which these compounds reach the urban drainage channels, the improper disposal of vials medicines is also another important pathway to contaminate the environment (Roveri et al. 2020d). In this context, the Federal Law No 12,305/2010 requires the correct disposal of expired drugs (Brazil 2010). For this, Health Surveillance

Agency (Anvisa) through the ABNT standard No 16457:2016, established a reverse logistics program, where pharmacies and drugstores throughout the country became accredited collection points (ABNT 2016). These establishments receive the expired and unused drugs to forward them to their final destination, thus minimizing the risks of environmental contamination. This way, the city hall of Guarujá needs to carry out a program of awareness of the residents, so that they can carry out the reverse logistics of medicines and avoid the inappropriate disposal of these drugs into the environment.

3.3 Public Cleaning Services

As described in sub-topic 3.1, inadequate USW disposal was constantly observed in the streets, drainage channels and beaches of Enseada and Perequê (Roveri et al. 2020a, b, c, d). Moreover, it is known that complex mixture of pollutants (physical, chemical and microbiological) can enter the urban drainage channels through multiple pathways, among which the launching of untreated sewers and/or leachates from USW (Roveri et al. 2020a, b, c, d). Therefore, the city hall needs to intensify the cleaning of public roads in order to reduce the inappropriate disposal of USW and/or leachates from USW into the channels (especially during the period of greater rainfall in the region). In addition, a program of cleaning and silting of the channels needs to be intensified, as provided in Complementary Law No 44/1998—articles: 3 to 7 and 73 to 89 (Guarujá 1998). To more details about the cleaning of public roads which occur in Guarujá, see Fig. 3a, b.

Fig. 3 Services of silting (**a**) and cleaning (**b**) performed by the city hall of Guarujá in the urban drainage channels of Enseada, Guarujá, São Paulo coastal zone, Brazil. *Source* Personal archive

3.4 Correction of the Sanitation Infrastructures

The channels of Enseada and Perequê beaches are considered to be the most impacted of the city, since they receive the clandestine domestic sewage from regular and irregular occupations along these beaches, mainly during the Brazilian summer (period of greatest tourist affluence) (Roveri et al. 2020a, b, c, d). Regarding the regular occupations, it is urgent that the Guarujá city hall makes the inspection of the commercial and residential buildings in the municipality and requires the connection of these infrastructures to the existing municipal sewage collection system, as supported by the Supplementary Law No 44/1998—Articles: 62 to 66 and 67 to 72 (Guarujá 1998). Moreover, it is necessary to carry out the land regularization of the irregular occupations on the hills of Enseada and on the edge of Perequê, since according to article 38 of Federal Law No 9,605/1998, it is prohibited to degrade these areas of permanent preservation (Brazil 1998). The land regularization of these areas (a responsibility shared among the Federal, State and Municipal governments) is provided in Article 14 of Federal Law No 13.465/2017 (Brazil 2017). Without this land regularization, the State Sanitation Agency is forbidden, due to legal issues, to install a sewage collection system in these neighbourhoods.

3.5 Installation of Floodgate System in the Channels

It is essential that the Guarujá city hall install a floodgate system in the urban drainage channels and interconnect them into the SPS of Vila Zilda (for more details, see Fig. 1), such as already occurred in the city of Santos, São Paulo, Brazil, a neighbouring city of Guarujá. Although both Guarujá and Santos channels are made of concrete, Santos's channels have already a floodgate system with an automatic closure and opening mechanism (for more details, see Fig. 4a, b). During the dry period, the floodgates are closed and the diffuse load flows to the SPS of Santos. However, during intense rain and floods events, the floodgates are opened, and the diffuse loads are discharged directly into the bathing waters of Santos. In this way, this physical barrier in the channels of Enseada and Perequê will prevent that the complex mixture of the channels come into contact with the seawater, thus reducing the health public risks for the bathers.

3.6 Installation of an Oceanic Interceptor Upstream the Floodgates

In addition to the installation of a floodgate system, it is recommended that the Guarujá city hall install an oceanic interceptor (also similar to the one existing in

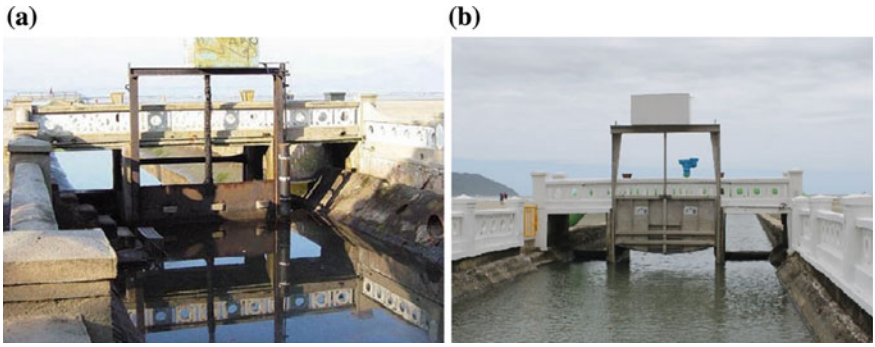

Fig. 4 Floodgate system installed in the urban drainage channels of Santos, São Paulo coastal zone, Brazil. **a** Presents the closed floodgates, preventing urban drainage from coming into contact with sea water. **b** The locks are opened by the city hall when there is rain and, this way, floods in the city are avoided. *Source* Personal archive

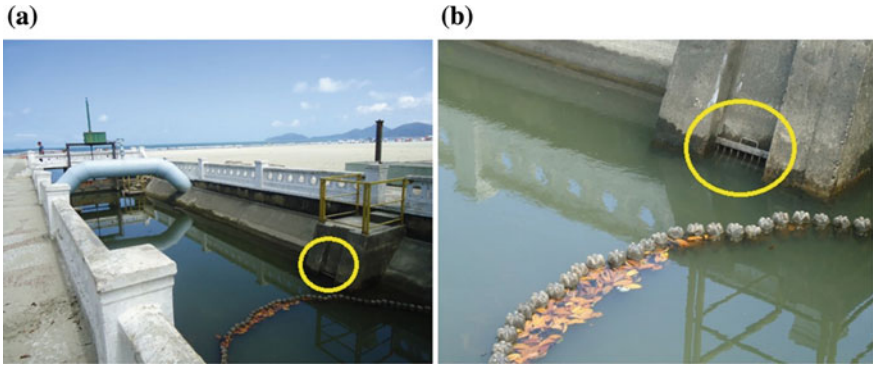

Fig. 5 Oceanic interceptor, installed upstream of the floodgate and signalled in yellow, conducts the waters from urban drainage (by gravity) to the Sewage Pre-Conditioning Station of Santos, State of São Paulo, Brazil, avoiding the contribution of this diffuse cargo directly to the beaches of the municipality. *Source* Personal archive

Santos) (for more details, see Fig. 5a, b) that interconnects the waters of the channels to the Guarujá SPS. Therefore, the water from the urban channels will be conducted to the pre-conditioning station, together with the city's sewers and, soon after, this complex mixture will be launched into the sea, via submarine outfall. With the removal of this diffuse load from the beach area, there will certainly be an improvement in the bathing waters with direct effects on public health, tourism and economy of the city.

3.7 Installation of Containment Barriers

To reduce the risks of accidental spillage of chemical and/or oil substances generated along the cities, which generally flow through drainage channels, it is necessary to install containment barriers, upstream of the oceanic interceptor, avoiding that these pollutants are discharged to the sea (for more details, see Fig. 6a). In this context, an accidental municipal sewage leak on Pitangueiras beach, Guarujá, occurred in 2018, which was conducted to the sea through the urban drainage channels (for more details, see Fig. 6b). At that time, Cetesb banned temporarily the use of beaches (Cetesb 2020). It is important to emphasize that the disposal of oil substances is considered an environmental crime according to the Federal Laws No 9605/1998—(Article 54) and No 9966/2000—(Articles 15 to 21) (Brazil 1998, 2000).

3.8 Improvements in the Treatment of the Guarujá Sewage

The sewage of Guarujá is treated through a combined system, where the largest portion, covering the tourist beaches and the neighbourhoods of the shoreline (included, Enseada and Perequê), is served by the SPS of Vila Zilda, where the sewage goes through a preliminary simplified system (railing and screening for the removal of solids), which is followed by a chlorination step for the elimination of pathogenic microorganisms (De Souza Abessa et al. 2012; Baptistelli and Marcellino 2016; Ortiz et al. 2016). The final destination of this pre-conditioned sewer is a 4500-m-long and 14-m-deep submarine outfall that disposes the sewers

Fig. 6 **a** Content barrier system (configured in "U" shape), used to retain solid waste and other chemical and/or oily pollutants that are conducted into the urban drainage channels in Santos, Brazil; **b** Accidental sewage leak in Pitangueiras beach, Guarujá, Brazil (in 2018), conducted to the sea through urban drainage channels. *Source* Personal archive

daily in the marine environment (Enseada beach), with a flow of 1.45 m^3/s (For more details, see the localization of submarine outfall in Fig. 1). Consequently, physical and chemical micropollutants are not removed by SPS of Vila Zilda (Roveri et al. 2020e). The other parcel, covering the district of Vicente de Carvalho, is served by a Wastewater Treatment Plant (WWTP) with a secondary level of treatment (removal of organic load), located at the other end of the island. This WWTP rejects the sewers in the Acaraú River, whose final contribution is the Bertioga Channel (see localization of WWTP in Fig. 1). Together, both systems are sized for a population of approximately 450,000 inhabitants (De Souza Abessa et al. 2012; Baptistelli and Marcellino 2016; Ortiz et al. 2016). Therefore, the quality of the coastal waters and, especially, of the Guarujá beaches, is greatly influenced by the conditions of the city basic sanitation. The greater is the coverage of the collection network, the better is the level of sewage treatment. Like that, the chances that the contribution of pollutants will occur in these water resources will be low, contributing to the maintenance of good ecological and sanitary conditions of the waters (De Souza Abessa et al. 2012; Baptistelli and Marcellino 2016; Roveri et al. 2020e). Thus, although the SPS together with the submarine outfall operation present benefits for the quality of Guarujá's beaches (because it keeps the sewage away from the recreation area), the disposal of pre-conditioned sewage in the marine environment does not represent the best solution for the environmental sanitation of this coastal region (De Souza Abessa et al. 2012; Baptistelli and Marcellino 2016). For this reason, the revision of Federal Law No 430/2011 becomes fundamental, so that more sustainable operational criteria for the SPS of Guarujá can be adopted, such as the installation of a system with secondary and/or tertiary level of treatment (Brazil 2011; De Souza Abessa et al. 2012).

4 Conclusion

Jointly with the disorderly growth of the Guarujá city, considered one of the main destinations of the Brazilian tourist, several urban woes have occurred and are of great concern for the political authorities, environmental agencies and general public. Among these problems, mainly caused by high-population density together with the absence of urban planning, the negative socio-environmental impact of urban surface runoff on the coastal water quality is among one of the most serious ones. Historically, the urban surface runoff flowing into the beaches of Enseada and Perequê, in Guarujá, is responsible for introducing physical, chemical, and biological pollutants directly into the tourist beaches, known as regions of intense human recreation. In an attempt to solve the disorderly growth of the municipality, the city government implemented in 2010 the "Guarujá Waterfront Project". However, despite its socioeconomic and environmental importance, this project still lacks effective strategies for controlling the urban surface runoff which occur in the tourist beaches of the Guarujá, São Paulo, Brazil. The present study indicated best management practices for controlling the urban surface runoff which occur in

beaches of the Enseada and Perequê, based on BMPs (e.g., LID, GVS&DD and OSM programs) which were successfully adopted in Canada, New Zealand and United States. Moreover, the recommendation of some BPMs was supported by the current Brazilian legislation, both at the federal and municipal levels. The results showed that (i) environmental education programs; (ii) awareness programs on the collection of drug residues; (iii) public cleaning services; (iv) correction of the sanitation infrastructures; (v) installation of a floodgate system in the channels; (iv) installation of an oceanic interceptor upstream the floodgates; (vii) installation of containment barriers; and (viii) improvements in the treatment of the Guarujá sewage, were important issues to be implemented, which can subsidize the action plans for the Guarujá Waterfront Project. Moreover, in regional scale, the data from this work will allow the state environmental agency to adopt best management practices throughout the Metropolitan Region of Baixada Santista. In São Paulo coastal zone, there are 600 urban drainage channels, whose diffuse loads flow into 290 tourist beaches. Moreover, at global scale, the major findings from this work will support the stakeholders (civil society, public authorities and environmental agencies) to adopt best management practices in different coastal zones worldwide, namely, in developing countries. Therefore, regardless of the local sphere of this case-study, the results from of this study intents to promote the Sustainable Development Goal nº6 from UN, i.e., "ensure a sustainable management of water and sanitation for all".

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Vinicius Roveri, M.Sc. is a PhD student in the Faculty of Science and Technology of the Fernando Pessoa University (FCT-UFP), Porto, Portugal. He is also professor in the Metropolitan University of Santos, Municipality of Santos, State of São Paulo, Brazil.

Luciana Lopes Guimarães, Ph.D. is a professor at the Santa Cecilia University, in Santos, São Paulo, Brazil, in the Postgraduate Program in Sustainability of Marine and Coastal Ecosystems and in the Courses of Pharmacy and Dentistry.

Alberto Teodorico Correia, Ph.D. is header of the Group of Ecophysiology of the Interdisciplinary Centre of Marine and Environmental Research (CIIMAR) in Matosinhos Portugal. He is also professor at the Faculty of Health Sciences in the Fernando Pessoa University (FCS-UFP), Porto, Portugal. Has expertise in Aquatic Ecology and Ecotoxicology.

The Role of Environmental Health Workforce and How the World Has Discovered the Importance of Prevention

Susana Mónica Marinho Paixão

1 The History

We can consider that Environmental Health, which is based on health promotion and disease prevention, was already known and taken into consideration in ancient Greece, when Hippocrates, a Greek physician from the fifth century BC (considered the father of medicine), focused, perhaps, for the first time, in the perspective that diseases were not caused by angry spirits or Gods, but that they were caused by environmental factors and causes related to the individual such as their habits and lifestyles, having even transposed all this information into the famous Treaty "On airs, waters and places" and where Hippocrates advice physicians to "consider the seasons of the year, and what effects each of them produces" (Levin 2017).

Hippocrates also developed the theory of miasma or miasmatic theory, which argued that diseases were spread by a miasma, the ancient Greek word for pollution, a harmful form of "bad air", caused, for example, by decomposing organic matter (Pereira and Veiga 2014).

With the Middle Ages, and despite the emergence of diseases such as the black plague, which killed more than a third of the European population, the principles of preventive medicine and in particular of environmental health issues have proved essential. There are very interesting reports that take us back to this period and enable us to understand that there was no sense of order and far less knowledge

S. M. M. Paixão (✉)
Department of Environmental Health, Coimbra Health School, Polytechnic Institute of Coimbra, Coimbra, Portugal
e-mail: supaixao@estescoimbra.pt

S. M. M. Paixão
Centre of Studies in Geography and Spatial Planning, Coimbra, Portugal

S. M. M. Paixão
International Federation of Environmental Health, London, UK

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about basic sanitation, where people lived in the middle of all types of waste, with risks, in particular for health, which all this entailed.

It was with the Renaissance that attention was once again given to environmental issues and to how these conditioned the onset/incidence of disease. But it was at the end of the nineteenth century that the sanitary vision became dominant and particular emphasis was placed on the importance of basic sanitation and its importance for the health of the population.

Among the structural changes that allowed the paradigm shift, we can highlight those carried out by the English lawyer Edwin Chadwick, namely with regard to urban sanitation and public health, after the publication of his 'Report on the sanitary conditions of the working population of Great Britain' in 1842, in which he calculated the average life expectancy of the population, based on their social class and the place where they lived in.

We can say that the genesis of Environmental Health, as a branch of public health and workforce, happened in 1883, when the Association of Public Health Inspectors was founded, with Edwin Chadwick as its first president (CIEH 2021).

But it was the father of modern epidemiology, the physician John Snow, who gave Environmental Health another boost. In being skeptical of the miasma theory, which dominated this period, Snow focused on observing the evidence. It is worth mentioning the cholera outbreak that in 1849 affected the residents who used the public water pump located on Broad Street (currently Broadwick Street), in London and that with Snow's intervention, namely with visits to the site and conversation with the residents, established a pattern of disease that managed to persuade government officials to deactivate the water pump, and the number of cases decreased considerably, allowing to establish a relationship between the role of water supply in the cholera epidemic (Pereira and Veiga 2014).

It was the discovery of John Snow that led to the rejection of the Miasma theory and after 1880 the theory was completely replaced by the Theory of Germs of diseases, which is based on the premise that specific germs are responsible for causing specific diseases. It is important to highlight that the Miasma Theory was very important for the basis of Public Health and particularly for basic sanitation, since it managed to make of cleaning the cities and "getting rid of garbage" a priority (Tulchinsky and Varavikova 2014; Pereira and Veiga 2014).

The sanitary vision became dominant at the end of the nineteenth century and was consolidated during the twentieth century.

Throughout the twentieth century there are several moments and events that we can highlight namely for reinforcing the importance of Environmental Health and of how there is a direct relationship between the environment that surrounds us and our health.

In 1962, the American biologist Rachel Carson alerted to the effects of DDT (a pesticide widely used at the time and which has been shown to have implications for human health) on the environment, in general and in particular on human health, by writing a book entitled "Silent Spring". Many consider that this work was the genesis of the environmental movement and that it awakened the global

environmental awareness, leading to an in-depth study and regulations pertaining thereto (Skerrett 2012).

Still in the United States, the Love Canal tragedy, originated by the deposition of hazardous waste without any environmental protection system, and the subsequent use of the area for the building of a neighborhood and a school, where the inhabitants began to suffer from various nervous system diseases, respiratory diseases and various neoplasms led, in 1978, President Jimmy Carter to declare the site as a "Disaster Area" and launch the "Super Found" Program which aimed at the environmental recovery of all similar sites that were impacting both the health of populations and the environment (Brummer et al. 1983).

In Europe, on the other hand, the Chernobyl Disaster is commonly considered the most striking moment in terms of environmental health issues. In April 1986 at the Nuclear Power Plant in Chernobyl, Ukraine, an explosion occurred in one of the reactors, in addition to the local deaths and injuries, it was the origin of a radioactive cloud that reached most European countries, causing a number of victims impossible to calculate. Perhaps it was at this point that the old continent still constrained by borders, had realized that for environmental issues "there are no borders". Thus, in 1989, and concerned with the growing evidence of the impact of environmental factors on the health of populations, ministerial Conferences began, with the ministers of Health and Environment of all countries and held every five years, with the World Health Organization (WHO)/Europe coordination, towards a comprehensive approach to primary prevention in environmental health and to facilitate the formulation of intersectoral policies (European Parliament 2016).

2 The Twenty-First Century

In 2000, members of the United Nations met and, based on the OECD (Organisation for Economic Co-operation and Development) document "Shaping the 21st Century Strategy", defined the Millennium Development Goals (MDGs). In 2015, the date set for reflection on the performance of the MDGs and centered on the progress achieved, the United Nations established a document, the 2030 Agenda, now aiming at the fulfillment of the 17 Sustainable Development Goals (SDGs) (United Nations 2015).

The importance that the environment has for health is well expressed in the SDGs and we can establish a direct relationship between Environmental Health and most of the SDGs. The image, from WHO, which places Objective 3 "Health and well-being for all", at the center of all the other goals is particularly strong and represents the importance of health and being healthy to achieve all the other goals. In fact, we all know that without health it is impossible to be able to work and evolve. The SDGs are closely linked to the environmental and social determinants of health: the environment directly influences health in several ways, including through harmful exposures, inadequate infrastructure, degraded ecosystems and poor working conditions; environmental risks, such as climate change and air

pollution (particularly inside homes), are disproportionately affecting poor countries (UN 2015, WHO 2018).

Environmental and social impacts lead to health problems, and these health problems further affect people through increased spending on health care, loss of shelter, loss of income or increased spending to compensate for inadequate services. Interventions to improve the environment can contribute a lot to the fulfillment of the SDGs and, consequently, the promotion of health and, for this, the world governments should start to commit, more and more, to Prevention.

On January 30, 2020, the World Health Organization declared the outbreak of the disease caused by the new coronavirus (COVID-19) as a Public Health Emergency of International Importance—the Organization's highest level of alert, as provided for in the International Health Regulations. On March 21 of the same year, COVID-19 was defined by WHO as a pandemic.

This health crisis is directly linked to the lack of prevention and the failure to meet the objectives that we have set for Sustainable Development. In fact, we all know that we have always cohabited with viruses and bacteria. In well-preserved habitats, with a great diversity of species that live in balance, viruses are distributed among different species and are "remote" from humans. But this is the real problem, environmental issues are the order of the day, we have an increasingly polluted planet, with poor air quality, particularly in large cities. We are a consumer society that needs more and more than nature can afford to give us.

In such a different year as 2020 was, and according to Global Footprint Network (2020), Planet Earth has lived on "credit" since August 22nd, Erath Overshoot Day. A little later than in previous years, due to the "forced stop" that the World had to make. This means that we have exhausted the natural resources available for 2020 and we are demanding that the Planet continues to provide us with everything we consider important even if it is at the expense of the nature that surrounds us and that is no longer able to regenerate.

Living Planet Report 2020 (WWF 2020), says that our planet is losing biodiversity like never before and the numbers are frightening, showing 68% average decline of birds, amphibians, mammals, fish, and reptiles since 1970.

When nature is altered or destroyed, or when we hunt or feed on wild species, as the situation that caused the SARS CoV2 virus to appear, we bring the virus closer to us, increasing the risk of transmission to humans.

For the first time, in January 2020, participants in the annual assessment of the World Economic Forum considered that environmental risks are the most likely to affect the world, bearing in mind that nature protection has to be included in the economic recovery.

The COVID-19 Pandemic is not part of a unique event, but of a pattern that reflects the damage we are doing to our Planet. We have to be resilient and preserve our forests, our animals, in short, our ecosystems.

According to Dr. Tedros, General Director of WHO, "Pandemic is a reminder of the intimate and delicate relationship between people and the Planet. All efforts to make our world safer are doomed to fail, unless they address the critical interface

between people, pathogens and the existential threat of climate change, which are making our home less habitable" (WHO 2020).

In the last year we managed to verify what we already knew about the importance and strength of Environmental Health. This Pandemic has come to demonstrate the vital role of the Environmental Health workforce worldwide to face this challenging time for the whole of humanity, and Governments around the world are beginning to understand the true value of committing to Prevention as this is the only way to stop the SARS CoV2 virus.

On May 26, 2020, WHO released the "Manifesto for a healthy recovery from COVID-19" based on six key ideas, namely: (1) Protect and preserve the source of human health: Nature; (2) Invest in essential services, from water and sanitation to clean energy in healthcare facilities; (3) Ensure a quick healthy energy transition; (4) Promote healthy, sustainable food systems; (5) Build healthy, liveable cities; (6) Stop using taxpayers' money to fund pollution.

The purpose of this Manifesto is to seize the moment! (WHO 2020) The world, because of COVID-19, is going through the worst recession in decades, with losses in business, and consequently in jobs and income, which will bring irreparable damage to the achievement of the desired 17 SDGs. On the other hand, this pandemic has come to "uncover" the inequalities, namely concerning existing healthcare in the world. There is therefore a need for a fast recovery and an unprecedented investment worldwide. However, this investment cannot be made in order to return to normality. Investments must be made to avoid environmental degradation and pollution, in particular, not favoring the growing emission of greenhouse gases that are already known in common sense to cause global warming and promote climate change. We have to invest that same money to promote a fairer, more sustainable economy, for a more equitable, environmentally and more sustainable society, in a better, healthier and greener world (Furie and Balbus 2012).

3 The Role of the Environmental Health Workforce

According to WHO, Environmental health addresses the physical, chemical and biological factors external to a person, and all the related behaviours. Data from 2016 show us that 24% of global deaths (and 28% of deaths among children under five) are due to modifiable environmental factors (WHO 2018). To improve this numbers our governments have to bet and work, based on prevention.

The Environmental Health professionals and their entire workforce are the ones who ensure that the environment around us, either in our homes and in our workplace, in schools, in the places where we go shopping or elsewhere, we go to, simply look for some sort of fun or distraction, are safe, hygienic and healthy. These professionals, when working in the field, have a higher knowledge of local customs; they are familiar with the risks and know how to get the "message" across. Acting locally but thinking globally.

Environmental Health professionals from all over the world are busy, at the forefront of this struggle, in order to prevent the spread of the SARS CoV2 virus, playing a multiple role that varies from country to country, being possible to develop: in the health surveillance of water systems for human consumption; in the health surveillance of the collection, transport system (including the management of internal circuits) and the final destination of urban waste; in the health surveillance of business premises, particularly the ones related to catering, namely in the promotion of sanitary conditions of functioning and operation; participation in actions aimed at food hygiene and conditions of sale and consumption; in the collection and interpretation of data for the preparation of reports and development of guidelines in order to combat COVID-19, as well as the assessment and control of risks associated with different activities; raising awareness and training of the populations, as well as intervention in training and collaboration actions in the professional development of health personnel and other professionals involved in times of pandemic; in the development and supply of educational and communication materials in Environmental Health; cooperating, developing, promoting and applying political guidelines, laws and regulations with the remaining health authorities, as well as the other relevant entities (Rodrigues et al. 2020; NICD 2020).

By tracking contacts, inspecting establishments (teaching, commerce, industrial, etc.) in the implementation of preventive measures to combat COVID-19 and enforcing government guidelines, the Environmental Health workforce is preponderant in overcoming this Pandemic.

Quoting Dr. Tedros (WHO 2020) "Attempting to save money by neglecting environmental protection, emergency preparedness, health systems and social safety nets, has proven to be a false economy—and the bill is now being paid many times over." (WHO 2020).

It is necessary that the world understands there is an integral connection between the environment, health and the economy. So, it is therefore important to invest in healthy and green recovery, close to all communities, with the support of the Environmental Health workforce.

4 Conclusion

The COVID-19 Pandemic came to show Humanity the importance of prevention. Nowadays it is difficult to find anyone who does not know how to correctly put on and take off a mask. With the exception of deniers, it is also normal for people to understand the importance that the correct use of adequate personal protective equipment has to prevent the onset of the disease. It is also common sense the importance of hygienic spaces not only through cleaning but also through ventilation.

In a broader sense, Humanity is also beginning to realize the importance that nature, from flora to fauna, has to preserve health and well-being.

It is expected that the forced stops, in the form of lockdown, that the Pandemic of COVID-19, has been making the whole world pass through 2020 and 2021 will be an awakening to the importance of preserving habitats and the need for us to live within our possibilities and taking into account what our Planet can give us.

Is time to take advantage of this window of opportunity to raise awareness of Environmental Health, which by working at the level of the Health/Environment binomial and working within the scope of Health promotion and disease prevention, is key to the adversity the world is experiencing as well as those ahead, namely climate change (Furie and Balbus 2012; Marion and Murphy 2016).

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Rural Electrification and Transition to Clean Cooking: The Case Study of Kanyegaramire and Kyamugarura Solar Mini-Grid Energy Cooperatives in the Kyenjojo District of Uganda

Elkhan Richard Sadik-Zada, Andrea Gatto, and Nuwe Blick

1 Introduction

More than one-third of the global population still use firewood, charcoal or dung for cooking (*cf.* Couture and Jacobs 2019). Roughly 3 Billion people still rely on solid fuels for cooking and heating (Quinn et al. 2018). The use of these fuels is overwhelmingly concentrated in rural and sub-urban areas within developing countries (Lacey et al. 2017). Cooking with wood and charcoal leads to increased levels of deforestation, soil degradation, loss of critical ecosystem services, loss of biodiversity, high level of per capita greenhouse gas emissions, and gender inequality (Puzzolo et al. 2016, Hayduk 2017, Sanga and Januzzi 2005, Rodriguez 2018, UNESCO 2012).

E. R. Sadik-Zada
Institute of Development Research and Development, Ruhr University Bochum, Bochum, Germany
e-mail: ers61@cam.ac.uk

CED—Center for Economic Development and Social Change, Naples, Italy

Centre Environment, Resources and Energy Economics (CURE), Faculty of Management and Economics, Ruhr-University, Bochum, Germany

A. Gatto (✉)
Wenzhou-Kean University, Wenzhou 325060, Zhejiang, China
e-mail: a.gatto@greenwich.ac.uk

Livelihoods and Institutions Department, Natural Resources Institute, University of Greenwich, Central Avenue, Chatham Maritime M4 4TB, UK

N. Blick
International Organization for Migration, Global Migration Analysis Data Center (GMDAC), United Nations, Berlin, Germany

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According to Chakravarthy et al. (2004, p. 49) global carbon emissions released from the combustion of wood fuels are equivalent to 500 million tons (Mt) of carbon and this is because the most impoverished people tend to rely on energy technologies that are very expensive and inefficient. This continues to be a norm in most developing countries since the majority of people continue to use firewood and charcoal among others.

Rural electrification is perceived to be a strategy that can substitute the use of charcoal, firewood and other fossil fuels with more efficient and clean energy fuels. Most rural electrification projects have been designed to rely more on renewable energies, and this has environmental advantages in comparison to the conventional fuel technologies that depend on fossil fuels such as diesel, oils and petrol. Moreso the costs involved in the use of fossil fuels can be quite expensive for the rural population. Off-grid networks that are based on solar energy displaces existing non-renewable power source and a long-run reduction in carbon emission (Chakravarthy et al. 2004 p. 49, Niez 2010, p. 16, World Bank 2008, p. 47).

The use of the firewood, charcol, animal dung and fossil fuels is detrimental it terms of public health of the respective rural communities and global climate change dynamics (Sadik-Zada and Gatto 2021b; Cisco and Gatto 2021). These sources are significant sources of indoor air pollution in developing countries (Imelda 2020). World Health Organization (WHO) estimates that inferior indoor cooking behavior, which is responsible for the indoor air pollution, leads yearly to more than four million premature deaths in Southeast Asia, Latin America and Africa (WHO 2018). Indoor pollution increases the probability of pneumonia, ischemic heart diseases, chronic obstructive pulmonary disease, and lung cancer (WHO 2018).

In India, indoor air pollution is induced by traditional cooking methods such as firewood case annually 400,000–500,000 premature deaths of children under five and adult women (Gupta and Pelli 2020). African Development Bank (AfDB) estimates that indoor air pollution caused by traditional cooking methods cause alone in sub-Saharan Africa approximately 600,000 deaths annually (AfDB 2017). As illustrated in Fig. 1, the problem of cooking with dirty fuels and the related problems with health and environmental issues are disproportionately pronounced in sub-Saharan Africa, where still 83% of the households do not have an access to clean cooking and 93% of households rely on firewood for their daily cooking needs (Cerutti et al. 2019).

Sub-Saharan Africa is at the same time the region with the largest per capita electricity access gaps (Couture and Jacobs 2019). This is why there is a hope that rolling out rural electricity programmes would not only contribute to more opportunities for income generation, greater learning hours and empowerment of females. These strategies are, indeed, also detected to lead to better environmental and health outcomes over the reduction of firewood, charcoal and dung based cooking. Access to clean and efficient energy is significantly being integrated with in development plans as a path to development. With ongoing massive investments, efforts and resources in a bid to expand electrification coverages (World Bank 2010). Despite high growth rates of rural electrification in large parts of

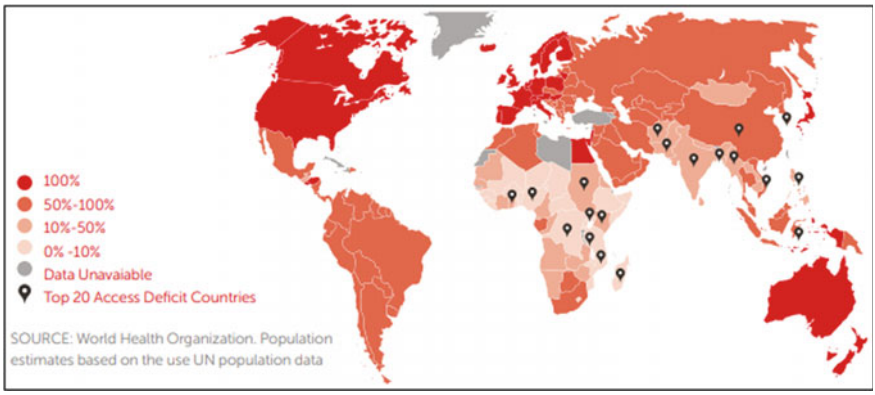

Fig. 1 Share of people with access to clean cooking 2016. *Source* World Health Organization 2021. Population Estimates based on the use of UN population data

sub-Saharan Africa, SEforALL (2018) estimates that by 2030 2.3 Billion people will lack access to clean cooking technologies. In addition to electricity access, the access to clean cooking stoves is also more than questionable.

Despite the relevance of the question of the nexus between rural electrification and indicators of socioeconomic development in sub-Saharan Africa, as indicated in Peters and Sievert (2016), the literature on the socioeconomic and environmental repercussions of rural electrification has been focusing mostly on Asia and Latin America. The literature on sub-Saharan Africa is rather scant. Hence, this chapter addresses the nexus between solar off-grid electrification and cooking behavior in rural Uganda.

This study explores case studies of rural electrification and transition cooking in sub-Saharan Africa. To this end, it is made use of two solar mini-grid projects—the Kanyegaramire Solar Mini-Grid Project and the Kyamugarura Mini-Grid Project, both located in the South Western Uganda, in Kyenjojo district. Both projects are currently, registered as one cooperative society but being run independently in the form of an association. The project is jointly funded by Energy for Development (e4D), which provided the generation costs, and the Rural Electrification Agency Uganda, which provided the civil work and distribution grid. According to the Rural Electricity Agency, the network offers 13.5 Kw, and it is expected to serve approximately 500 households in the coming years and nearby social service centers in the area however currently Kanyegaramire Solar Mini-Grid Project has 62 connections where as Kyamugarura Mini-Grid Project has 72 connected members.

The chapter observes the following organization. The next Sect. 2 explores rural electrification in Uganda. Following, data and methods used in this inquiry are described in Sect. 3. Hence, the sorting results are synthesized in Sect. 4. The last Sect. 5 concludes.

2 Rural Electrification in Uganda

Uganda's rural electrification status is among the least globally. With reports showing that 22% of the world's population does not have access to electricity. Out of this, 85% of this population that stays without electricity comes from rural areas. (Niez 2010; World Bank 2010). According to the Uganda Bureau of Statistics (UBOS), only 20% of the rural population used and had access to electricity. Seventy one percentage of the entire population continue to use firewood or charcoal for cooking and other household needs (UBOS 2014), and this has adverse effects on the environment with high cases of deforestation. The same census report further states that 75% of the Ugandan population live in rural areas—hence this implies a significant number of the populace staying in rural areas. This same group lack access to electricity since electricity accessibility is mostly found in urban towns.

In addressing this challenge, the Ugandan government has embarked on the implementation of rural electrification programs with some expected results from rural household dependency on electricity. An example is the use of power in the development of social services, a general increase in household incomes and environmental contribution of rural electrification—hence driving the motivation for this study. According to the rural electrification agency strategic plan, the government of Uganda has come up with some models in the process to attain universal electrification coverage by 2040. The strategy is being supported by different policy guidelines such as the electricity act of 1999, the Rural electrification agency established by the Statutory Instrument 2001 no. 75 (REA 2013).

The Uganda rural electrification agency urges that the government takes a central role in rural electrification processes that is planning, providing concessions, and providing all the necessary support to the industry. The government takes on the pivotal role in leading, providing financial capital and building infrastructural capacity for electricity services because rural electrification in the countryside continues to be a risky venture for the private sector thus to make this a success the Ugandan government needs to provide incentives that can make rural electrification targets achievable.

According to REA (2013), some of the impending challenges in the industry have been due to uncoordinated roles. Thus, it significantly recommends and adopts a centralized authority and in this case the Uganda Rural Electrification Agency (REA 2013, p. 2–8). It further argues that it will be feasible for the private investors and commercial financing to take over once a ground level had been set up by the government structures. With the country using a centralized system to reach its universal electrification targets, some other strategies have been accommodated into the overall plans. These include the use of decentralized power generation facilities that still report or be regulated by the central agency, the case studies of Kanyengaramire and Kyamugarura mini off-grid project belong in this category and even when there is a local management team, it does monitor and manages cooperatives a delegated responsibility (REA 2013, p. 10).

According to the World Bank (2008), the allocation of rural electrification projects by utility companies and the governments is mostly based on the cost-effectiveness of the projects, social allocation or a hybrid of cost-effectiveness and social allocations. Cost-effectiveness considers the ability of the connected population to afford to pay for their connections and utility charges. With social allocation, preferences go to the rural communities that usually lie into deprived areas, characterized by low socioeconomic indicators such as high poverty levels and poor natural resource base among others. The same report further state that private companies involved in rural electrification projects do not usually target the poor since the cost involved in connections is too high and above the average incomes of the rural population. Therefore, these projects tend to favor the well-off.

Uganda Rural Electrification Agency is encouraging the use of a cooperative model in rural electrification. It is argued as an efficient way of managing transactional costs and hence create better or affordable prices for energy in the countryside. Cooperatives ownership by the local communities helps in the mobilization of local resources by creating an investment hub for the rural populations; this also encourages mass participation in shaping national policies that affect their community. Cooperatives act as a collective voice for the marginalized groups, and they can negotiate for their needs, priorities, and their preferences were a priority (International Labour Organization 2013).

Other key attributes of adapting to the cooperative's model in rural electrification programming include: possibilities of local innovations for renewable energy that is said to be cheaper than imports and local participation in management and decision making. Thus, it serves as an alternative to conventional approaches where the management of rural electrification has always been centralized (International Labour Organization 2013).

3 Data and Methods

3.1 Research Design

This is study is based on both primary and secondary data analysis, based on qualitative and quantitative data. Data focus on the understanding of the influence of rural electrification on socio-economic empowerment. The use of a mixed study method was due to the need for more quality data since it minimizes the weaknesses of relying on either a qualitative or quantitative study. The choice of qualitative and quantitative data helped to ensure that the results are corresponding and corroborating with each other (Creswell 2013, p. 215; Bryman 2006, p. 106).

For valid results, quantitative results in this study rely on data collected from 79 households that are connected or not connected to the grid. For the qualitative component of this study, the researchers conducted three semi-structured interviews and further uses documentary analysis to get more data that can support empirical data from the surveys and interviews conducted. In this work, both primary and

secondary data is used to derive descriptive statistics as procedures in examining the degree to which variables from electrification are associated and related with socioeconomic empowerment indicators (Cook and Cook 2008 p. 101). The three interviews enhanced the quality of the acquired results since they corroborate with information from the survey questionnaires, whereas some questions need to be answered from a management and design level and this required the need to use qualitative means in both the collection and analysis of data findings.

When it comes to the inquired households, the research covered the whole population in the areas that have access to grid power in Kanyegaramire and Kyamugarura parish, by mainly focusing on the people that live within approximately one kilometer from the grid points. Whereas for the three interviews, the researchers purposively selected the three interviewees due to their association with the projects and their relevance to the interview questions that are the program officer in charge of the national rural electrification program at the REA head office and two interviews with chairpersons for the two cooperatives.

Initially, the researchers had planned to use a random sampling procedure to draw out this study's targeted households. However, this had to change to considering the whole population since the sample numbers were too low and thus the researcher realized that it was possible to collect data from all the households since they all live near the grid points. This procedure further prompted the inclusion of all the families and businesses in the study with the sole aim of ensuring that all the families have equal chances of being involved in the research (Teddlie and Yu 2007).

The local cooperative management offices had a register of households that are connected to the grid. This factor also helped to increase the effectiveness of this procedure since it was easy to keep track of the members that were being interviewed and a follow up on ones that could have been missed and were willing to participate in the study. Preliminary data characteristics are presented in Table 1.

Table 1 Respondents that are connected to the grid

			Households
Do you use electricity	Do you use electricity yes	Count	63
		% within do you use electricity	55.80%
		% within whether questionnaire is HH or enterprise	79.70%
		% of total	45.30%
	Do you use electricity no	Count	16
		% within do you use electricity	61.50%
		% within whether questionaire is HH or enterprise	20.30%
		% of total	11.50%
Total		Total count	79
		% within do you use electricity	56.80%
		% within whether questionaire is HH or enterprise	100.0%
		% of total	56.80%

Source Field data September 2017

Considering that only 57 units were connected and 16 not connected this meant that the population of the study was not unbalanced and as a countermeasure, the researchers had to include in a new case study the Kyamugarura Mini-Grid Project and the assessment of enterprises since they were initially not in the first design.

3.2 Data

This study relies on the collection of both primary and secondary data. The use of survey questionnaires helped to measure the household's electricity use behaviors and perceptions. The characteristics of the households connected to the grid, and how this is associated with socioeconomic indicators in the study. Questionnaires also helped to assess the differences between households that are connected to the grid and households that are not connected to the off-grid (Cook and Cook 2008, p. 104).

This study further uses three semi-structured interviews to complement the household survey questionnaires as a preferred technique for gaining insight on top managers or policymakers experiences on rural electrification (Hewitt 2007, p. 1149). The use of interviews helped to gather information on the context and more in-depth details concerning the off-grid energy projects about the two case-study mini-grid projects of Kanyegaramire and Kyamugarura. Furthermore, the researchers complement the collected primary data with visual methods, and observational technique as backup support collected from interviews and survey. The use of visual methods helped to actual the daily life experiences mostly on income variable since it mainly captures how lighting is supporting enterprises and the young people in the area to operate makeshift businesses even in the dark hours.

The study focused on respondents from the villages of Kyamugarura and Kanyegaramire all found in the Kanyegaramire sub-county. The demographic characteristic assessed in this report focuses on age, education of respondents, and the sex of respondents. According to William et al. (2009, p. 11), demographic characteristics help to compare and tell the differences within the study representatives. Therefore, this influenced the presentation of respondents' demographic data within the cross-sectional Table 2 and segregated respondents from enterprises and households.

Table 2 Why household decided not to buy the off-grid electricity system

		Frequency	Percent	Valid percent
Valid	It is expensive	9	6.5	33.3
	it is not a priority	7	5.0	25.9
	It is not important	3	2.2	11.1
	Any other reason	8	5.8	29.6
	Total	27	19.4	100.0

Source Field data September 2017

4 Results

4.1 Rural Electrification in Kyenjojo

Rural electrification was ascertained by the number of people that have access to the grid system on the assumption that this enables an individual to decide on whether to connect or not to connect. The other indicators assessed are the individual's capacity to afford the tariffs, that is if they perceived it to be expensive or affordable and then the use of electricity or its intended purpose when subscribed for connection. Out of 139 (enterprises and households) 81.3% were connected to the grid system, while 18.7% were not. This was a surprising result because some reports show that the overall coverage of rural electrification in Uganda stands at less than 19% (Bernard 2012, p. 39, Niez 2010, p. 14, World Bank 2016,[1] World Bank 2010, p. 9). However, one needs to note that these are two pilot projects on a trial of a cooperative model, with some incentives such as the ability to negotiate tariffs and this is encouraging connections. Furthermore, connections are also concentrated to households/enterprises that are close to the grid points whereas a majority of household in those same villages that are not near to the grid points continue to stay without any connection.

On interviewing the head of off-grid electricity systems in Uganda, he revealed that demand for electricity increased, after negotiating with members on the tariff and since then they have been overwhelmed with the number of people applying for connection.

> I know that demand can grow—which is good. I can see demand grow, demand doubling in 2 to 3 years
>
> ***Interview 1 HQ-line 154-155***
>
> We started at 1500 per unit /: it is now at 1000 /: and we haven't had complaints which is good indicator because it was a negotiated tariff with them. So 1500 Ugx it was not acceptable /: so there were complaints about it. We have learned that the demand rapidly if we have fairly a good tariff. We have a similar project, we did it with the University of Southampton, so there is a similar project in Kenya which has a much higher tariff—I think 2000 to an equivalent of 2500 Ugx—and the demand is not growing. The demand in Kanyegaramire and Kyamugarura. Actually, the projects have reached capacity, you know the design capacity, so that means we need to upgrade /: it is the same way you do not want constrained growth
>
> ***Interview 1 HQ-line 136-144***

Therefore, this is in agreements with some other studies as earlier highlighted rural households have a high willingness to use electricity if it is provided on tariffs deemed manageable by the users as the demand for use doubled in three years hence implying that the technology has been acceptable.

[1] World Bank (2016), Sustainable Energy for All (SE4ALL) database from World bank, Global Electrification database retrieved on 26th October 2016.

Table 3 Possibilities of getting connected in the near future

		Frequency	Percent	Valid percent
Valid	Yes	25	18.0	92.6
	No	2	1.4	7.4
	Total	27	19.4	100.0

Source Field data September 2017

On further probing from the respondents, the researchers asked them to answer why they were not connected to the grid. 2.2% of the respondents indicated that it's not a special need to connect to the electricity system, and thus they consider connecting to electricity as a luxury. 5% said that it is not a priority to have an electricity connection since they had other needs of priority but will connect in the near future. 6.5% Said that it is expensive to pay connection fees and installation payments and while 5.8% had other reasons such as owning personal solar systems, its capacity is too low and thus do not need grid connection among others. However, Table 3 shows that a majority of them at 92.6% indicated that they were planning to get connected to the grid.

Analyzing the statements from the interviews indicates that there is a high willingness to connect by nearly the whole population, this result is in agreement with what different scholars have reported about the rural population's willingness to use electricity. The World Bank (2010, p. 36) explains that, usually, rural people have a high willingness to connect to electricity. That is if they find connection fees to be affordable however the only challenge goes to their consumption which is mostly on lighting, and they cannot afford to use electricity for productive purposes. As a result, it discourages investments in rural electrification projects.

On rural electrification use, respondents were asked to give reasons as to why they chose to connect to this grid system and with enterprise respondents, as shown in Fig. 2, it is indicated that 89.8% of respondents connected to use electricity for

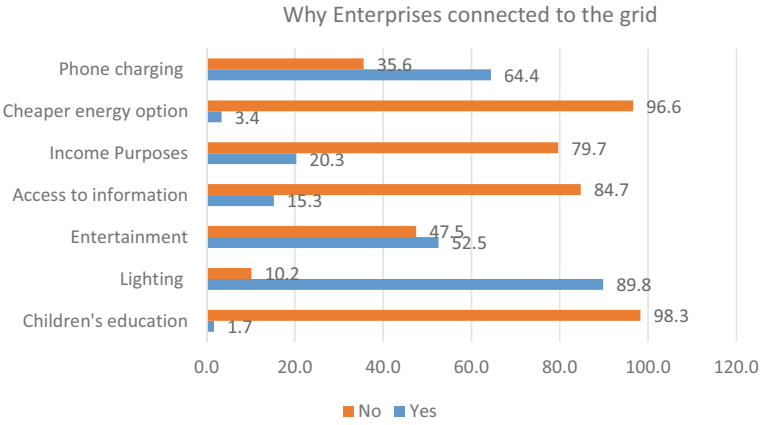

Fig. 2 Reasons for connecting to the grid in enterprise respondents. *Source* Field data September 2017

lighting purpose. 64.4% of the respondents listed phone charging. 52.5% for entertainment purposes since it is used to support the use of television sets to attract customers. Only 20.4% itemized income generation purposes as a reason why they chose to connect. 15.3% connected to the off-grid power system so as they can have more access to information, 3.4% indicated that they connected to electricity because it is considered to be a cheaper energy alternative. Importantly, it should be further noted that children's education is listed last at 1.7%.

This trend is repeated within the household respondents as indicated in Fig. 3, however the ratio of using electricity for children's education changes to 29.2%. For entertainment reasons, it changes to 43.2%, whereas consideration of electricity as a cheaper energy alternative changes to 16.9%. And the intended use of electricity for lighting purposes is still ranked highly at 90.8%, and this is in agreement with most reports on rural energy use.

It is reported that electrification in rural communities is mostly used for lighting purposes, entertainment purposes or watching television, and lately, phone charging has been added to a list of reasons why rural households connect to the electricity system. Since these intended purpose do not directly contribute to socioeconomic empowerment indicators as described in this study, this tends to be a limiting factor in the general management and investments with rural electrification projects (Pueyo and Hanna 2015, Kanagawa and Nakata 2008).

Low use of lights to enhance study hours has been a limiting factor to the research questions since this study is partly based on the assumptions that electricity is mainly used for lighting, and thus it plays a role in extended study hours at home. It is argued that electricity is used in production and therefore boosts income and in some cases used as cheaper and cleaner cooking energy. Some reports show that rural communities tend to rely more on candles or kerosene lamps for lighting purposes whereas wealthier households use electricity for its convenience and more lighting, and sometimes electricity can be used on small appliances (Douglas and Willem, 1996, p. 4, IEA 2006, p. 420). However, this is poised to change if the tariffs are affordable as is with this case from the mini-grid projects in the Kanyegaramire sub-county.

4.2 Affordability of Solar Electricity

Overall, more than 90% of the respondents indicated that electricity tariffs were manageable with 98% enterprise respondents and 91.5% from the households' respondents showing that tariffs were affordable and only 2% in enterprises and 8.5% indicating that the costs are still high as indicated in Fig. 4.

Through their cooperatives, members agreed with the Rural Electrification Agency to reduce tariff charges from Ugx 1500/= to Ugx 1000/=. With this reduced tariff, members are currently satisfied with the payment system, and this is said to be a significant reason as to why the number of people connected increased. This increasing demand for connection and in the long run overwhelmed the capacity of

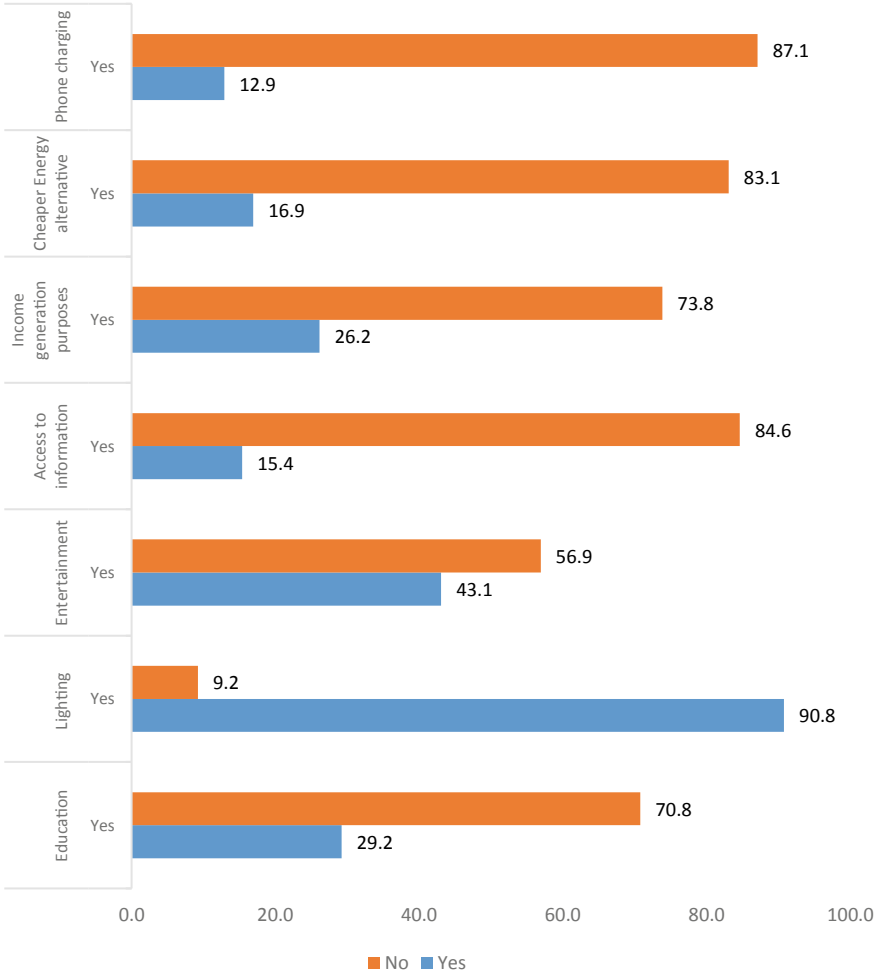

Fig. 3 Reasons for connecting to the grid—household respondents. *Source* Field data September 2017

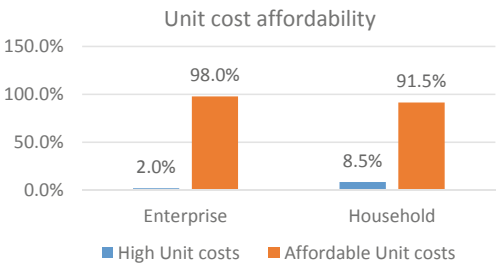

Fig. 4 Affordability of mini-grid tariffs. *Source* Field data September 2017

the grid system, hence implying that heavy machinery cannot be operated on the network. About the sustainable livelihood approach, this approach shows that the enhancement of members' capabilities through freedoms to participate and enforce their desired tariffs will be used as means to improve the livelihoods of the poor people (Simpson 2007, p. 187).

4.3 Energy Sources for Cooking Purposes

Through the households survey, the research found much as households have adopted the use of electricity for light, the findings are different within the energy being used for cooking purposes, three types are being used for cooking. 78.6% of the respondents still use firewood for cooking, while 71.4 use charcoal stoves for cooking and only 4.3% of the respondents were using electricity for cooking. This may be mainly attributed to the fact that the respondents perceive electricity as not be reliable and they say that it is expensive when compared with other energy fuels (Fig. 5).

As from this study findings, different literature agrees with the fact a significant percentage of the rural population use firewood for cooking. The national census statistics show that 71% of the households in Uganda use firewood for cooking (UBOS 2014, p. 31). Other international reports show that more than 40% of the world's population on solid fuels that includes firewood and charcoal (Pachauri et al. 2012, p. 37, IEA 2011, p. 472) further states that 95% of this population leave in rural areas of sub-Saharan Africa or developing economies in Asia. It is also reported that firewood is mostly substituted with cow dung or other agricultural residues when it is in shortage (Douglas and Willem, 1996, p. 2, IEA 2006, p. 420, Gatto et al 2016).

> The only development brought about by electricity is that people who have been using paraffin have now realized that it's dangerous to their health and now love the use of electricity, to the extent that they cannot do without electricity

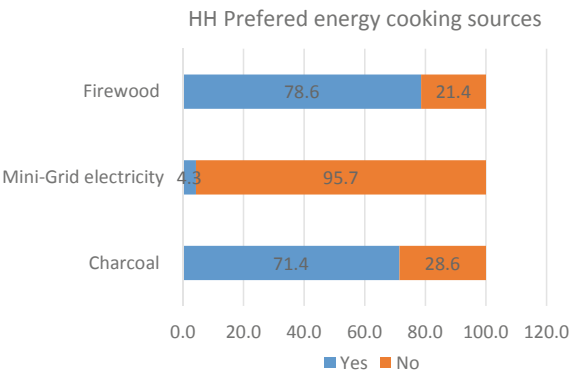

Fig. 5 Energy sources being used for cooking. *Source* Field data September 2017

Interview 2 Kanyegaramire-line 267-269

Access to firewood is not a big challenge yet… People wanted electricity to aid them in businesses and home lights since access to firewood is not yet a challenge because people can still access firewood and charcoal in case firewood is not accessible

Interview 2 Kanyegaramire-line 252-254

Ok! People haven't started using power for cooking, but they have that interest of using it in all ways. As I have told you before, we have a low voltage issue, but people would love to use it in many ways, and I think once its capacity gets a boost all these changes will be seen, people will be able to buy those cooking appliances and use it

Interview 3 Kyamugarura line 110-113

These interviews statements complement data from household and enterprise survey. The results are in line with other reports on the subject and survey results, agreeing that there is low adaptability of electricity for cooking as an alternative to firewood and charcoal for cooking, whereas electricity is essential to household lighting. It is further stated that electricity is preferred for lighting because of its advantages over the other energy alternatives such health effects of kerosene lamps. It is also noted that when it comes to the use of firewood and charcoal, people tend to pick the latter because of its greater reliability. It is also easy to access firewood and charcoal and they are used to the system and thus see no negative effect of its continued use. Furthermore, the grid capacity or low voltage is blamed as a reason.

The International Energy Agency (2006, p. 422) reports that electricity is usually used sparingly at the start, the rural population tends to shift from unclean forms of energy to clean energies over time, as they usually start with electricity for light and later on substitute firewood with electricity eventually. However, this deviates from the assumption to say that rural electrification access leads to the adoption of electricity as a clean form of energy. Hence, this continued use of firewood means that the communities continue to be associated with negative environmental implications, in-house pollution and its effects, as it continues to account for greater carbon dioxide (CO_2) emissions among other effects (IEA 2006, p. 427, World Bank 2010, p. 11).

5 Conclusion

Rural electrification can be a determinant for a clean, sustainable and just energy transition towards renewable energy transitions. However, one shall bear in mind that any ecological transition will have to be progressive and keep carrying part of the original models and assumptions. This is true also for upcoming energy transitions, that will still have to rely on non-renewable-energy sources (Sadik-Zada and Gatto 2021a). In this process, energy democratization has taken the lead and pushes for the implementation of energy cooperatives, empowering the vulnerable and enhancing energy justice for all (Gatto and Drago 2021). These communities are spreading all over the Global North and South and are often supported by

domestic, international and third-sector funded projects, as well as microfinance programs. To facilitate this process happening, increased attention needs to be devoted to the achievement of sound policy and communication and robust research (Drago and Gatto 2018). This step passes through the acquisition of more granular and extensive data on energy, poverty, inequality and sustainable development (Gatto et al. 2021).

The presented study aimed to analyze selected variables of rural electrification and cooking behaviors within rural households. The purpose was to investigate leading determinants of energy poverty in sub-Saharan Africa. The performed analyses indicate that electrification has not substantially changed the cooking behaviors of the households. Furthermore, the study analyze the causes for the lagging transition to clean energy use in cooking. This study finds that besides behavioral and taste aspects affordability and level of education play an important role in the context of the household-level energy transition. This significance of education may be imputed to the fact that poor rural people have not been educated about environmental protection and paves the way for new research explorations and sustainable development policy and energy transition modeling.

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Elkhan Richard Sadik-Zada works at Ruhr-University, Bochum, Germany. Since 2012, he is a visiting lecturer at the University of the Western Cape in South Africa. Dr. Sadik-Zada Richard is honorary fellow at CED in Naples.

He published in Socio-Economic Planning Sciences, The European Journal of Development Research, Mineral Economics, Post-Communist Economies, Sustainability, Energies, Review of Development Economics, XXI Bek, IJEEP, Economies, Data in Brief, and the Atlantic Economic Journal.

Andrea Gatto is Senior Assistant Professor at Wenzhou-Kean University (US-China). He is Visiting Research Fellow and Lecturer at the Natural Resources Institute (NRI), the University of Greenwich. Andrea has got a publication record in international peer-reviewed journals, including Energy Policy, Journal of Cleaner Production, Ecological Economics, Journal of Environmental Management, Corporate Social Responsibility and Environmental Management, Energy Research & Social Science and Journal of International Development.

An economic and business consultant, Dr. Gatto is President of the CED—Center for Economic Development & Social Change and is Deputy Director and Fellow at the Centre for Studies on the European Economy at UNEC. Andrea sits on several international peer-reviewed journals' editorial boards (Q1–Q2). He has conducted fieldwork and worked for longer appointments in twelve countries worldwide, including positions for the European Commission, CalPoly, CREATES—Aarhus University and the NCH at Northeastern University. He is fluent in Italian, English, French, and Portuguese, and speaks some Spanish.

Nuwe Blick is a highly trained professional with over nine (9) years of experience in development policy analysis and data Management, Refugee and Migration Policies, Monitoring and Evaluation, Humanitarian Programming, Development Planning in Local Governments, and International Cooperation at Policy, Strategic and Operational levels. Blick works as a Data Analyst at IOM's Global Migration Data Analysis Centre (GMDAC) in Berlin. The role supports the review, editing and presentation of information and data on migration governance.

Before joining GMDAC, Blick worked at IOM's Headquarters in Geneva as a Migration Health Policy and Partnership and with IOM Tanzania as a Migration Data and Health Consultant and a Displacement Tracking Matrix Coordinator. Prior to joining IOM, Blick worked as a District Demographer/Population Officer with Bushenyi district local government and with the Uganda Red Cross society as a Data and Research Officer.

Blick holds a Master of Arts in Development Management from the Ruhr-University in Bochum and an MA in Development Studies and Postgraduate Diploma in Project Planning and Management from Mbarara University of Science and Technology. Blick's other qualifications include (i) a postgraduates diploma in Monitoring and Evaluation from Uganda Management Institute and (ii) a Bachelor of Arts degree in Development Studies from Uganda Christian University, Mukono.

The Geography of Urban Sustainability Transitions: A Critical Review

João Morais Mourato and Fronika de Wit

1 Introduction

Recently, Sustainability Transitions (ST) research has shown increased attention towards the urban context (Wolfram and Frantzeskaki 2016). Aiming towards a systemic turn to sustainability led by profound socio-technical, cultural and institutional transformations (Nevens et al. 2013; Loorbach et al. 2017), the governance of Urban Sustainability Transitions (UST) has been mainly realized through diverse forms of experimentation. By means of sustainability-oriented labs, such as Urban Living Labs (ULLs), cities have adopted a form of 'laboratorial governance' as a way to address complex challenges, such as climate change mitigation and adaptation (Bulkeley et al. 2019).

UST research is still in its infancy and faces various challenges and core-questions for future research, e.g. What are the unintended consequences UST might produce (Bulkeley et al. 2016)?; How does urban experimentation affect institutional change (Fuenfschilling et al. 2019)?; How to enhance urban capacity needed for UST to take place (Wolfram et al. 2019)?; and how to successfully scale-up and embed UST in larger transition strategies and multi-scalar governance dynamics (Ersoy and van Bueren 2020; Puerari et al. 2018)? Almost all UST research has been carried out in Northern-European urban contexts (Bulkeley et al. 2019), but in what way does this specific geographical setting influence transitions and urban experimentation?

Although earlier ST research lacked a more geographical perspective, a growing 'Spatial Turn' has shed light on the research potential of the geographies of ST

J. M. Mourato (✉) · F. de Wit
Universidade de Lisboa, Instituto de Ciências Sociais, Av. Professor Aníbal de Bettencourt 9, 1600-189 Lisboa, Portugal
e-mail: joao.mourato@ics.ulisboa.pt

F. de Wit
e-mail: fronika.wit@ics.ulisboa.pt

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(Coenen et al. 2012). Unpacking its spatial dimensions is one of the future research directions identified by the Sustainable Transitions Research Network (STRN) (Köhler et al. 2019). However, research that explores this geographical lens within urban contexts is still scarce and only focussed on well-known pioneering and success-cities with a long historical process regarding ST, such as Freiburg-Germany or Rotterdam-the Netherlands (see Fastenrath and Braun 2018; Frantzeskaki et al. 2018). Bulkeley et al. (2019) point to the need for further research in the ways in which sustainability-labs work in other spatial contexts, both inside and outside of Europe.

Can UST happen anywhere? And if so, what are the basic conditions to catalyse it? In light of these questions, the aim of this chapter is two-fold. First, it provides a literature review on the upcoming debate on geographies of UST. Second, it goes beyond stereotypical UST success-stories by comparatively examining them in relation to the Portuguese UST landscape. Research on ST-related innovative forms of urban governance in Portuguese cities is rapidly increasing (see Simões et al. 2019; Mourato et al. 2018; Campos et al. 2017; Vasconcelos et al. 2013). Making use of three geographical lenses stemming from economic geography (Hansen and Coenen 2015)—we highlight how historical path-dependencies, agency and power, and diverse institutional settings affect the room for urban experimentation.

This chapter is structured as follows: We start off by outlining the state of the art of UST research and the advantages of taking on board a geographical perspective to ST research. Secondly, we apply three geographical lenses to UST experimentation in general, and explore this argument in-depth by focusing specifically on the Portuguese transition landscape. Finally, this chapter concludes with a set recommendations on how to further advance a future research agenda on the geography of UST.

2 Towards the Geographies of Urban Sustainability Transitions

2.1 Urban Sustainability Transitions Research

ST research emerged almost two decades ago as a science-policy experiment in the Dutch national governance context (Kemp et al. 2007; Loorbach and Rotmans 2006; Rotmans et al. 2001). Based on work by Hughes (1983) on socio-technical system transitions, ST research advocates transitions through system innovation: change from one socio-technical system to another, where systems can be conceptualized as sectors, like energy, mobility and water management (Elzen and Wieczorek 2005). ST are processes of fundamental change in culture, structure and practices underlying systems, leading to more sustainable ways of living (Frantzeskaki and de Haan 2009; Markard et al. 2012).

Research outlines various particularities of ST processes; They are long-term, multidimensional, open-ended, normative processes with multi-actor dynamics, and

hold a dialectic relationship between stability and change (Kohler et al. 2019; Loorbach et al. 2017). ST are often linked to innovation and thereby portray sustainable development as system change (McCrory et al. 2020). Nevertheless, ST governance should focus not only on creative innovation, but also on destabilising existing regimes: being both a 'motor of innovation' and a 'motor of creative destruction' (Kivimaa and Kern 2016).

Its interdisciplinarity has resulted in at least three different approaches towards ST research: (1) a socio-technical approach; (2) a socio-institutional; and (3) a socio-ecological approach (Loorbach et al. 2017). The first and most-widely used, emphasizes the need for socio-technological change through 'innovative journeys' and holds a (technological) innovation perspective (Elzen and Wieczorek 2005). The second approach focuses on analyzing institutional dynamics, emphasizing the concepts of discourse, power and agency and how these affect ST processes (Fuenfschilling and Truffer 2014). The socio-ecological approach emphasizes planetary boundaries and aims to increase the system's resilience to deal with disturbances (Rockstrom et al. 2009; Folke et al. 2005).

Frequently used in combination with ST is the Multi-Level Perspective (MLP). This analytical lens understands transitions as the interaction between three levels: (1) *the landscape level*: the wider global context in which transitions take place, including long-term trends and crises; (2) *the regime level*: the established, mainstream structures, cultures and practices; and (3) *the niche level*: the "incubation room" for innovation projects and experiments that are deviant from business as usual. The interaction between and within these different levels triggers non-linear change and the realignment of the three levels into a new, stable socio-technical regime (Geels 2002).

ST research has quickly been gaining momentum under Urban Studies researchers (see Bulkeley et al. 2016; Von Wirth et al. 2019; Bulkeley et al. 2019; Hodson et al. 2017). UST processes and its governance involve multiple dynamics and 'politics of experimentation' (Bulkeley et al. 2019). Fuenfschilling et al. (2019) emphasize the importance of using 'experimentation' instead of 'innovation', as the first allows for failure and learning-by-doing and portrays the processes as fluid, open-ended and reflexive. Also, 'innovation' is not able to capture the processes of creative destruction and destabilisation of existing regimes taking place within ST (Hodson et al. 2017).

Different kinds of 'sustainability-oriented labs' have been popping up as forms to study UST and in real time. Examples of these different types of labs are: Urban Living Labs (ULL), Urban Transition Labs (UTL), Real World Labs (RWL) and Evolutionary Learning Lab (ELL) (McCrory et al. 2020). Urban labs stimulate the interaction and co-creative collaboration between research, innovation and public policy (Bulkeley et al. 2016; Nevens et al. 2013). Reflecting the multiple nature of UST, urban labs make use of distinct types of experimentation: from more controlled experiments that aim to secure specific outcomes, to more contingent ones, which aim to create the conditions for new socio-material relations and governance arrangements (Bulkeley et al. 2019).

In an empirical analysis of the emerging practices of 'urban laboratory governance', Bulkeley et al. (2019) identify three types of governance arrangements: strategic, civic and organic labs. Strategic labs contain a certain degree of governmental control and involve private sector partners. They often emerge in a competitive setting as part of international and national programmes and funding competitions. Civic labs, on the other hand, hold more contextual and contingent characteristics and their main focus is on local priorities. Lastly, organic labs are characterised by their focus on the highly diverse priorities and needs of a particular neighborhood or community, resonating with the literature on community-based innovation (Seyfang and Smith 2007).

2.2 *Sustainability Transitions from a Geographical Perspective*

At its start, the ST literature largely ignored the spatial dimensions of transitions or used rather naive conceptualizations of space, which frequently led to the idea that transitions can take place anywhere (Coenen et al. 2012). Earlier we described ST's analytical lens—the MLP—and although this lens uses seemingly geographical metaphors of the macro, meso and micro level, it should not be confused with geographical scales (Geels and Raven 2006). There is an urgent need to go beyond the MLP to overcome inadequate conceptualisations of space in transition research to better understand socio-economic processes (Fastenrath and Braun 2018).

That is why, recently, a research agenda on the Geographies of Sustainable Transitions (GoST) was introduced (Coenen et al. 2012; Hansen and Coenen 2015; Truffer et al. 2015; Lawhon and Murphy 2012). This *spatial turn* in ST research calls for a more profound analysis of the influence and role of geography and a multi-scalar perspective on ST. Coenen et al. (2012) argue that a spatial perspective on ST contributes in three ways: (1) It contextualizes the lack of territorial sensitivity in the current ST literature; (2) It recognizes and studies institutional diversity in ST processes across space; and (3) It emphasizes the need and opportunity to connect to the body of literature on multi-scalar transition dynamics.

In 2019, the Sustainable Transitions Research Network (STRN) presented its updated research agenda with nine directions for future research, one of them being GoST (Kohler et al. 2019). STRN highlights the particular importance of research in developing countries as well as urban transitions. Future research should dive into the divergent place-specific conceptualizations of and perspectives on sustainability for improved governance. The authors also point to the importance of research on the conditions behind urban experimentation: how does urban experimentation emerge; how does upscaling of experimentation take place?; Can experimentation emerge anywhere and can it be translated to diverse urban geographies?

In a commentary on the STRN updated research agenda, Binz et al. (2020) criticize the GoST directions for being too narrow and lacking a more profound incorporation of the geographical concepts of scale, place and space. With regard to scale, Binz et al. point to the multi-scalarity of transitions and the importance for future research to analyse the interdependencies and collaborations between different levels of governance. The authors also claim for more engagement with geography's place-making theories and conceptualizations that see place not as static, but as relational. That way, future research will be able to focus on the multiplicity of the various regimes part of ST. Lastly, with regard to space, the authors emphasize the spatial variation in transitions and the need to further study how this spatial variation in capabilities and capacities influence innovation processes.

This commentary by Binz et al. (2020) resonates an earlier groundbreaking publication on GoST and the incorporation of geographical theoretical perspectives by Hansen and Coenen (2015). They highlight three outtakes and their different conceptualisations of space that stem from economic geography: (1) an *evolutionary perspective*, highlighting the importance of historical path dependency; (2) a *relational perspective*, emphasising how space is socially constructed; and (3) an *institutional perspective* emphasising the importance of institutional settings and variations (See Table 1). Unpacking the spatiality of ST highlights how transitions do not merely affect places, but should be understood as geographically-constituted processes and also significantly change the research questions we ask. Instead of focused on temporalities and innovation rates, they shift to questions about spatial differences (Bridge et al. 2013).

3 Applying Geographical Perspectives on UST Governance

Although not frequently applied in UST research, geography-based perspectives are highly valuable analytical lenses for ST at the urban level (Fastenrath and Braun 2018; Wolfram and Frantzeskaki 2016). The scarce literature on the geographies of UST all describe emblematic success-stories situated in Northern European cities

Table 1 Geographical perspectives on sustainability transitions

Geographical perspective	Definition	Link to sustainability transitions
Evolutionary perspective	Importance of historical path dependency	Economic and policy trajectories drive or hinder sustainability transitions
Relational perspective	Space is socially constructed	Place-based perspectives and narratives help to design make sense of sustainability transitions
Institutional perspective	Importance of institutional settings and variation	Institutional settings affect room for innovation and experimentation

Source Adapted from Hansen and Coenen (2015)

(see Bulkeley et al. 2019; Frantzeskaki et al. 2018; Fastenrath and Braun 2018). What about UST and urban experimentation in other parts of Europe? This section looks at these well-known Northern cases and compares them with the emerging Portuguese UST landscape in light of the evolutionary, the relational and the institutional geographical perspective on ST.

3.1 The Impact of Local Institutional and Governance Cultures

The *evolutionary* perspective takes pre-existing local structures into consideration and how these condition the development of innovation and experimentation within ST pathways. Using the construction sector in the 'green' city of Freiburg-Germany as a case study, Fastenrath and Braun (2018) use a detailed approach to tracking its transition process so as to provide empirical insights of this "successful" UST. They highlight how the creation of Freiburg's transition path results from very specific and enabling path dependencies, constant negotiations and extensive learning processes and can therefore not be simply and uncritically transferred to other spatial contexts.

Unlike Freiburg, Portugal's local governance contexts feature clear structural resistance to transition pathways. Portugal's (local) institutional and governance culture, from an evolutionary perspective, still reflects the impact of a nearly five decades-long repressive, authoritarian and highly centralized regime. Only in the 1980s, early in the re-democratization process, environmental awareness started to emerge into mainstream political and policy communities. Overall, the development and transformation of Portugal's governance and institutional culture has been highly influenced by the Europeanisation process that followed the country's adhesion to the then European Economic Community, currently European Union, in 1986 (Mourato 2011). European spatial planning policies and its 'neomodern' concepts, such as territorial governance, deliberative democracy and collaborative planning were slowly incorporated into the Portuguese spatial planning context and governance culture (Ferrão 2011; Ferrão and Mourato 2015). Notwithstanding, decision-making processes in urban planning and urban climate action remain frequently fragmented across departments considering different criteria, and place-based integrated approaches are seldomly employed (Mourato et al. 2018; Simoes et al. 2019).

As local climate governance is concerned, the Portuguese governance landscape remains mostly sectorial and hierarchical is nature; Hardly ever local climate change policies are integrated into other sustainability policies, such as water management, energy, mobility and spatial planning (Carvalho et al. 2014) and its 'disjointed continuity' (Schmidt et al. 2013) is one of its main challenges. Huntjens et al. (2011) characterize Portugal's adaptive water management regime as 'ad hoc problem solving' with low levels of policy learning and multilevel collaboration

structures, which results in less innovative and advanced climate adaptation strategies. A survey among Portuguese municipalities on local climate governance, shows how climate change in planning agendas is still 'little' or 'not important' and civil society participation is attributed a 'low importance' (Campos et al. 2017).

Recent developments, however, hint at a growing dynamic of change. For one, a volunteer network of municipalities, Adapt.Local, emerged around the topic of climate action and governance. Second, the development of a wide array of supramunicipal and local climate action policy instruments is mobilizing a growing number of domestic knowledge transfers, best practices identification and a growing institutional learning and capacity building process that is helping shift the Portuguese climate governance landscape (Mourato et al. 2018).

3.2 The Role of Agency, Power and Knowledge Systems

Wolfram and Frantzeskaki (2016) highlight the *relational* or place-based perspective in UST research and the importance of looking at cities as places shaped by and shaping interactions between multiple systems. Frantzeskaki et al. (2018) aim to bridge UST literature and the relational perspective—which they call 'placemaking'—by looking at the *Resilience Lab* situated in the Carnisse neighborhood in the city of Rotterdam-the Netherlands. According to the authors, the symbolic understanding and narratives of place connected to a shared vision, helped to improve the design and governance of this UST.

In contrast to Rotterdam, the place-based interactions in the Portuguese urban landscape are often hindering more than triggering UST processes. Although Schmidt et al. (2014) emphasize the vital importance of genuine community involvement and the active exploration of sense-of-place and cultural identity, they also indicate disbelief and distrust of social actors to participate, to be heard and to be recognised as partners by the political powers in their various governmental settings. Mourato and Bussler (2019) highlight how Portuguese community based initiatives' (CBI) transformative change agency is context-dependent and bound by politicization dynamics. The authors emphasize the policy role that CBIs *could* play in UST, as they are well positioned to facilitate co-creative transformative processes between social innovators and incumbent institutions.

In relation to knowledge incorporation, Schmidt et al. (2013) point to a weak and ineffective science in the Portuguese climate governance landscape, as well as a lack of participatory processes that enable cooperative science. Guimarães et al. (2015) also highlight the need for more cooperative dynamics. Using the coastal system of Praia da Vitória bay, Azores, Portugal as a case study, the authors highlight the need to promote stakeholder dialogue and interaction at the earliest opportunity, as it promotes the articulation of various perspectives, social learning, trust and transparency. They call for more ambition when it comes to stakeholder participation in Portugal, as it is essential for promoting the integration of science and policy in sustainability issues.

Portugal's UST governance landscape also shows success-stories of locally shaping and place-making participatory processes. In their work on collaborative governance for marine protected areas, Vasconcelos et al. (2013) involved the local community in a constructive stakeholder dialogue, which revealed to have a substantial impact in enhancing trust building and empowerment. After participating in the project, stakeholders showed greater autonomy to pursue independent initiatives within their newly consolidated network. Another positive example is Portugal's ClimAdaPT.Local, a research-to-policy project assisting 26 municipalities in the elaboration of their local climate adaptation strategy. Aiming to unpack its innovative potential, Mourato et al. (2018) emphasize how the project introduced and reinforced a local participatory culture and enhanced the communication capacity amongst different audiences.

3.3 The Rise of Territorial and Institutional Inter-, and Intra-National Disparities in Terms of Transition Capacity

An example of the *institutional* perspective on the urban level comes from a Special Issue on Experimentation and Institutional Change, edited by Fuenfschilling et al. (2019). Raven et al. (2019) study institutional arrangements in urban contexts in Germany, the Netherlands and China, and show how each institutional context is unique and thus creates different versions of smart city experimentations. Mukthar-Landgren et al. (2019) look at the role of municipalities in urban living labs. They distinguish between three roles of the municipality: a promoter, an enabler or a partner. The authors highlight the importance of local governments to not only promote or collaborate with urban experimentation, but to also create the enabling context for experimentation to take off. Fuenfschilling et al. (2019) summarize the insights by stating that local institutional settings clearly affect the form and degree of experimentation and thus the space for innovation in a specific geographical context.

Looking at Portugal's UST landscape through an institutional lens, the country shows extreme intra-national institutional variation, especially in terms of transition capacity. Decisive for urban transition capacity is the knowledge co-production process through which this is achieved, ensuring that new understandings are actually adopted and shared by the actors involved (Wolfram et al. 2019). However, not all Portuguese municipalities have the capacity to organize such participatory co-creative processes. Campos et al. (2017) point to clear differences with regard to local climate governance between Portugal's coastal and hinterland regions. Smaller rural municipalities often lack appropriate organizational structures and institutional capital to enable effective and participatory UST processes.

However, this is a fast changing scenario. Municipalities participating in innovative research-to-policy projects fast-track their transition capacity. A positive

example of participatory co-creation and urban experimentation is the earlier mentioned ClimAdaPT.Local project. Mourato et al. (2018) highlight how the 26 participating municipalities were able to strengthen their local administrative and institutional capacity, which later led to the creation of a flourishing national network of municipalities for local climate action Adapt.Local. The network is now incrementally taking on the role of a nation-wide platform for knowledge dissemination, political mobilization, funding solutions, and overall awareness-raising for climate action. To further bolster this dynamic, Campos et al. (2017) highlight the fundamental role of transnational governance initiatives, such as ICLEI—Local Governments for Sustainability, the Covenant of Mayors, and the Mayors Adapt initiative. Engaged municipalities appear better equipped to develop climate change policies and actions, due to the knowledge exchange and information offered through these networks.

Municipal finances also play an important role in the willingness to invest in UST processes. Two of Portugal's wealthiest municipalities (Cascais and Sintra) are also the most advanced in their climate governance, showing the need for financial capacity (Carvalho et al. 2014). In a comparative study on local adaptive governance, Schmidt et al. (2014) point to the difference in financial willingness of local governments to contribute to coastal defence efforts. Campos et al. (2017) highlight it is likely that the majority of Portugal's municipalities cannot adequately assess local climate impacts as these studies are very expensive. This is a widely acknowledged obstacle. As such there are currently several ongoing national policy experiments, such as the National Initiative for Circular Cities—InC2, which require municipalities to apply for funding as networks. In addition, there are geographical coverage and dimension parameters that add value to the assessment process. In other words, pioneering, or more capacitated municipalities are mobilized to partner up with lagging local authorities to better foster knowledge and resource transfers. These networks are gradually contributing to mitigate currently existing intra-national institutional capital and capacity disparities.

4 Concluding Remarks

We can witness a double *spatial turn* in ST research. First, there is an increased focus on the urban level and urban experimentation. Cities are playing a leading role in transitions towards sustainability (Bulkeley et al. 2016). Secondly, the application of geographical theoretical perspectives has become a key research direction for ST (Köhler et al. 2019). In this chapter, we conducted a literature review that combined both these spatial turns and linked geographical theories to UST processes. To do so, we performed a critical interpretation of the spatial dimensions of UST dynamics, within the emerging Portuguese UST landscape.

We believe there are still some critical knowledge gaps. Sustainability and its multiple conceptualizations shape transition processes at the urban level (Hodson et al. 2017). Applying transition management at this level is a transition in itself: It

begs for a shift of mindset: from technical and disciplinary short-term thinking, to a systemic approach, from 'have to' to 'want to' (Nevens et al. 2013). The break-down of the Portuguese case studies illustrates how local institutional and governance cultures can hinder UST, by looking at sustainability from a narrow, technocratic and disciplinary perspective.

Another critical factor is the power/knowledge nexus and the 'governmentality' towards urban experimentation: the rationalities, techniques, programmes and subjectivities which underpin it and give it form and effect (Stripple and Bulkeley 2013). Our case studies highlight that although participatory methodologies and civil society involvement are increasingly being used, disbelief and distrust in local decision-making are still high.

Last but not least, a crucial gap concerns the lack of focus on rising territorial and institutional inter-, and intra-national disparities in terms of transition capacity. Portugal's UST landscape showcases how spatial inequality between Portuguese municipalities makes translating and upscaling success-stories a daunting task.

These knowledge gaps are often caused and enlarged by non-communicating streams of literature. In particular, we emphasize the missing link between UST research and three key streams of literature. A first missing link is the (re)politicization of the (U)ST literature, which is still very much based on a depoliticized discourse, thus undermining the needed debate on citizenship and the desired democratic nature of UST (Pepermans and Maeseele 2016; Mourato and Bussler 2019).

Secondly, UST research is not linked to Sustainability Governance. Although recent ST research mentions the 'governance of transition processes' (Loorbach et al. 2017), it does not dive deeper into public policy and decision-making processes, transparency and accountability, its evolution and its multi-level dynamics. Although using an evolutionary perspective, UST research does not refer to Evolutionary Governance Theory (EGT). EGT is an upcoming body of literature on sustainability governance that perceives governance as radically evolutionary: all its elements are subject to evolution, they co-evolve, and most of them are the product of governance itself (Van Assche et al. 2014).

Finally, when spatializing concepts, you automatically have to deal with patterns of unevenness and therefore potencial injustices. However, the concept of environmental justice and its multiple (spatial) dimensions, is lacking in UST research. Justice dimensions related to distribution, procedure and recognition (see Schlosberg 2013; Schlosberg and Collins 2014) are of fundamental importance for just UST dynamics.

To further develop UST research our recommendation is three-fold. First, we have to rethink the very *nature of UST research*. This requires, more extensive and longitudinal research on the negative effect a governance culture might have on urban transformative capacity, and more in-depth comparative studies between policy discourse and subsequent implementation.

A second recommendation concerns the *level of UST research*. Economic geography literature highlights the important distinction between geographical proximity and multiple forms of non-spatial proximity. Further research should be

conducted, especially on institutional settings of a non-spatial character, such as cognitive, social and organizational dynamics, and how they affect ST processes (Hansen and Coenen 2015) and innovative governance arrangements and community-based initiatives (Mourato and Bussler 2019).

A third recommendation is related to the *object of UST researc*h. Further work should be focused on how networked governance evolves, either in smaller, less-equipped municipalities, or in supra-urban structures (Fuenfschilling et al. 2019). In particular, we should shed light on the role and impact of 'transition coaches' and 'knowledge brokers' to facilitate urban experimentation trajectories (Nevens et al. 2013; Mourato et al. 2020).

In sum, institutional innovation is rapidly reconfiguring the UST landscape. However, both UST research and geographical perspectives on transitions are still in its infancy. It is about time academia starts playing catch-up with UST practices.

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João Morais Mourato is a Research Fellow and lecturer at the Institute of Social Sciences of the University of Lisbon. An Architect (UTL 1999) and PhD Town Planning (Bartlett School UCL 2011) João investigates and lectures on the evolution of Spatial Planning as public policy in Portugal. His work focuses on studying the dynamics of adaptation, learning and institutional innovation in the face of the challenges of the socio-ecological transition to sustainability. He

currently consults with the Directorate General of Territory at the Portuguese Ministry of Environment and Climate Action.

Fronika Claziena Agatha de Wit holds a BA in Geography (University College Utrecht 2005) and MSc in Development Studies (Utrecht University 2008). She worked as a sustainability coordinator at the local government of Dordrecht, the Netherlands. From 2011 to 2016, she lived in the State of Acre, in the Brazilian Amazon, where she worked on local and international socio-environmental projects. Currently, she is a Ph.D. candidate at ICS-ULisboa in Climate Change and Sustainable Development Policies, investigating the issue of Polycentric Climate Governance in the Amazon.

Groundwater in the Field of Water Policies, in Spain

Ignacio Sotelo Pérez

1 Introduction

At the present time, it is verified that, in most of the countries with an arid or semi-arid climate, such as Spain, a very important increase in the use of groundwater has been taking place over the last decades, destined, mainly to irrigation or to the supply of large urban centers. In this way, prior to achieving these objectives, it must be understood that the vast majority of the masses of groundwater present in each of the determined territories come largely from the so-called hydrological water cycle, that it is nothing more than a system by which the water resources present in each territorial demarcation, circulate from the seas and oceans existing on the planet, towards the atmospheric delimitations, and from these to the continental territories, in which they settle both in the terrestrial surface layers, and in the underground ones, to later return again to the oceans (Sotelo Navalpotro et al. 2017).

The foregoing must be considered within the water legislation, which in turn must consider the existing disparities between the aspects concerning surface waters and those corresponding to groundwater, as well as the human impact on the different interrelationships (Embid Irujo 2016).

2 Ethical-Legal Aspects of the Extraction and Use of Groundwater

In relation to groundwater, it should be noted that the vast majority of the masses of fresh water on the globe (with the odd exception, for example, the polar regions) are located in the subsoils. These water masses located in the subsoil flow and are

I. S. Pérez (✉)
University Institute of Environmental Sciences (IUCA/UCM), Complutense University of Madrid, C/Manuel Bartolomé Cossío, s/n., 28040 Madrid, Spain
e-mail: ignaciosoteloperez@ucm.es

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retained in a series of geological configurations classified as aquifers. The stored water of the aquifers is closely linked to the so-called Hydrological Water Cycle, since through the recharges they perceive, as well as the discharges of water thrown, they manage to nourish the springs and the fluvial courses of the rivers and its wetlands (with what is easy to perceive, the great environmental role that groundwater plays). However, although the impression that may be had on groundwater is of some resources, that are capable of guaranteeing water supplies in those periods when water resources are scarce, this feeling is usually contrasted with the fact that groundwater tends to be strongly conditioned and largely very limited resources (despite its marked degree of resilience, which makes them natural elements of great strategic value, especially in those areas where the scarcity of these water resources is usually more accentuated, especially due to the very long periods of drought they suffer). In one way or another, groundwater is configured in Spain as part of resources that must be preserved and conserved, making it essential to have adequate and sustainable management of said water resources (Andreu Rodes and Fernández Mejuto 2019); in this work, the current situation of the Underground Water Bodies is analyzed in detail according to whether they are found in one or another Peninsular Hydrographic Demarcation (including those of Ceuta, Melilla, and the Balearic and Canary Islands, with their corresponding delimitation of their underground waters).

At this point, and in achieving the objectives incardinated to favor good management of groundwater, it is essential to mention each and every one of the regulatory bodies that have been dealing with the regulation of groundwater masses, initially highlighting the following normative provisions of both community and internal law (Sotelo Navalpotro and Sotelo Pérez 2018):

(A) **Community Legislation**

(A.1) In the first place, the appearance of Council Directive 80/68/EEC, of 17 December 1979, on the protection of groundwater against pollution caused by certain dangerous substances, would focus within its article 1.1, the object of the same, showing itself as said object, would be included in «preventing the contamination of groundwater by substances that belong to the families and groups of substances listed in lists I and II of the Annex, hereinafter referred to as (substances of the lists I or II. Council Directive 80/68/EEC, 1979), and reduce or eliminate, as far as possible, the consequences of its current contamination». In the same way, this normative provision of community law would stand out for containing, within the same article 1.2, what would have to be understood as «(a) **(groundwater)** means all water which is below the surface of the ground in the saturation zone and in direct contact with the ground or subsoil; (b) **(direct discharge)** means the introduction into groundwater of substances in lists I or II without percolation through the ground or subsoil; (c) **(indirect discharge)** means the introduction into groundwater of substances in lists I or II after percolation through the ground or subsoil; (d) **(pollution)** means the discharge by man, directly or indirectly, of substances or energy into groundwater, the results of which are such as to

endanger human health or water supplies, harm living resources and the aquatic ecosystem or interfere with other legitimate uses of water», this would open the way to the consideration from the European legislation of having precise actions to protect the Community's groundwater against contamination (paying particular attention to the contamination caused by certain toxic, persistent and bioaccumulative substances), which would in turn lead to an approximation through legislation (both to citizens and public powers), to a series of essential concepts to understand and address the matter of groundwater masses.

(A.2) In second place, after the adoption of **Directive 80/68/EEC**, by the European Union, the apparent need to establish more inflexible and innovative measures aimed at protecting both the quantitative and chemical states of water bodies was stressed underground. In this need, the emergence of Directive 2000**/60/EC**, of the European Parliament and of the Council of 23 October 2000 establishing a framework for Community action in the field of water policy, established a series of strategies to prevent and control groundwater contamination, ruling in this sense that «*The European Parliament and the Council shall adopt specific measures to prevent and control groundwater pollution. Such measures shall be aimed at achieving the objective of good groundwater chemical status in accordance with Article 4(1)(b) and shall be adopted, acting on the proposal presented within two years after the entry into force of this Directive, by the Commission in accordance with the procedures laid down in the Treaty*» (Article 17) (The incorporation into the Spanish legal system of the aforementioned Directive 2000/60/CE, materialized, in general, through article 129 of the Law 62/2003, Of 30 December, Fiscal Measures, Administrative and Social Order, establishing that the «Article 129. Amendment of the recast text of the Water Law, approved by Royal Legislative Decree 1/2001 of 20 July, incorporating into Spanish law, Directive 2000/60/EC establishing a Community framework for action in the field of the water policy» (Sotelo Pérez et al. 2019). Proceeding in this way to modify the Consolidated Text of the Water Law, approved by Royal Legislative Decree 1/2001, of July 20). The provisions of this directive on the strategies adopted both by the European Parliament and by the commission aimed at controlling and preventing the contamination of groundwater masses, would be specified in the second, third, fourth and fifth paragraphs of Article 17 of the Water Framework Directive, which would stipulate that «(1) In proposing measures the Commission shall have regard to the analysis carried out according to Article 5 and Annex II. Such measures shall be proposed earlier if data are available and shall include: (a) criteria for assessing good groundwater chemical status, in accordance with Annex II.2.2 and Annex V 2.3.2 and 2.4.5; (b) criteria for the identification of significant and sustained upward trends and for the definition of starting points for trend reversals to be used in accordance with Annex V 2.4.4. (2) Measures resulting from the application of paragraph 1 shall be included in the programmes of measures required under Article 11. (3) In the absence of criteria adopted under

paragraph 2 at Community level, Member States shall establish appropriate criteria at the latest five years after the date of entry into force of this Directive. (4) In the absence of criteria adopted under paragraph 4 at national level, trend reversal shall take as its starting point a maximum of 75% of the level of the quality standards set out in existing Community legislation applicable to groundwater» (art.17. Directive 80/68/EEC).

Without leaving aside the measures and strategies contemplated by this European Directive, the Water Framework Directive would reinforce some notions, such as that of water sustainability, as it is based, as some authors have explained, in "the concept of integrated management of hydrographic basins", this perspective being the one that has led to the notion of "groundwater mass" being used and identified with the term sustainable use of groundwater.

(A.3) In third place, would be approved, the Directive 2006/118/EC of the European Parliament and of the Council of 12 December 2006 on the protection of groundwater against pollution and deterioration. The following Directive, in accordance with the provisions of the first and second paragraphs of Article 17 of Directive 2000/60/EC, would establish a series of specific measures aimed at preventing and controlling the contamination of groundwater. Some of these measures will include, in particular, (a) criteria for assessing the good chemical status of groundwater, and (b) criteria for the determination and reversal of significant and sustained increasing trends and for the definition of the starting points of trend reversals. In the same way, this Directive completes the provisions contained in Directive 2000**/60/EC** aimed at preventing or limiting the entry of pollutants into groundwater and preventing the deterioration of the state of all bodies of groundwater (all this is contained as part of the object that this Directive 2006/118/EC, **2006**, includes in its first article).

Illustrative is the incorporation into the Directive of a series of definitions, such as «For the purposes of this Directive, the following definitions shall apply in addition to those laid down in Article 2 of Directive 2000/60/EC:(1) **"groundwater quality standard"** means an environmental quality standard expressed as the concentration of a particular pollutant, group of pollutants or indicator of pollution in groundwater, which should not be exceeded in order to protect human health and the environment; (2) **"threshold value"** means a groundwater quality standard set by Member States in accordance with Article 3; (3) **"significant and sustained upward trend"** means any statistically and environmentally significant increase of concentration of a pollutant, group of pollutants, or indicator of pollution in groundwater for which trend reversal is identified as being necessary in accordance with Article 5; (4) **"input of pollutants into groundwater"** means the direct or indirect introduction of pollutants into groundwater as a result of human activity; (5) **"background level"** means the concentration of a substance or the value of an indicator in a body of groundwater corresponding to no, or only very minor, anthropogenic alterations to undisturbed conditions; (6) **"baseline level"** means the average value measured at least during the reference years 2007 and 2008 on the basis of monitoring programmes implemented under Article 8 of Directive 2000/60/EC or, in the case of substances identified after

these reference years, during the first period for which a representative period of monitoring data is available» (Article 2, Directive 2006/118/EC).

(B) **Spanish national legislation**
Including the most relevant legislation in charge of Groundwater, we can stand out:

(B.1) **The Spanish Constitution and Law 29/1985, of August 2, Waters**
Within what our **internal legal system** comprises, we must pause in the brief analysis of the figure of the publicization of natural resources as a protection technique. In relation to this figure, both the most prominent doctrine and the most consolidated jurisprudence have been discerning that the incorporation into the public domain of certain specific assets has to be understood as a technique designed to protect them, being the constituent itself the one in charge of strengthening this criterion through the inclusion within article 132.2 of the **Constitutional Text** that «the property of the State public domain shall be that established by law and shall, in any case, include coastal area, beaches, territorial waters and natural resources of the economic zone and the continental shelf» (The Spanish Constitution 1978). For its part, the jurisprudence of the Constitutional Court (maximum interpreter of the constitutional precepts), would rule in the resolution of some appeals of unconstitutionality against Law 29/1985**, of August 2, Water**, ruling in its Sentence 227/1988**, of November 29** (Antecedent fourteen) that «*In effect, the incorporation of a good into the public domain implies not so much a specific form of appropriation by public powers, but a technique aimed primarily at excluding the affected good from private legal traffic, protecting it from this exclusion through a series of rules exorbitant of those that are common in said traffic iure privato*» (STC 227/1988, of November 29, said jurisprudence delves into the sense according to which «the good in the public domain is thus above all res extra commercium, and its affectation, which has that essential efficacy, can pursue different ends: Typically, ensure public use and its public distribution through concession of private uses, allow the provision of a public service, promote national wealth—art. 339 of the Civil Code—guarantee the management and controlled or balanced use of an essential resource, or other similar ones). Within this broad category of public property, it is necessary to distinguish between those uniquely affected by a public service or the production of certain goods or services under public ownership and those others that, as genres, are declared not susceptible of private appropriation in attention to their natural unitary characteristics. In the former, the affectation is closely linked to the management of each specific public service or activity, of which they constitute mere material support. On the other hand, the generic inclusion of entire categories of goods in the demand, that is to say, in the determination of the so-called natural public domain, underlie other constitutionally legitimate purposes, ultimately linked to the satisfaction of primary collective needs, such as, for example, the one guaranteed by art. 45 of the

> Constitution, or to the defense and rational use of the "wealth of the country", insofar as it is subordinate to the general interest (art. 128.1 of the Constitution). For this reason, in the event that a singular asset is affected under a public service stricto sensu, it is clear that the ownership of the asset is accessory to that of the competence for the management of the service, unless expressly prescribed otherwise, to what is not opposed by art. 132.2 of the Constitution. In such cases, both the State and the Autonomous Communities may exercise the powers conferred on them by the Constitution (art. 128.2 of the Constitution) and the Statutes of Autonomy, when this implies an allocation of assets to the public domain, and in accordance with the laws that regulate the legal regime of the latter (art. 132.1 of the Constitution).

On the contrary, in the case of the "public domain", it is logical that the power to sue is reserved exclusively to the State and that the natural kinds of goods that unitarily comprise it are also included as an indivisible unit in the public domain of the State. This statement is even more evident with reference to an essential resource such as water, given the character of a unitary resource and part of the same (hydrological) cycle that it undoubtedly has and that the contested Water Law itself recognizes. All this without prejudice to the powers attributed to the Autonomous Communities on the management and use of hydraulic resources, by virtue of the Constitution and their respective Statutes of Autonomy, powers to which, for the reasons indicated, the power to affect and the ownership of the property on which they fall is not inherent». What is dealt with in this article 132 of the Constitution regarding the recognition of certain assets as part of the public domain, together with the environmental protection contained in article 45.2 of the Law of Laws, according to which «the public authorities shall safeguard rational use of all natural resources with a view to protecting and improving the quality of life and preserving and restoring the environment, by relying on essential collective solidarity», affirm the teleological nexus that unites arts. 45 and 132 CE, defended by the reiterated doctrine and by the most recent constitutional jurisprudence, such as STC 233/2015, whereby, the High Court resolves the unconstitutionality appeal filed against Law 2/2013, dedicated to the protection and sustainable use of the coastline and the modification of the Coastal Law.

This is why, the configuration of a natural public domain (as a protection technique for some of these assets mentioned in the aforementioned doctrine and jurisprudence), where our legislation has found a refuge to take refuge to protect some of the most important natural resources for the social, cultural, and economic development of our environment. In fact, with regard to continental waters (in which if we return to the old nineteenth century Water Laws of 1866 and 1879, they were already included within the so-called public demand), Law 29/1985**, of August 2, on Waters** would complement the trend by declaring the almost absolute demanialization of all continental waters, and later with the adoption of Royal Legislative Decree 1/2001**, of July 20, by which the revised text of the Water Law is approved**, it would be confirmed, with the imposition of a concession for those who want to make private use of these water resources, excepting, however, the use of underground aquifers

when these do not reach annual volumes of about seven thousand cubic meters, in which then the Consolidated Text establishes with respect to private uses by legal provision that «under the conditions established by regulation, water from springs may be used in a property when the total annual volume does not exceed 7000 m^3. In the aquifers that have been declared as overexploited, or at risk of being so, new works of those covered by this section may not be carried out without the corresponding authorization» (art.54, Royal Legislative Decree 1/2001) (Galindo Elola-Olaso. F 2010; Rastrollo Ripollés; A. Synopsis of article 45. Spanish Constitution. As stated in the cited synopsis, in the application of article 132 of the Constitutional Text, Law 22/1988, July 28, on Costs -later modified by Law 2/2013, of May 29, on the protection and sustainable use of the coastline and by modification of Law 22/1988, of July 28, on Coasts- would establish as part of the so-called public domain the maritime-terrestrial zone, whose purpose would be incardinated in reducing the deterioration of the coastal áreas). Similarly, Law 22/1988, of July 28, of Coasts, which in its article 20 would state that «The protection of the maritime-terrestrial public domain includes the defense of its integrity and of the purposes of general use for which it is destined; the preservation of its characteristics and natural elements and the prevention of the harmful consequences of works and installations, in the terms of this Law», it would be dedicated to establishing within its articles a series of limitations to the property rights applicable to the neighboring territories classified as maritime-terrestrial domain, which would restrict, among other issues, the possibilities of building. Nor can we fail to mention Law 43/2003, of November 21, on the Countryside (that with the approval of Law 10/2006, of April 28, which would modify Law 43/2003, of November 21, on the Countryside), that by forming another case of legalization it would try to protect the natural landscapes, being in its article 12 where it would establish after the distinction between the mountains of public domain, and the patrimonial mountains that «(1) *They are in the public or public domain and are part of the public forest domain:* (a) *For public service reasons, the mountains included in the Catalog of Public Utility Forests at the time this law comes into force, as well as those included in him in accordance with article 16.* (b) *The communal mountains, belonging to local entities, as long as their use corresponds to the common of the neighbors.* (c) *Those other mountains that, without meeting the above characteristics, have been assigned to a public use or service.* (2) *Assets are those of public property that are not public domain*», integrating within the forest demand the mountains that were included in the "Catalog of Public Utility Forests, the communal forests and others that have been assigned to a public use or service".

After the above, it is noted that the **Magna Carta**, unlike the recognition provided in article 132 for the terrestrial maritime public domain, would leave some freedom for the establishment of the continental water regime, since it does not state anything regarding the aforementioned continental waters, Except of course, it is the specific competence of these. Regarding Law 29/1985**, of August 2, on Waters,** as shown above, it would include groundwater within the public domain (in consideration of the unanimous acceptance of the moment towards the principle of basin unity, and in attention to the hydrological knowledge that at that time was

had on these matters), one of the most relevant consequences being the transcendental change caused by the transfer of an appropriation model belonging to the owners of the properties in which the underground aquifer was located, to a system in which these underground aquifers were publicly assigned according to legislative policy guidelines, which in turn was subordinate to the availability of the corresponding resources ("one of the faculties—that of the utilization and delivery of groundwater—that until that moment included land ownership, the delimitation of rights and the determination of the faculties that comprised and formed part of the modern conception of property rights and of its constitutional configuration as a right conditional on its social function whose content is delimited, for each type of property, by the legislator) (Del Saz Cordero 2016).

(B.2) **Royal Decree 849/1986, of April 11, which approved the Regulation of the Public Hydraulic Domain, that develops the preliminary titles I, IV, V, VI and VII of Law 29/1985, of August 2, on Waters**

Through this Royal Decree, Directive 80/68/EEC, of the Council, of December 17, 1979, on the protection of groundwater against pollution caused by certain dangerous substances, would be incorporated into our Spanish legal system. Regarding the regulatory development planned for compliance with Law 29/1985, of August 2, on Waters (valid since January 1, 1986), start from the fundamental fact that this Law would authorize the Government in its second final provision, to dictate, at the proposal of the Ministry of Public Works and Urban Planning, a whole set of regulatory provisions, necessary for it to be fulfilled (this regulatory development, provided for in the legal text, would not be presented urgently for each and every one of its chapters, since said text would explicitly contain some of the concepts contained in it, which would facilitate its direct application. However, the transitory provisions contained in the Law itself would offer a sufficient degree of foresight that would in turn facilitate the development of the corresponding regulatory provisions without so much haste (Royal Decree 849/1986, of April 11, which approved the Regulation of the Public Hydraulic Domain, which develops preliminary titles I, IV, V, VI and VII of Law 29/1985, of August 2, on Waters). In the Consolidated Text of this Royal Decree it is shown as «the matters regulated in the Preliminary Titles, I, IV, V, VI and VII, which refer to the definition of the public hydraulic domain and its use and protection, ***including the police and economic-financial regimes*** of the same, demand an immediate development at the regulatory level that allows, in coordination with the provisions of Royal Decree 2473/1985, of December 27, relative to the table of validity in matters of water law, approved in accordance with the provisions of the provision Third repeal of Law 29/1985, the application of this Law, which must progressively form the new hydraulic order desired by the legislator. Regarding this point, it is appropriate, on the one hand, to define the concept and regulation of the so-called **Water Police**, as the activity of the water administrations in charge of regulating and monitoring the good orders of the uses and exploitation of the hydraulic public domain, of those areas

easement, as well as each and every one of the protection perimeters. These police functions within the State Hydraulic Administration are exercised directly by the different environmental agents, assigned to the water police stations of each basin organization, which enjoy public authority, and therefore the acts carried out by them are assumed a highly relevant presumption of innocence (this definition agrees with the one provided in the 2019–2020 environmental practical report, published in Francis Lefebre, and in which it is analyzed in relation to the police and easement regime, the protection zones of the public hydraulic domain, and the zones floodplains and their reference flow, all in line with the definition of water police). In the same way, **in** Royal Legislative Decree 1/2001**, of July 20, which approves the revised text of the Water Law**, it regulates in its articles very broadly the issues related to the **water police**, showing itself as «(1) *The water police and other elements of the public hydraulic domain, easement zones and protection perimeters, will be exercised by the competent hydraulic Administration.* (2) *In the basins that exceed the territorial scope of an Autonomous Community, the water police stations of the Basin Organizations shall exercise the following functions:* (a) *The inspection and control of the public hydraulic domain.* (b) *Inspection and monitoring of compliance with the conditions of concessions and authorizations relating to the public hydraulic domain.* (c) *Carrying out gauges, information on floods and control of water quality.* (d) *The inspection and surveillance of the works derived from the concessions and authorizations of the public hydraulic domain.* (e) *The inspection and surveillance of the exploitations of all the uses of public waters, whatever their ownership and the legal regime to which they are covered.* (f) *The management of the river nursery services.* (g) *In general, the application of the water and channel police regulations.* (3) *In the exercise of their function, the Environmental Agents assigned to the water police stations of the Basin Organizations have the character of public authority and are empowered to:* (a) *Enter freely at any time and without prior notice in the places subject to inspection and to remain in them, with respect in any case to the inviolability of the home. When carrying out an inspection visit, they must communicate their presence to the inspected person or his representative, unless they consider that such communication could prejudice the success of their functions.* (b) *Proceed to carry out any investigation, examination or test that they consider necessary to verify that the legal provisions are correctly observed.* (c) *Take samples of substances and materials used or in the establishment, take measurements, obtain photographs, videos, record images, and draw up sketches and plans, provided that the employer or his representative is notified.* (4) *The facts verified by the officials of the Scale of Environmental Agents that are formalized in the corresponding minutes will have the presumption of certainty, without prejudice to the evidence that the interested parties may provide in defense of the respective rights and interests.* (5) *The River Guards will carry out support and assistance tasks for Environmental Agents in the exercise of their water police functions*» (Article 94).

(B.3) **Royal Decree 606/2003, of May 23, which modifies Royal Decree 849/1986, of April 11, by which the Regulation of the Hydraulic Public Domain is approved, which develops the preliminary Titles, I, IV, V, VI and VIII of Law 29/1985, of August 2, on Water**

After the approval of this Royal Decree, the Regulation of the Hydraulic Public Domain, approved by Royal Decree 849/1986, of April 11, would be modified, in such a way that the protection of underground aquifers is enhanced and control over discharges is reinforced, updating the list of polluting substances. Said Royal Decree would be characterized by having a single article called «Modification of Royal Decree 849/1986, of April 11, which approves the Regulation of the Hydraulic Public Domain, that develops the preliminary Titles, I, IV, V, VI and VIII of Law 29/1985, of August 2, on Waters», and for regulating the following subjects (Royal Decree 606/2003, of May 23, which modifies Royal Decree 849/1986, of April 11, by which the Regulation of the Hydraulic Public Domain is approved, which develops the preliminary Titles, I, IV, V, VI and VIII of Law 29/1985, of August 2, on Water): (1) the use of the public hydraulic domain. (2) the protection of the public hydraulic domain and the quality of continental waters. (3) the financial economic regime of the use of the public hydraulic domain. (4) Infractions and sanctions. (5) the contract for the transfer of rights to the exclusive use of the waters.

(B.4) **Law 11/2005, of June 22, which modifies Law 10/2001, of July 5, on the National Hydrological Plan**

This law is relevant, since it establishes within its seventh additional provision section (e) the generic regulatory empowerment for the Government, so that it within the scope of its corresponding competencies (and previous consensus with the autonomous communities), can carry out the appropriate and pertinent actions regarding the matter of protection and management of groundwater (all this within the framework of the development of hydrological planning and of course within the deadlines required by the Water Framework Directive).

(B.5) **Royal Decree 1514/2009, of October 2, regulating the protection of groundwater against contamination and deterioration (Royal Decree 1075/2015, of November 27, amending Annex II of Royal Decree 1514/2009)**

Within the regulatory framework described so far, that is, the revised text of the Water Law and the aforementioned Law 11/2005, present an adequate and sufficient legal range for the incorporation into the Spanish internal legislation of the aforementioned Directive 2006/118/EC, all this through a standard with regulatory status. The Member States have intended to promote compliance with Directive 2006/118/EC, and therefore the European Commission would be responsible for the publication of guidance documents dedicated to a series of matters: (1) to monitor the state of groundwater. (2) to direct and indirect inputs of pollutants. (3) to groundwater in protected areas for the collection of drinking water and to the state of groundwater and evaluation of pollutant trends. Being in these guides, where exhaustive explanations were provided, of

the criteria and technical procedures related to the provisions contained in this Royal Decree 1514/2009, of October 2, which regulates the protection of groundwater against contamination and deterioration. This Royal Decree has been favorably reported by the National Water Council, and the autonomous communities and affected sectors have been consulted in its processing, focusing its object on «establish specific criteria and measures to prevent and control groundwater contamination, including the following: (a) Criteria and procedure for evaluating the chemical status of groundwater. (b) Criteria to determine any significant and sustained trend towards increasing concentrations of pollutants, groups of pollutants or pollution indicators detected in groundwater bodies and to define the starting points for trend reversals. (c) Measures to prevent or limit the entry of pollutants into groundwater and avoid the deterioration of the state of all groundwater bodies» (art.1. Royal Decree 1514/2009, of October 2, which regulates the protection of groundwater against contamination and deterioration).

3 By Way of Conclusions

At this point, it should be noted that after the above we can conclude that the hydrological cycle and its different phases and components are influenced, in the case of groundwater, by actions that depend on other sectors, perceived as regulating reservoirs of water flows. That can be used in a similar way to the use of surface reservoirs, so the volume of extraction of these waters depends on the relationship between the cost of drilling plus that of lifting energy, and the economic performance of the flow obtained.

Specifically, when it comes to groundwater trafficking in our country, it should be noted that, despite the fact that Spain has the largest number of aquifers available within its territorial limits, the management of these water masses has been considered by some authors as disorderly and incoherent, although it is an undeniable reality that at the present time around fourteen percent of the population settled in the Spanish territory, is supplied with the resources from these aquifers, distinguishing them, by giving priority to promoting the different agricultural operations.

We must not forget that in Spain, the use of water resources from the subsoil has undergone an enormous evolution, both from the social perspective, and in the use of these resources in the different economic sectors, as well as in their regulatory regulation (which in the latter case has been marked by the legislative development experienced in Europe, through its directives, which have subsequently been transposed into our national internal order).

In fact, the use of the water resources present in the subsoil has been increasing from the last century XX to the present day, the set of groundwater playing a decisive role in improving, among other issues, the progress of the sectors. economic, and the well-being of the citizens of our country (with the opportune

qualification according to which, in many cases, overexploitation, which has occurred on these resources, has caused that the use of these resources cannot always be considered as sustainable, which in many cases has caused the consumption of these resources).

The overexploitation of the resources stored in the subsoil, has had its maximum exponent in the agricultural yields and in the increasingly extensive urban settlements, issues all of which have caused eminent excesses on the environment, and therefore on the resources housed in aquifers (manifesting itself mainly in the disposition of groundwater strongly degraded in its quality).

Having replaced in modern law the unitary and unlimited concept of property by the statutory, there is nothing to object to an operation of publication of natural resources that is protected although not required by article 132 of the Spanish Constitution, although due to the nature of things. Consistent with this statement, the jurisprudence of the Constitutional Court would state that «it is true that that power of the legislator cannot, without infringing the Constitution, be exercised disproportionately, with excessive and unnecessary sacrifice of the economic rights of individuals, but it is also true that, as regards hydraulic resources, the Water Law does not impose such excessive sacrifice, if one takes into account, on the one hand, that most of these resources are already in the public domain, according to an uninterrupted tradition of our historical Law, and on the other, that the Law 29/1985 allows, although with certain limitations directed as a whole to the realization of the objectives that the appellants seem to share or at least do not fight, that the holders of rights over private waters maintain their ownership "in the same way as up to now". If to this it is added that to all the uses of water, whether public or private, the rules relating to the limitations of the use of the public hydraulic domain must be applied in the future (section 4 of the second and third transitional Provisions), it is not It is possible to accept that the option of the legislator favorable to the publicization of continental waters, but respectful of the voluntary preservation of pre-existing private rights, it must be understood as unconstitutional as disproportionate. In short, without entering into the political assessment that this may merit the appellants (about which no pronouncement can be made by this Court), the legislator has chosen one of the different possible alternatives, explicitly protected by art. 132.2 of the Constitution, without thereby violating the principle of interdiction of the arbitrariness of public powers enshrined in art. 9.3 of the same Constitutional Text» (STC 227/1988, November 29, 1988).

Finally, it should be noted that after the foregoing it is concluded that in our State, both the technological and scientific knowledge bases, concerning groundwater, are complemented by an effective and realistic water legislation (in turn, these scientific and technological knowledge are the basis for said water legislation). However, in my opinion, the legislation in charge of regulating groundwater (and in general the set of water bodies present in our territory), should not become mere scientific or technical documents, but should be characterized by their brevity, simplicity, durability and flexibility, in short, legislation capable of being applied according to the needs of each moment and each place (and where the objective of the regulatory norms as well as the provisions in charge of developing them and

putting them into practice, focus on those areas that are more punctilious and susceptible to being modified mainly due to the development and transformation of the sociological and physical reality of each region). Knowing, assessing and interpreting the competency and regulatory reality of groundwater, the reuse of desalinated water, the supply of water resources and the processes of sanitation and purification of water, allows us to approach the complex and at the same time, attractive, reality of Water Policies in our country (Sotelo Pérez et al. 2020), studying it from a territorial perspective, starting from a Constitutional framework of guarantees.

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"Water Footprint" and Territorial Sustainability in Spain

María Sotelo Pérez, Adriana Galvani, and José Antonio Sotelo Navalpotro

1 Introduction

The study of the Spanish water reality currently goes through our approach to the "Water Footprint", in our case to the differences and imbalances existing in our country. The term "Virtual Water" is a current concept, which takes on considerable interest in territorial study and analysis; this has its origin in the works of Professor John Anthony Allan, elaborated in the nineties and aims to calculate the "volume of water required to produce a good or service" (Allan Allan, 1998a, b). This question, based on the need to know the demands of water resources, becomes essential, since water is an essential resource for the development of human life, as well as necessary for the production of goods and services, giving a clear example of the interest in facing the growing water demands, with which to satisfy the unlimited needs of the inhabitants Similarly, it should be noted that the term was defined by Allan (1993), while conducting a study on the importation of "Virtual Water", used in the production of goods and services in Middle Eastern countries; this question was extremely relevant since it considered that, when exporting a certain product, it contains high levels of water resources ("Virtual Water") that have been used in their production, showing that product-importing countries do not. They need to use national water to produce a certain good, and, therefore, they can use that water for

M. S. Pérez (✉)
King Juan Carlos University (URJC), Paseo de los Artilleros, 38, 28032 Madrid, Spain
e-mail: maria.sotelo.perez@urjc.es

A. Galvani (✉)
University of Bologna, Via Guerrazzi, 20, 40125 Bologna, Italy
e-mail: adriana.galvani@unibo.it

J. A. S. Navalpotro (✉)
University Institute of Environmental Sciences (IUCM/UCM), C/Manuel Bartolomé Cossío, s/n, 28040 Madrid, Spain
e-mail: jasotelo@ucm.es

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other purposes. Likewise, other authors collect in the book "Economic Cooperation in the Middle East-Westview Special Studies on the Middle East. Boulder" (Fishelson 1989), that it was not conducive for those countries with water deficiency to carry out exhibitions of products in which substantial amounts of water had been used, and they highlighted the importance of specializing in the production and export of goods that used few water resources in their production process. In turn, it should be noted that, although the term "Virtual Water" has become more relevant in recent decades, the concept has been used since ancient times, and is based on two fundamental factors: firstly, information is collected regarding the amounts of water resources used in the production of goods and services; secondly, since it is used, or can be used, in national and international trade, it allows knowing the water flows between regions, through the import and export processes of "Virtual Water". Reasons why some authors such as Hanasaki et al. (2010) consider that the concept of "Virtual Water" is an essential element when it comes to collecting information on water demands, which allow knowing, analyzing and assessing the availability of water as well as the use of water. itself, in a certain territory.

2 The "Virtual Water" Demand in Spain

As is well known, water is a limited resource, since access to this good (drinking water), fundamental and necessary for life, is not available to everyone. The most important problem of this good is scarcity since, in most cases, the demands for water substantially exceed the natural supply of water itself. With this, the study of exports and imports of "Virtual Water" is fundamental, as well as novel, to face situations of deficit of water resources in a certain geographic area. For this reason, we will carry out a detailed study of the demands of "Virtual Water" in Spain in the primary, secondary and tertiary economic sectors.

2.1 Primary Sector

To calculate the demand for "Virtual Water" in the Primary Sector, for the years 2000, 2010 and 2019, the methodology of Champagain and Hoekstra (2004), Rodríguez Casado et al. (2008), and, of Sotelo Navalpotro et al. (2010, 2011).

As we can see in this Fig. 1, between 2000 and 2010 there was a slight decrease in the demand for Blue Water (irrigation), as a direct consequence of the progressive increase in demand for Green Water (from precipitation). Although, although in 2010 there was a considerable decrease in rainfall, this did not imply a notable decrease in the trend dynamics in the period 2000–2010. What is clearly seen in the graph is that, despite the conditions in which the Primary Sector is currently (subsidized and reinforced by structural policies by the European Union),

there has been a progressive decrease in the demand for "Virtual Water" that has worsened in the last period 2010–2019 as a direct consequence, not only of the decrease in aid, but also, as a result of the Covid-19 crisis (although, we must not forget that the Primary Sector is the largest demand for water resources in Spain).

The agricultural sector in our country presents the highest levels of demand for water resources, at the sectorial level. Its total water consumption was 34,217.47 hm^3 in 2019, although we can observe how the primary sector is a sector with a deficit in water resources, as described above, since it demands much more water than is offered in Spain. In this Fig. 2, we see how the Community of Andalusia is the one that demands the highest levels of "Virtual Water" in the Primary Sector (19.25%), followed by the Autonomous Communities of Catalonia (15.01%) and Madrid (14.89%). The demand trend for "Virtual Water" in the Primary Sector tends to be very high in most of the Autonomous Communities, especially in relation to the need that exists in our country to import agricultural and fishing resources, mainly.

For this reason, these high levels of "Virtual Water" in the Primary Sector are found in Autonomous Communities in which there is a high level of population and/or with strong tourist pressure.

2.2 *Secondary Sector*

To calculate the demand for Virtual Water in the Secondary Sector for the year 2020, the Sotelo Navalpotro et al. (2010, 2011), by Champagain and Hoekstra (2004), and, by Rodríguez Casado et al. (2008) (Fig. 3).

Taking into account each of the Autonomous Communities, the trend in demand for "Virtual Water" in the secondary sector (industrial and construction) we observe how, once again, the Autonomous Communities of Andalusia (18.76%), the Valencian Community (11.14%), Catalonia (16.21%) and Madrid (14.42%), are the

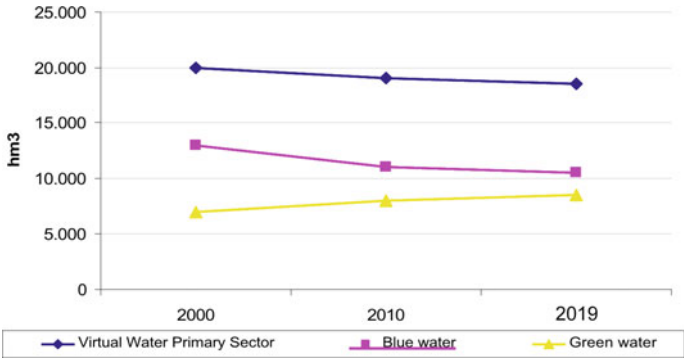

Fig. 1 "Virtual Water" demand of the primary sector, in Spain. *Source* Own elaboration

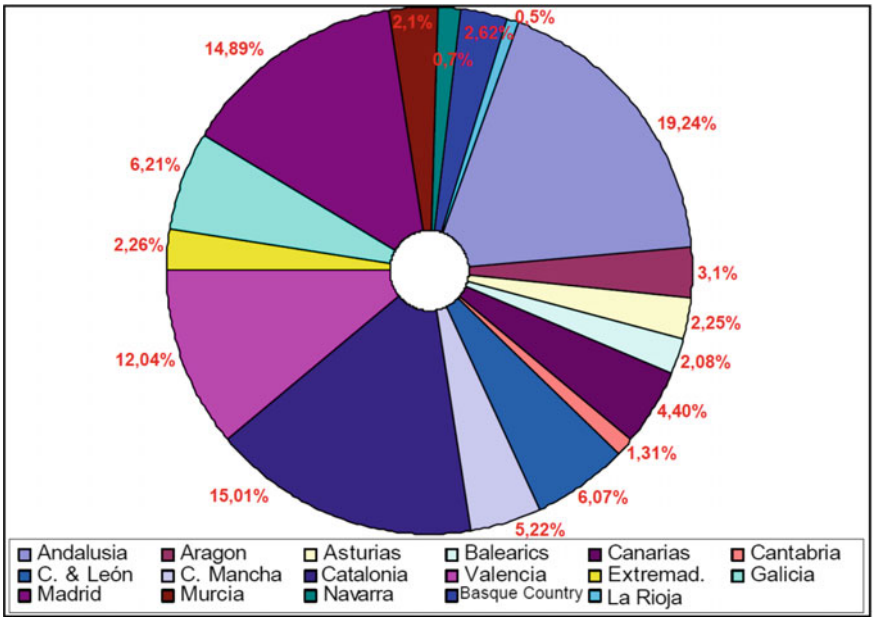

Fig. 2 "Virtual Water" demand from primary sector in Spain, by Autonomous Communities (2020). *Source* Own elaboration

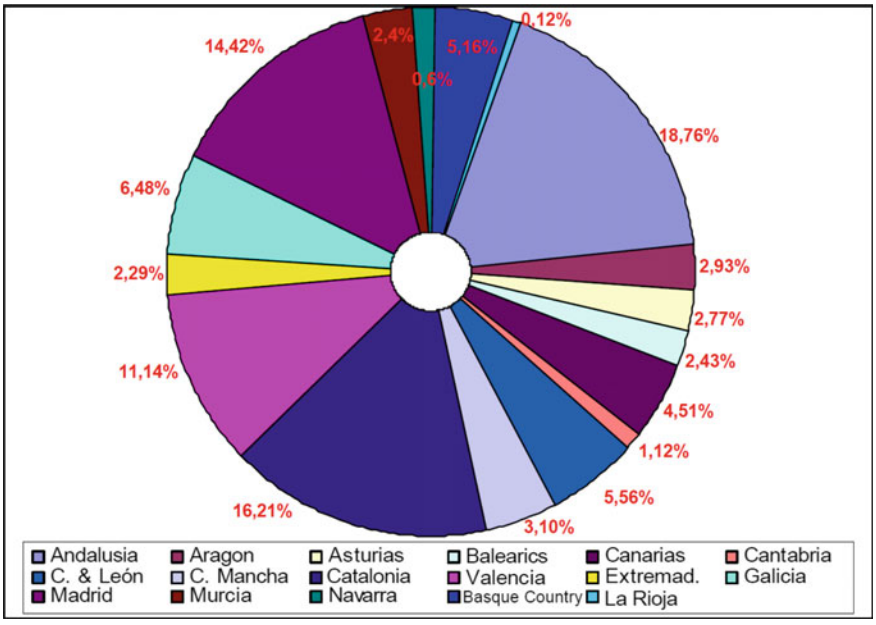

Fig. 3 "Virtual Water" demand from Secondary Sector in Spain, by Autonomous Communities (2020). *Source* Own elaboration

Autonomous Communities with the highest demand for "Virtual Water". Regarding the Autonomous Communities with the lowest demand, we find La Rioja (0.12%), Navarra (0.6%), and Cantabria (1.12%), where the demand for "Water Footprint" does not exceed 500 hm^3. One of the most representative questions in this graph is that in all the Autonomous Communities, exports are lower than total consumption and imports, with which we can affirm that Spain is a demanding country for industrial goods and services.

2.3 *Tertiary Sector*

The demand for Virtual Water in the tertiary sector (domestic use, services and tourism) was obtained, through the statistics of the National Institute of Statistics, using the calculation methodology Sotelo Navalpotro et al. (2010, 2011) (Fig. 4).

The information obtained from the database was: volume of registered water distributed in economic sectors (services), domestic (households), municipalities and others. The information available is at the aggregation level of Autonomous Communities and Spain. At the same time, it should be noted that the Water Supply and Sanitation Unit (USSA), used in the INE survey, comprises all activities (collection, purchase, sale and supply or distribution of low water in addition to the

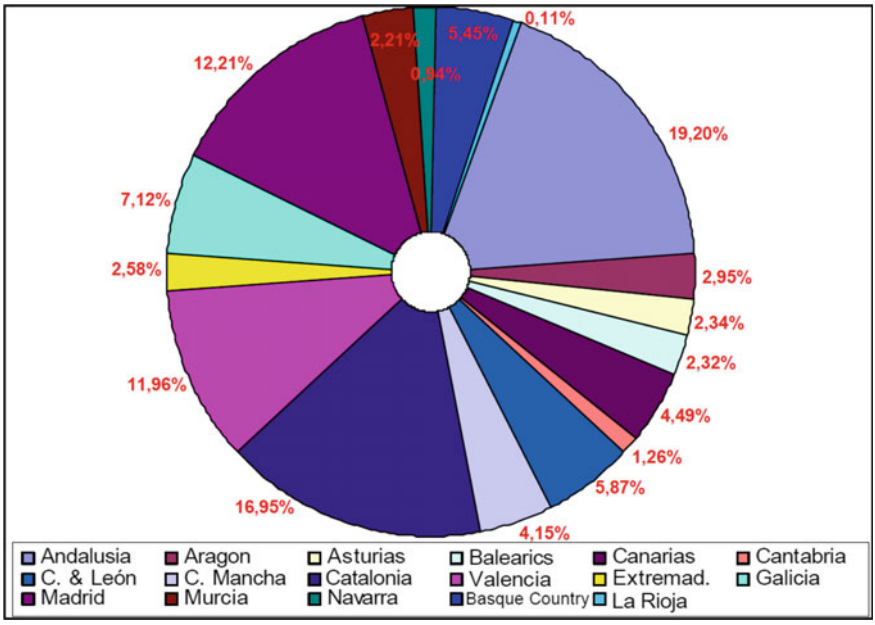

Fig. 4 "Virtual Water" demand from tertiary sector in Spain, by Autonomous Communities (2020). *Source* Own elaboration

collection and wastewater treatment) that a company or entity manages in the same Autonomous Community. Taking into account each of the Autonomous Communities, we find that Andalusia (19.20%), the Valencian Community (11.96%), Catalonia (16.95%) and Madrid (12.21%) are the Autonomous Communities with the highest demand of Virtual Water present, while Rioja, Navarra and Cantabria, where the demand for Virtual Water does not exceed 300 hm^3.

The main cause of this trend is found, fundamentally, in the inversely proportional relationship that exists between population and demand for goods and services in the tourism subsector and its link with the catering subsector. Undoubtedly, Spain is a country where tourism has an important weight in the Gross Domestic Product and that, in turn, affects the levels of direct and indirect water consumption.

3 The Trade Balance of Virtual Water in Spain, at Present

In order to know what those real demand values for "Virtual Water" in Spain are, it is essential to study and analyze the differences between imports and exports of water resources, by economic sector.

3.1 Primary Sector

As for the trade in "Water Footprint" only agriculture imports more than it consumes.

The agriculture subsector consumed 27,435.42 hm^3, exported 17,541.63 hm^3 and imported 32,742.36 hm^3. As shown in Fig. 5, the Autonomous Communities of Andalusia, Catalonia, Valencia and Madrid are those with the highest levels of percentage variation between "Virtual Water" imports and exports, that is, they are Communities in which large quantities of water are imported and exported, as a direct consequence of the population level, the intrinsic characteristics of the territory itself and the economic conditions of each Community. Similarly, we must bear in mind that the excess of "Huella Hídrica" in the agricultural sector comes fundamentally from the high levels of importation of "Huella Hídrica" in the primary sector, in Spain. In 2019, "Water Footprint" imports amounted to 42,214.45 hm^3, substantially exceeding national production, which was 35,478.751 hm^3. While exports were barely 21,331.45 hm^3.

3.2 Secondary Sector

After studying, in a disaggregated manner, each of the subsectors that make up the Secondary Sector, we find that Spain is a purely consumer country (28,652 hm^3)

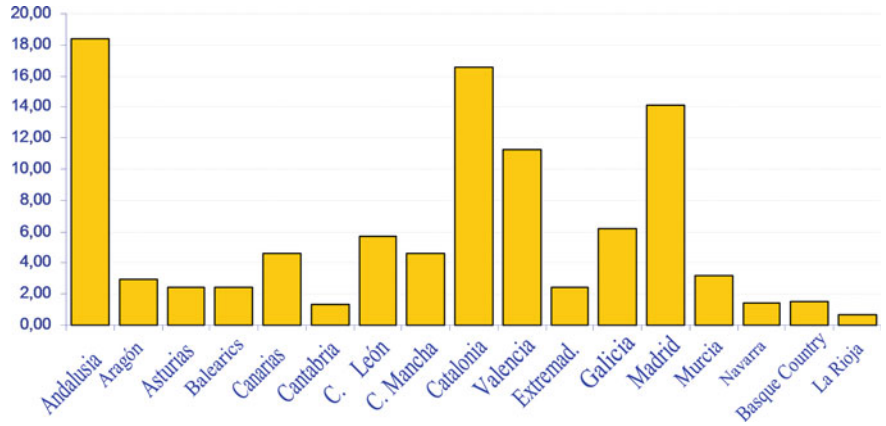

Fig. 5 "Virtual Water" trade balance in the primary sector (%), by Autonomous Communities (2019). *Source* Own elaboration

and an importer of industrial goods (10,945 hm^3); the weight of consumption with respect to the total "Water Footprint" of the industrial and construction sector is 121%, while its imports represent 42% and its exports 32%. As the data shows us, the construction sector (along with the food sector) was the main center of demand for "Water Footprint": the value of the trade balance (export and import) is remarkably low, since we are dealing with purely consumer goods (fundamentally, linked to construction assets and the sale of national homes to foreigners and vice versa), since we are faced with immobile goods. Similarly, subsectors related to construction such as metallurgy, wood and construction materials, present higher demands than other subsectors such as oil refining, the non-metallic products industry (19.84 hm^3) and materials plastics (2.84 hm^3).

All this makes us understand the reality shown in Fig. 6, in which, again, we find the Autonomous Community of Andalusia (17.99%), Comunidad Valencia (11.48%), Catalonia (16.05%) and Madrid (13.95%), as the Communities with the highest level of exported and imported "Virtual Water" present, although highlighting that these levels are slightly lower than those of the Primary Sector (demand is lower), to the detriment of the Basque Country (as is well known, the fundamental basis of the productive structure of said Community lies, fundamentally, in this Sector).

3.3 Tertiary Sector

As we can see in Fig. 7, the Andalusian Community (19.98%) is the one with the highest levels of "Virtual Water" in the Tertiary Sector, followed by Catalonia (17.25%) and Madrid (14.97%), while Navarra, La Rioja and Cantabria barely

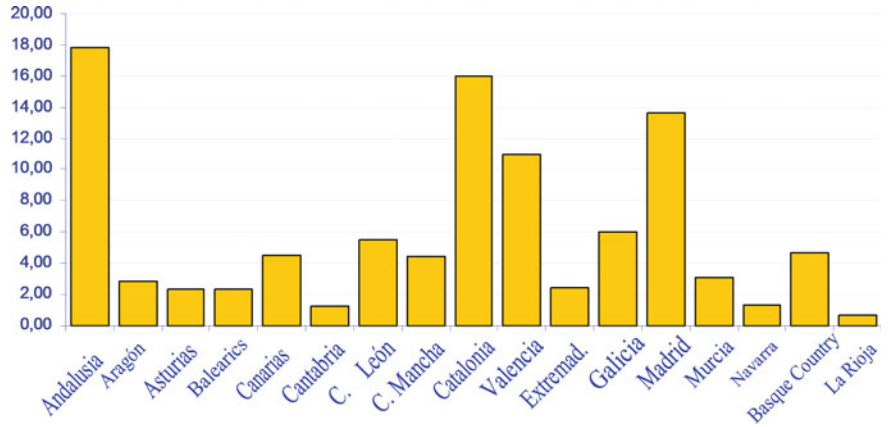

Fig. 6 "Virtual Water" trade balance in the secondary sector (%), by Autonomous Communities (2019). *Source* Own elaboration

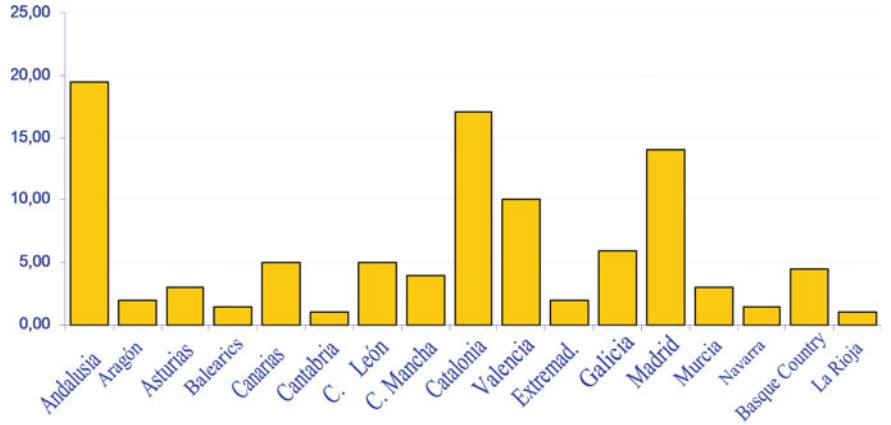

Fig. 7 "Virtual Water" trade balance in the tertiary sector (%), by Autonomous Communities (2019). *Source* Own elaboration

reach 1%. During 2019, exports in the Tertiary Sector were 954.13 hm^3 and imports were 1153 hm^3, with which we can affirm that Spain is a country that not only consumes "Water Footprint" but is also a country importer of said "Footprint" as a direct consequence of the influence that tourism exerts in our country.

The demand for "Water Footprint" in this sector is higher in the domestic subsector (10,285.51 hm^3), as a direct consequence of the population growth of our country in recent years. Similarly, the tourism and hospitality subsectors are the ones that demand the greatest amounts of "Water Footprint" (overall consumption was 10,954 hm^3) as a direct consequence of the real incidence of tourism in our country. On the other hand, we must not forget about the consumption of "Water

Footprint" of wastewater, since the treatment of said water is essential in a large part of the Autonomous Communities, which makes the treatment of these wastewater essential, in order to The latter is to increase the quality of life of the population, especially in those regions where water is a scarce commodity.

4 The Territorial Imbalances of the Spanish "Water Footprint"

From the scope of the so-called postmodernity that announces the end of the territory and the "no/place", the denial of the idea of region is also included, at a time when no subspace on the planet can free itself from the joint process of globalization and fragmentation that is, individualization and regionalization. However, regions today are presented to us as the support and condition of global relations. From this perspective, the analysis of the "Water Footprint" from a territorial scope has as a reference the region and its problems, in Spain.

Spain, over the last decades, has presented notable differences at the municipal, provincial, regional and national levels, which is why the evaluation, on these scales, of the hydrological footprint is especially important. For the year 2007, based on the works collected in "water footprint"—https://www.waterfootprint.org/en/-" (Hoekstra, A. Y. & Chapagain, A. K); the "Water Footprint" of the Spanish population is 2325 m^3/year, per capita. Although, as we pointed out previously, our calculations for this year placed it at 1752.6 $m^3/inhab^{-1}$. From this average, and taking into account the population, the "Water Footprint" of Spain has been calculated—in cubic hectometers—at different scales—state, autonomous, provincial and municipal. Likewise, it should be noted that, during the second half of the twentieth century and the beginning of the twenty-first century, the sustained increase in the levels of demand for water resources has been promoted through the formulation and execution of supply policies; whose origin emanates from the expansion of irrigation, increased development of tourist activities, industrialization processes, urbanization and hydroelectric use; sometimes exceeding the levels of natural water supply available.

Thus, the different administrations and political regimes existing in Spain have given priority to a *«Traditional Hydraulic Policy»* based on the increase in the supply of water to meet the growing demands for water, which has favored a greater risk of drought. hydrological. According to the estimates of the *White Paper on Water in Spain* (1998), the Spanish territory receives 111,305 hm^3/year in a natural regime, compared to uses that added in 1995 a volume of 35,323 hm^3/year and an effective consumption of 20,783 hm^3/year, after discounting a volume of returns that added 14,539 hm^3/year. The hydrographic confederations of the North, including Galicia Costa, added to those of the Duero and Tagus, total 56,450 hm^3/year, that is, 50% of the resources compared to consumptive uses that represent 26% of the national total. On the other hand, the Balearic Islands, the Canary

Islands and the territories attached to the Segura, Júcar and Sur confederations have demands close to or greater than the existing natural supply of resources. On the other hand, that Spain receives 111,000 hm^3/year in a natural regime, it does not imply that the availability of water resources is the same. Regulated or guaranteed resources serve to explain the lack of availability of water resources in the different territorial demarcations; These terms or expressions are defined and are included in the different Basin Hydrological Plans. Thus, the guaranteed resources amount to only 46,000 hm^3/year. There are several reasons. In the first place, because of the 111,305 hm^3/year, there are 29,908 hm^3/year, which correspond to the natural recharge of underground aquifers and the possibilities of accessing these resources are insufficiently exploited (Sotelo Navalpotro et al. 2010).

These extractions represent only 18.5% of the average annual recharge in the natural regime, which amounts to 29,908 hm^3/year. Of this volume, only 3.9% corresponds to the archipelagos of the Balearic Islands (508 hm^3/year) and the Canary Islands (681 hm^3/year), while higher recharge values are found in the areas of the North II basins (5077 hm^3/year), Ebro (4614 hm^3/year), Duero (3000 hm^3/year), Norte I (2745 hm^3/year) and Júcar (2492 hm^3/year). For drinking water, 1080 hm^3/year would be used to supply 10,325 population centers and 12,142,282 inhabitants, highlighting the Balearic and Canary Islands archipelagos, and the Provinces of Barcelona, Jaén, Alicante, Valencia, Castellón and Almeria. Many population centers in the Lower Guadalquivir, Mancha Occidental, Valles del Ebro and del Duero or on the Cantabrian coast that suffered severe restrictions during the drought of the first half of the 1990s could have alleviated them with the exploitation of their own aquifers. Despite its possibilities, it should not be forgotten that the intensive exploitation of reserves has led to the provisional declaration of overexploitation of 15 *hydrogeological units*, in the areas of Guadiana (Campo de Montiel, Mancha Occidental, Ayamonte-Huelva), Guadalquivir (Mancha Real-Pegalajar, Chotos-Cortijo Hidalgo, Sevilla-Carmona, Aljarafe, Rota-Sanlúcar), South (Campo de Dalías), Segura-Júcar (Jumilla-Villena, Sierra de Crevillente) and Segura (Ascoy-Sopalmo, Alto Guadalentín, Bajo Guadalentín, Cresta del Gallo). The administrative declaration does not include all the real situations of overexploitation that occur in Spain. For example, marine intrusion and excess nitrates are widespread in a large number of aquifers from the Maresme, to the Llobregat delta, Campo de Tarragona, Plana de Castellón, Gulf of Valencia, Alicante coastline of Denia-Jávea, Campo de Cartagena, Campo de Níjar or Campo de Dalías.

The analysis and interpretation of the "Water Footprint" of our country, from an autonomous perspective we find (Fig. 8) with the exception of Madrid, Catalonia, Valencian Community, and Andalusia, which the rest of the Autonomous Communities of our country they are below the 10,000 hm^3 figure. At the other extreme, the case of La Rioja stands out with a "footprint" of less than 1000 hm^3; the rest of the Communities oscillate between 1000 and 10,000 hm^3: we find Navarra or Cantabria, with figures below 2500 cubic hectometers, or others such as the Basque Country, Castilla y León or Galicia, which exceed 5000 hm^3. The Spanish Association of Water Supply and Sanitation (AEAS) places that gross

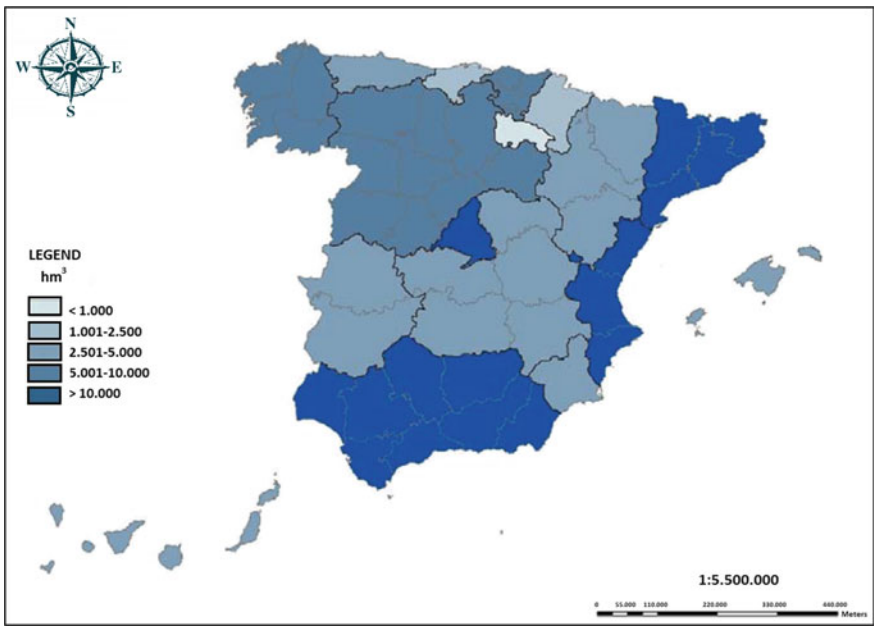

Fig. 8 Spanish "Water Footprint" map, by Autonomous Communities (2019). *Source* Own elaboration

demand between 4200 and 4750 hm^3/year, which includes unbilled volume, spending in industrial establishments connected to the network, water supplied free of charge to public entities, tourist and seasonal consumption, etc. (AEAS 2002) (Fig. 9).

If we go down to the provincial scale, we can see how Madrid and Barcelona are the provinces with the highest demand for "Water Footprint", exceeding 10,000 hm^3. Similarly, the provinces of Alicante, Valencia, Murcia, Cádiz, Seville and the Balearic Islands show water demands between 5000 hm^3 and 10,000 hm^3. While the provinces of Lugo, Orense, Vizcaya, Huesca, Teruel, La Rioja, Cáceres, all the provinces that comprise Castilla-La Mancha and Castilla y León (with the exception of the province of León), show demands for "Water Footprint" less than 1000 hm^3. We can find an explanation for this reality in that, at the beginning of the 1990s, unregistered water accounted for around 34% of the water in large metropolitan areas and, amounted to 24% of the populations that had less than 20,000 inhabitants. For its part, in 2019, as reflected in the survey carried out, the percentage of uncontrolled water had fallen to 24.81%, representing values of 19.72% in metropolitan areas and 29.52% in populations between 20,000 and 50,000 inhabitants. Among the main reasons that justify the high levels of unregistered water, the existence of errors in the control, sampling and measurement processes (18%), the losses registered in the network (48%), special situations due to fraud (5%) and other unknown circumstances (25%). We must bear in mind that

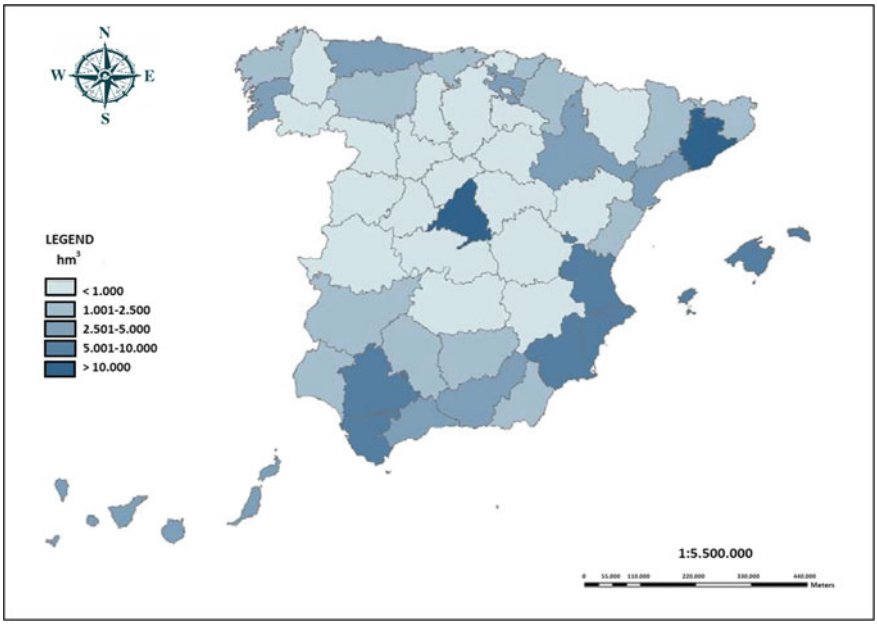

Fig. 9 Spanish "Water Footprint" map, by Provinces (2019). *Source* Own elaboration

the analysis of the territorial reality of water supposes a remarkable complexity, emanating from a wide and diverse reality in which scalar aspects and different situations, interests, desires and rights are intertwined. Any attempt at a solution must start from an objective, holistic and weighted analysis of the elements that make up that reality.

As we can see in Fig. 10, the municipalities that present higher levels of "Water Footprint" are those that correspond to urban centers, as a direct consequence of the location of water consumptive functions in them. In fact, if we grant a fully urban range to populations with more than 2000 inhabitants, we can observe that there is an almost total correspondence with a "Water Footprint" of more than 1000 hm^3, exceeding 5000 hm^3 in the areas of influence of the main cities in our country such as Madrid, Barcelona, Zaragoza, Seville,…, and in the coastal areas.

5 Conclusions

At this point we can conclude that the dominant natural hydrological reality in Spain is the Mediterranean; this means that we are subject to a scant annual volume of rainfall; with a season of the year that we could qualify as "dry", that can last several months, during which it rains little, even not at all for the purpose of increasing the flow of rivers or subsoil reserves. To this reality must be added a

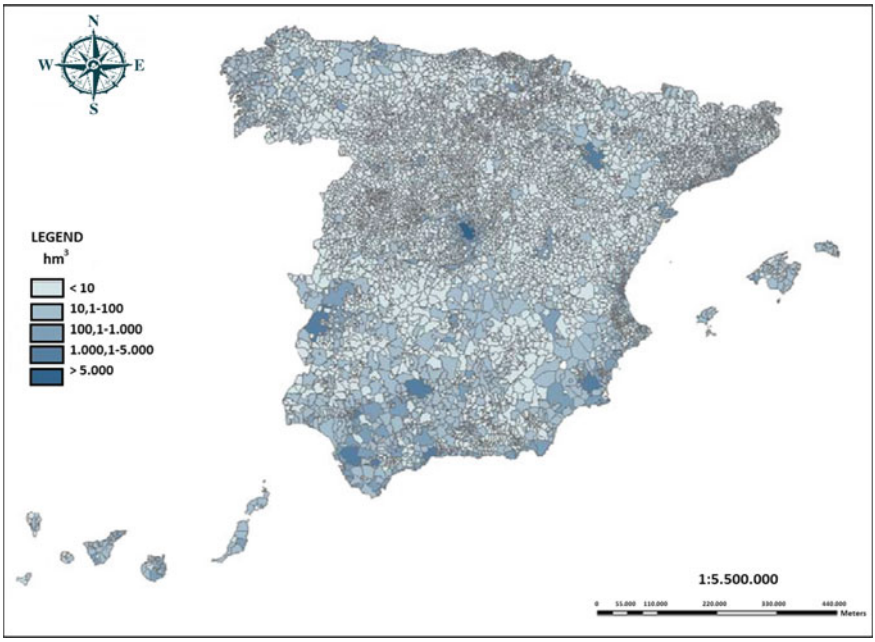

Fig. 10 The "Water Footprint" of the Spanish municipalities (2019). *Source* Own elaboration

strong evapotranspirant power of the atmosphere and a very variable interannual distribution of rainfall, so that with some frequency there can be series of several consecutive years of rainfall that are significantly below the average, that end up generating accumulated deficits in the supply systems of such an amount that they cannot be alleviated through reservoir works, unless we put one in each 500 km^2 stretch of the Hydrographic Basin, oversized to be able to make a hyper-annual regulation, capable of storing the "surplus" water from each rainy year, complemented by a dense network of hydraulic pipes and transfers.

As a consequence of the very geographical location of the Iberian Peninsula, in relation to the general atmospheric circulation of the west and subtropical subsidence, the processes of low-water and drought are shown to us as one of the most relevant natural risks of an atmospheric nature that affect the human activities. The responses, the forms of adaptation and the actions promoted by man to face this climatic episode have had an impact on the territorial organization of Spain from Roman times to the present day. However, at the dawn of the twenty-first century and after centuries of experiences, Spanish society has not been able to articulate the necessary measures to prevent the lack of water caused by droughts, from becoming one of the climatic risks that most economic damage and environmental repercussions caused in Spain throughout the nineties. On a regional scale, droughts offer as a common denominator the decrease in rainfall for more or less prolonged periods of time that, with this, restrict the natural supply of available water

resources. On the other hand, its effects, degree of perception and human responses are very different according to regions. The belonging of a large part of the Iberian Peninsula to the Mediterranean climatic domain, and its proximity to the subtropical subsidence area of the Azores anticyclone, explain the fact that it is more or less common and generalizable to all of Spain. However, factors of a geographical and hydrographic nature are those that explain the higher frequency of episodes suffered by the archipelagos of the Balearic and Canary Islands and the lands of the center, south and southeast of the peninsula. But these potential risk factors are by no means exclusive or determinative. Thus, the lack of hydraulic infrastructures, the increase in consumption or the precarious management of water have extended their effects to regions that are theoretically well endowed with resources such as the Cantabrian, Pyrenean and even Galician regions. A decisive factor has been the intensification of the demands caused by the expansion of cities and industries, the configuration of urban-tourist ridges in coastal territories and, on the other hand, the increase in more than two million hectares of irrigated land, during the last decades. Similarly, we can conclude that in order to understand the reality of the water footprint in our country, we must bear in mind that the intensification of urban-tourist demands produced during the second half of the twentieth century has increased the vulnerability of many water supply systems to long drought sequences. Behind the strong increase in drinking water consumption underlies the strong expansion of the cities and, together with it, the rise in the standard of living, the increase in spending modules due to the generalization of household appliances and hygiene habits. The increase in consumption in industrial establishments and in municipal cleaning services for streets and squares also intervenes. It should also be remembered that urban supply has a legally established priority of use over other demands (Art. 60. Consolidated Text of the *Water Law*), which is extended to its high quality requirements and supply guarantee. *The White Paper on Water in Spain* (1998), assigned a consumption of 4667 hm^3/year to urban uses. This consumption value does not correspond to the invoiced consumption, which is considerably lower, but to the gross demand that is satisfied by the supplying entities.

With all this, we must conclude that, from the perspective of the analysis and interpretation of the Water Footprint of our country, the treatment by Autonomous Communities masks issues related to a reality, at least complex. In fact, the estimates on drinking water spending in Spain are close to those offered by the National Institute of Statistics (2019), which raise gross consumption to 4781 hm^3/year. This expense would include the volume controlled by the supplying entities, which amounts to 3781 hm^3/year, and the unaccounted or lost water, which represents 1000 hm^3/year, that is, 20.9% of the gross demand. Of the controlled water (3781 hm^3/year), domestic consumption in homes amounts to 2482 hm^3/year, that is, 65.6%. It is followed by other consumer sectors, which include industries connected to the network, with 840 hm^3/year (22.2%); municipal consumption, with 303 hm^3/year, which represents 8% of the controlled water; and other consumptions, which amount to 155 hm^3/year. The regional distribution of consumption offers quite a few contrasts, so that Andalusia (667 hm^3/year), Catalonia (657 hm^3/year), Madrid (482 hm^3/year) and the Valencian Community (368 hm^3/year) add up to

2.174 hm^3/year, which represents 57.5% of the expenditure on controlled drinking water in Spain. This is why, in order to understand the above, we must descend to the treatment of the provincial and municipal reality, being able to conclude that from the territorial point of view in Spain, the highest levels of "Water Footprint" are located in large cities and towns. in coastal áreas (especially, on the Mediterranean coasts and the southern Atlantic of Spain) thus showing the territorial imbalances existing in our country.

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Is Health a just Transition Issue? Cross-Cutting Multiple Crisis: Economic, Unemployment, Climate and Healthcare

João Camargo

1 Introduction

The Covid-19 pandemic, having reached over 4 million deaths worldwide, has brought the world economy to a standstill, ushering a global economic recession. There has been a high increase in unemployment in most sectors, but in particular in those connected to tourism, arts, culture, retail and construction. According to ILO (2020), the equivalent to 255 million full-time jobs were lost in 2020 (although translated mainly by rising inactivity rather than immediate unemployment). For 2021, ILO estimates a further job loss equivalent to a range of 36–130 million full-time jobs. Governmental support, in particular income support, has been unequal (countries in the Global North have provided cover for lost salaries, but many in the Global South have provided no support, according to Hale et al. 2021) but has somewhat served as a buffer preventing some of the worst effects of this double crisis in public health and economic recession. These supports are dwindling, in particular with the initiation of the vaccination process, while discussions on recovery have begun almost since the onset of the pandemic.

During this period, the issue of climate change has been relegated in public debates. Global emissions have tumbled 7% in 2020, but even this reduction is well outside of what the IPCC points as necessary in its 2018 special report (IPCC 2018). According to this report, to avoid exceeding the threshold level of 1.5 °C, as framed in the Paris Agreement, a 45–50% of global greenhouse gas emissions cut by 2030 compared to 2010s levels is required, which implies an unprecedented economic and sociopolitical transformation, both in speed and depth of modification.

According to the United Nations Environmental Programme, 2019 was the year with highest emissions ever, with 59.1 $GtCO_2e$ emitted, 65% of which coming from

J. Camargo (✉)
ICS - Instituto de Ciências Sociais, Universidade de Lisboa,
Av. Prof. Aníbal Bettencourt 9, 1600-189 Lisboa, Portugal

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fossil fuels and carbonates. The CO_2 emissions drop connected to the Covid-19 pandemic "offers only a short term reduction in global emissions and will not contribute significantly to emissions reductions by 2030 unless countries pursue an economic recovery that incorporates strong decarbonization" UNEP (2020). By 2030, the level of annual emissions needs to be within the range of 12–19 $GtCO_2e$ to achieve the 1.5 °C target.

During the pandemic, health problems and mortality have seen a spike (The Lancet 2020), and these trends will persist over time, with the established direct link between the climate crisis and the aggravation of health issues. Action on climate change is crucial to render the right to health effective. The increase in extreme temperatures, shifts in humidity, increase in disease vectors, as well as the increase in extreme events, combined with an increased prevalence of serious health-related suffering among patients, an ageing population in the West and lack of quality health support in many countries, puts an important focus on healthcare in this period but also on the ongoing energy and digital transition. Covid-19 has further led to a massive increase in the workload of the healthcare workforce, with fatigue and psychossocial stress further straining these workers.

Covid has exposed the strengths and weaknesses of the global and national healthcare systems, with chronic under-investment in education and training of the healthcare workforce and often a mismatch between health systems and health needs. To reach its Global Strategy on Human Resources for Health, corresponding to achieving the United Nations Sustainable Development Goals and health targets, the WHO (2016) proposes a total global health workforce of 81.3 million workers.

The mass mobilisations in 2019 around climate change came to a halt with the global lockdown, yet the popular demands put forward, reflecting the scientific consensus around this existential threat, are still looming over institutions, and have been an identified component in most of the recovery plans for post-Covid19. The grand transformation taking place, far from ideal or even effective in terms of emissions' cuts (Camargo et al. 2020), has accelerated with the coronavirus lock-downs, very much focused on energy systems and, to a lesser degree, on transport systems. Yet, this story has begun long before.

In the 1990s, trade unions in North America developed the concept of Just Transition to articulate workers' demands on the new productive systems, namely the workers from high-emitting sectors such as fossil fuel production, energy-intensive industries or aviation. Later, the climate justice movement would support and adopt this concept and, in some countries, climate jobs campaigns were developed to provide a political platform between grassroots climate activists and trade unionists. These campaigns are based on the idea that the most relevant sectors in terms of emissions—energy, transport, construction, forestry, agriculture—will be the stage both for the destruction of some jobs and the creation of others, with the clear indication that many more will be created than those destroyed (Kis et al. 2018). This would be a way to achieve said transformation without leading to massive impoverishment or deepening exploitation of natural resources, breaking the dichotomy that associates climate action with unemployment and opening the field for broad political alliances. As these sectors would be the technological stage

for a transition, they would also be its main political stage, where it would be possible to mold the transition. On the other hand, the climate justice movement has growingly assumed care economy as a main focus on this transformation as well.

Health systems are a key component of the "care economy" but yet, healthcare work is noticeably absent from Climate Jobs campaigns and Just Transition programs. The reasoning that the campaigns were mostly focused on the sectors most affected by this transition leaves out the fact that healthcare systems and their workforce will also be at the center of this transformation, likely as much as renewable energies. The Green New Deal (GND) proposal by Alexandria Ocasio-Cortez and Ed Markey in 2018 included Universal Healthcare at its center, and many debates on Just Transition have included the need for free access to quality public services including health, education and care for the elderly. Historically, the labour movement fought for workers interests both as workers and as citizens, which led to a strengthening of all the public sector, including healthcare, education, transport and housing, even more so than industry and energy production. On the other hand, as Stevis and Felli (2020) refer "In the absence of a just transition for workers in the health sector it is not likely that there will be enough support for its green component, particularly since some of the strongest supporters of the GND are unions in the health sector.".

This chapter aims to discuss the absence of a prominent role of healthcare in the political programs of Just Transition and Climate Justice, in the ongoing transformation which is currently happening, and of the central role that healthcare workers and healthcare jobs can have in the movement for the revolutionary transformation necessary to achieve the necessary greenhouse gas emissions cuts in the next decade.

2 From the Paris Agreement to Post-Covid19 Economic Recovery—Green New Deals and European Green Deal

Within the framework of the Paris Agreement, governments and firms have accelerated towards plans for decarbonization in the sectors of energy, mobility, industry, construction and agriculture. The need to shift into a low carbon economy happens in a degraded institutional framework with depleted financial sectors and the global pandemic that further degraded the ideal conditions for this shift. The push for new climate policies within the United States and the EU introduced a new set of financing and investment frameworks, combined with post-Covid19 green recovery scenarios. The European Commission's Next Generation stimulus package totals 750 billion euros. The financing framework for the EU for the 2021–2027 period includes €1074 billion, part of which allocated to climate transition. The action against climate change must accelerate in order to deliver the necessary emissions' cuts to keep global temperature increase under the safe thresholds agreed in the Paris Agreement (Camargo et al. 2020). On the other hand, there are currently 188 million unemployed workers and 630 million who work and live in poverty (ILO 2020).

Job creation is a powerful element of political discourse to mobilise investment and social support for climate action. Previous research (Kis et al. 2018; Blyth et al. 2014) indicates that renewable energy sources create more jobs upfront in construction and manufacturing than fossil fuels production. Renewables and energy efficiency are more labour-intensive than fossil fuel operations, both in short-term construction phase and in average plant lifetime (IEA 2020).

The idea of a New Deal, directly derived from Keynesian economics, is to create millions of jobs and wrestle mass unemployment with massive public spending, ascertaining that only governments can turn the tide and restore confidence. That is, to a large extent, what governments in some of the richest countries, namely in the EU and the USA, are proposing, with the addition of important provisions on climate change, namely the need to exert a part of the necessary cuts. In an historical retrospective, it is important not to exaggerate the political cohesion brought about by the original New Deal: Roosevelt's plan was opposed on each proposal and legislation, fought in the courts and Congress. The biggest alliance was with the labour movement: the New Deal strengthened labour rights and created millions of new jobs, increasing the workers organisations that were the political body that sustained this political program.

Ocasio-Cortez and Markey's GND strongly resonates with Roosevelt's New Deal, with the idea of mobilising and creating a political and social body for this political program, anchoring it in trade unions and the strengthening of workers and poor people's rights, proposing a broad spectrum of new economic rights such as healthcare, housing, food and a clean environment. Joe Biden's political platform has watered down this proposal, both in terms of emissions cuts (the GND proposed net-zero emissions across the economy by 2030, while Biden proposed that this only happens by 2050) and spending (the GND number is at US$18 trillion over 30 years according to Drollette 2019, while Biden proposed US$1.7 trillion in over 10 years). Yet, combined with his US1.9 trillion pandemic-relief bill, this is already the highest public relief package in the USA since Roosevelt's New Deal.

On the other side of the Atlantic, the European Green Deal was proposed in 2019 as a European Union strategy for intervention on the economic sectors, in particular electricity, transport, heating and industrial processes, to achieve emissions neutrality by 2050. For this, it would create a European Climate Law that legally binded its Member States to collectively reach net zero greenhouse gas emissions by mid-century and create a Just Transition Fund, to mobilize 143 billion euros until 2030.

None of these plans achieve the necessary emission cuts, namely as they have no provision for the dismantling of the current oil, gas an coal production capacity and infrastructure (the US is the world's biggest producer of oil and gas, as well as the third producer of coal), as the biggest emitters of greenhouse gases are now based in the Global South (and the US and EU import their manufactured products, promoting carbon leakage) and there is no global integrated approach to emission cuts, with a focus on achieving neutrality rather than actually cutting emissions.

The latest Paris Agreement Synthesis Report about governments' pledges on emissions cuts (https://unfccc.int/sites/default/files/resource/cma2021_02E.pdf),

puts total GHG emission levels from implementation of government targets in 2030 at 0.7% lower than 2010s emission levels, rather than the identified target of 45–50%. There is currently a 98.9% gap between climate policy and climate science.

The focus of economic recovery around the world is looking into reestablishing the same productive and distributive system that had fuelled climate crisis before the shutdown. According to the Energy Policy Tracker (2021), since the beginning of the pandemic, G20 countries committed at least US$260 billion to support fossil fuels.

3 Climate Jobs Campaigns and the just Transition Framework

According to the Portuguese climate jobs campaign (Empregos para o Clima 2017), climate jobs are:

- New jobs, created to stop global warming, *i.e.* directly contributing to reduce the amount of greenhouse gas emissions released into the atmosphere;
- Dignified jobs, with fair conditions, that respect the rules of environmental protection, health, hygiene and safety at work;
- Created under the public sphere as a public service.

This definition is not common to all climate jobs campaigns and to all Just Transition literature. There are concrete contradictions between capacity, autonomy and willingness of state and inter-state institutions to oversee a Just Transition in a neoliberal capitalist framework, where control over energy production and consumption is shared or delegated to private companies while states have weaker institutional powers than ever.

According to the Global Climate Jobs campaign, 150 million jobs need to be created in the next 20 years, to cover the world with renewable energy like wind and solar power that produces the entirety of electricity, to switch from cars to buses and trains, and run almost all transport on renewable energy, to insulate and convert all homes and buildings to use less energy and to heat with renewable energy and to convert and redesign industry to use less energy and renewable electricity wherever possible. According to the campaign, these jobs will be in renewable energy, construction, and transport. There are currently eight national climate jobs campaigns: Canada, France, Norway, Portugal, Scotland, South Africa, United Kingdom and United States.

Climate jobs are often at the center of the demands/discussion of the growing stream in the literature sustaining that the transition to a low carbon economy should address not only emissions but also justice, the idea at the base of the concept of Just Transition. According to the International Trade Union Cofederation's Just Transition Centre, a Just Transition "secures the future and livelihoods of workers and their communities in the transition to a low-carbon

economy. It is based on social dialogue between workers and their unions, employers, government and communities". Sweeney and Treat (2018) add to this definition the creation of climate jobs and the emergence of energy democracy. In 2015, the concept of Just Transition advanced dramatically into the mainstream, with the Paris Agreement including in its text the need for "a just transition of the workforce and the creation of decent work and quality jobs" (UNFCCC 2015).

There are significant differences between definitions of Just Transition, measured in different scales, levels of inclusiveness and fairness across sectors and geographies, as well as the scope of justice (distributional, procedural, recognition and restorative) (Stevis and Felli 2020). There is also a very significant difference between the climate jobs advocated in the Just Transition literature and the jobs created in the transformation currently happening.

When addressing Just Transition, environmental justice literature extends distributive justice concerns to the allocation of environmental goods and harms, including those related to health and wellbeing (Ciplet and Harrison 2020), but has clearly divided the "green" (environmental impacts) and "brown" (jobs and public health) frameworks for mobilising opposition to energy infrastructures.

4 Just Transition and Social Acceptability of Decarbonisation

Increasing jobs is not enough to ensure successful climate mitigation or justice goals. Ciplet and Harrison (2020) include the need to create "decent" jobs, directly connected to job quality, attractiveness to people who lost employment in traditional industries, accessibility to people from different backgrounds and skill sets (Pai et al. 2020). Other authors highlight the importance of job security, long duration and "forms of community resilience and innovation in the face of dynamic energy markets" (Healy and Barry 2017).

Skill gaps and a dichotomy between winners and losers in the transition may contribute to reduce the social acceptability of transition which is crucial for its success, with different strategies for decarbonisation overlapping with previous social and economic conditions (Galgóczi 2020). Many strategies for decarbonisation outside the concepts of Just Transition and Climate Justice may "simply displace ecological destruction and extractivism for industrial development and profits to more vulnerable communities" (Sovacool et al. 2021), with political consequences, not only for the workers affected, but for the entirety of communities engaged in this transformation. New renewable technologies and systems, still subordinate to the logic of neoliberal capitalism, will continue to be highly susceptible to boom-and-bust cycles. The very concept of Just Transition is at risk of being denied by workers and trade unions themselves, if processes are perceived as unjust transformations with no social and community participation.

Beyond job creation, wage and contractual conditions, other forms of satisfaction also contribute to social acceptability outside of the confines of work, such as the development of social relations, sharing goods and time and caring for people in need (Räthzel and Uzzell 2019). Some of the political consequences of the transition include questioning of the notions of work, growth, consumption and relationships with nature and other communities. Also in political terms, movements involved in Just Transition, be them climate justice grassroots or trade unions, have been divided between 'affirmative', advocating for transition within the capitalist political-economic system and 'transformative' who envisage a post-capitalist transition (Gough 2010). The different outcomes of the strategies followed and the transformation ocurred will push these actors into any of these directions.

When the term Just Transition was first coined in the 1990s, it corresponded to a strategy by unions and environmental justice activists in North America. The Oil, Chemical and Atomic Workers Union suggested a green industrial policy, supporting new jobs for workers in the chemicals, weapons and other toxic industries. Apart from the jobs created, the union proposed occupational, health and environmental rights and standards for all workers, as well as universal health care and the formation of a new labour party (Morena et al. 2019), not strictly focusing on the job component. As Neale (2021) also mentions, "Historically, unions have been built by people who were fighting for greater causes beyond the workplace—the vote, the welfare state, education, health, socialism, colonial independence and racial equality. Climate is that kind of cause.". The labour movement has in the past ushered broad social change, assuming its agency as proletarians rather than simple wage earners, and we are currently at an historical moment where different waves of political movements and natural phenomena will open the window of a grand transformation, and labour could be at the forefront of this, provided it sees itself as something broader than the sum of its parts (Velicu and Barca 2020). Yet, according to Barca (2019), in the last four decades, labour has adopted ecological modernization and western lifestyle "as the only possible definition of well-being, one to be extended into the future via a green growth agenda".

Uzzell (2010) further raises the question of workers and communities' identities as intimately connected to their professions, with pride in one's work identified as a possible further obstacle for a Just Transition. To counteract on this, many works left "outside" the productive sphere need to be valued: social work, care and education, maintenance and creative work. According to Räthzel and Uzzell (2019), the labour movement should re-transform into a social movement, promoting the participation of their members not only as workers, but also as citizens, expanding its action into creating a world they want to live in and a different life they want to lead.

Finally, there is a contradiction between the rapid shift to low-carbon societies and the increased extraction of minerals and metals, with intensification of social and ecological injustices elsewhere (Bainton et al. 2021).

5 The Current Transformation

A transformation in the energy sector towards renewable energies and lower carbon emissions is happening. Yet, the rhythm of change is still far from enough and justice is not an integral part of the process. To respond to climate change as the existential threat to humanity that it is, a transition needs to accelerate and drive the transformation to other sectors in society. This transition needs high levels of social acceptability across social groups, economical sectors and geographies, which implies broad scopes of justice. The current transformation focuses mostly on a diversification of assets portfolio from private companies in the energy and transport sectors, with emergency public funding support.

As referred, the willingness of workers to support climate policies is substantially affected by the job losses that can be rightly or misleadingly attributed to these policies. Dissatisfaction can be amplified if these losses concentrate in particular social groups or geographies that have suffered from economic recession or increasing competition with globalisation. This is true independently if at a more aggregated level the benefits of carbon mitigation (including air quality and new jobs) largely overpass these job losses. This concern has become particularly urgent as societies are confronted with the perceived need to recover from the socioeconomic consequences of the pandemic.

Among the key drivers for the current energy transformation, beyond climate change, are air pollution and health impacts. Health plays a leading role in the transformation for society at large, in the short-run and in the medium-run, both connected to pollution and to climate impacts but, "unless the health effects of climate change are easily understandable, verifiable and perceived to be large, poorer households are unlikely to be willing to support" Just Transition (Vona 2019). Often, job creation takes precedence over health issues, even for the people most affected by the most polluting activities and infrastructure. A focus on fossil fuel production, Healy and Barry (2017) argue, draws new focus on overlooked elements of the productive cycle, such as human health impacts in the actors that organise extraction, processing and distribution of fossil fuels, paying attention to ecological damage and health impacts for those living and working in these degraded environments, the fossil fuel's 'sacrifice zones'. With privatization and outsourcing of services and disagreggation of activities that support industrial production, many overlooked workers in the industry and communities suffer these impacts without being acknowledged as part of the industry and left outside the transition process. In the oil sands in Canada "for example, women and racialized workers are highly overrepresented in feminized and invisible service, retail and care work" (Mertins-Kirkwood 2018).

The current transformation is the antithesis of a Just Transition. Rather than a participated and planned shift in productive systems, it is a top down transformation, strictly based on technological modifications and intensification of extractivism. This transformation aims to achieve the continuation of economic growth based on material expansion (even in the shift for renewables) and the displacement

of highly emitting sectors into other regions of the globe. In 2019, the world consumed 100.1 Gt of materials, divided between minerals (50.8 Gt), ore (10.1 Gt), fossil fuels (15.1 Gt) and biomass (24.6 Gt). Of all the materials consumed, only about 8.6% were reused or recycled, with a material waste of 91.4 Gt in various forms (https://www.circularity-gap.world/2021).

The announcement of the closure of fossil fuel infrastructures has been met with resistance from workers as they are kept well out of the process, equated simply as a factor of production.

6 The Healthcare Workforce, just Transition and Climate Justice

According to the WHO (2016), in 2013 the global health workforce was over 43 million (9.8 million physicians, 20.7 million nurses/midwives and 13 million other workers). According to its projections, the WHO estimates that by 2030, this number will rise to 67.3 million (13.8 million physicians, 32.3 million nurses/midwives and 21.2 million other workers), well beneath the 81.3 million workers identified as necessary to achieve the UN Sustainable Development Goals.

Global health spending has been on the rise between 2000 and 2018, reaching 10% of global GDP that year, with US $8.3 trillion (WHO 2020). According to the Economist Intelligence Unit (https://www.eiu.com/n/campaigns/Covid-19-the-impact-on-healthcare-expenditure/), in the world's 60 biggest economies healthcare spending fell under Covid19, due to non-urgent care cancelled and populations avoiding hospitals and clinics, but continued to rise at the global level 10.4% of GDP in 2020. The delays in non-urgent treatments, as well as the treatments and vaccines for the virus will result in a surge of healthcare spending, while the exposed problems in the systems will likely lead to a consolidation of that spending.

Haines and Scheelbeek (2020) identify many benefits for health in climate action beyond the reduction of GHGs, namely the reduction of fine particle air pollution, reducing premature mortality form ischaemic heart disease, stroke, chronic obstructive pulmonary disease by $\sim$3.6 million annually worldwide. There would also be major benefits from a greater use of public transport, walking and cycling, from the provision of green spaces in urban areas with improvement of mental health and the reduction of urban heat islands. Improvement of housing through retrofitting, insulation and adequate ventilation would reduce cold and heat exposure, further improving conditions for healthier living. A major shift in diets would include healthier and less processed foods, with a reduction in consumption of red meats. This would lead to a reduction in obesity and risk of heart disease and strokes.

Although health co-benefits for the transition are identified, they are an often undervalued and a non-quantified aspect: but the cost of transition in any given scenario of the Paris Agreement compared to health co-benefits is very favourable.

The entire cost of reducing emissions in all of Asia could be covered by the health co-benefits in China and India alone. In the EU, health co-benefits do not exceed the cost of transition, yet may cover from 7 to 84% of the cost, while in the USA it may cover 10% to 41% of the cost (Markandya et al. 2018). This implies that very stringent mitigation efforts might be much more financially "acceptable" by including health co-benefits.

The impacts of climate change on health are a major issue, as the enormous environmental degradation that global warming implies, in whichever scenario, will create a society of less healthy individuals, less healthy communities and weaker healthcare systems. The impacts of a new climate on human health are usually divided between (http://unionsforenergydemocracy.org/climate-change-and-health-gnu-2019/):

- Those directly related to the exposure to extreme weather and new climatic conditions (storms, floods, droughts, forest fires);
- Those connected to the disruption in ecosystems and weather patterns that conduce to water scarcity, poor quality water, food shortage, malnutrition, and increased disease vectors;
- Those which result from the civilizational disruption produced by the material collapse of social, political and economic systems, with frequent violence and mass dislocation of populations.

Mental health risks are highly exaccerbated by all of these impacts, and in particular by their likely overlap and the increasing number of people and communities exposed to them, leading frequently to depression, anxiety and Post-Traumatic Stress Disorder.

These are risks which are already materialising, and that will further intensify with the increasing temperature, up to the point of systemic rupture.

In 2018, the WHO (2018) predicted direct damages to health from climate change between $US2–4 billion per year until 2030, with an additional related 250 thousand deaths per year between 2030 and 2050 due to aggravation of malnutrition, malaria, diarrhoea and heat stress. This leaves out the unquantifiable impacts of mass dislocation of population and conflicts. Robinson and Shine (2018) point out that without decisive climate action that curtails the worst effects of runaway climate change, the need to keep temperature increase under 1.5 °C compared to the pre-industrial age, there is no possibility of achieving the fundamental human right to health.

According to 2020 Lancet Countdown on Health and Climate Change (Watts et al. 2021), in 2018 extreme heat produced 296,000 deaths, the climate suitability for dengue fever, malaria and Vibrio bacteria transmission has risen and direct effects of coal combustion have lead to more than 1 million deaths, with some 390,000 of these as a result of PM2·5 particles. Global deaths from PM2·5 pollution in 2018 were estimated in 3.01 million. Crop yield potential has declined by 1.8–5.6% between 1981 and 2019, and excess consumption of red meat has led to some 990,000 deaths in 2017.

Despite this, climate change is mostly framed without regard to health impacts. Less than one-tenth of all peer-reviewed articles about climate change discuss health dimensions and, in the political arena, the connection between health and climate change is rarely mentioned in international or national fora (Watts et al. 2021).

The global healthcare system is responsible for around 5% of global GHG emissions (Haines and Scheelbeek 2020). The known effects of climate change on human health, specially on the most vulnerable populations, are overwhelming. Yet, workers in the healthcare system have been mostly excluded as stakeholders in the public debate both on Just Transition and on Climate Justice.

On Just Transition, a concept that had its origin in highly polluting sectors and that aimed at bridging the gap between workers and environmental and social movements, the focus was on making clear the beneficial effects of a technological transformation away from high-emitting sectors into low-carbon and renewable ones, in job creation and in environmental gains. As there was no perceived destructive effect of this transition in the healthcare sector, it was left outside.

Climate Justice, on the other hand, expressed the interdependency between all societies for a simultaneous and common shift from the fossil fuel economy, and also on the need to live differently (Goodman 2009). Partially adopting the framework of Just Transition, according to the Bali Principles of Climate Justice, it "affirms the right of all workers employed in extractive, fossil fuel and other greenhouse-gas producing industries to a safe and healthy work environment without being forced to choose between an unsafe livelihood based on unsustainable production and unemployment.". Emerging initially from social and indigenous movements in the Global South, and strongly based in the 1991s Environmental Justice Principles, the 2002s Bali Principles only addressed health issues as consequences of planetary degradation, with a focus on planetary and ecosystem health.

7 Is Health a just Transition Issue?

There are calls from inside the healthcare field itself, appealling to the ethical codes of those that work on human health and wellbeing to engage on climate action: "Clinicians, researchers, employees, and citizens need to assert daily that there is a climate emergency, and to act accordingly." (Rouf and Wainwright 2020).

It seems that, beyond the political program of Climate Jobs, the broader framework of Green New Deals or similar is more adequate for healthcare as a core issue, both in terms of jobs and of collective political action. That is, Health seems to be less of a Just Transition issue and more of a Climate Justice issue.

"Nurses' unions are already playing an important role in the fight for climate justice." according to Sweeney et al. (2019), participating in the struggles against fossil fuel projects and supporting the victims of climate change all around the world. The call for a further engagement, specifically as a group and specifically relating to the issue of climate change itself, seldom occurs.

According to the Glasgow Agreement, signed in November 2020 by global climate justice movements, Climate Justice "acknowledges and integrates the care economy into daily life, with the shared responsibility of persons, regardless of their gender identity, for care and maintenance activities, both inside homes and within society—climate justice puts life at the centre". The care economy and reproductive labour are inside the Climate Justice agenda, in a clear articulation with feminist and ecofeminist perspectives, and it advocates the works of sustaining life as a core issue, with domestic work, teaching, nursing and healthcare in the spotlight.

Barca (2020) stresses the overlay with the sexual division of labour, with the attributed role of breadwinners for men, bargaining for wages that damage their health or accept jobs that compromise the health and safety of communities and territories, while women are the caregivers "with little or no bargaining and decision-making power in society". Is Health relegated due to its predominantly female composition and interpretation, with its reproductive labour?

The engagement of the healthcare workforce and the caregiving community in climate action is still hindered. Krisberg (2020) stresses that healthworkers have a key role as messengers, that would highlight how climate change affects people directly and how it affects communities in a differentiated way, reducing the idea that it is strictly an environmental issue. Health as a Climate Justice issue also attenuates a technocratic view of the transformation currenty happening and the one needed, by framing climate change through a human and even personal perspective, rather than an energy, transport or agricultural sector problem.

Specifically for nurses, Sweeney et al. (2019) outline six key areas where they can use expertise and political strength to fight climate change, to achieve climate and health justice:

- support and participate in campaigns to stop the expansion of fossil fuel use;
- demand that vital health services are fully staffed and capable of responding to climate instability;
- use their voice in helping to ensure that countries and regions plan for the future in ways that can best protect vulnerable populations;
- continue to draw attention to the roles that poverty, racism, and the lack of workers' rights play in exposing oppressed people to the worst impacts of climate change;
- push for a shift towards a "public goods" approach to climate and health policy, anchored in adequately funded public services;
- fight for energy democracy and the extension of public control over energy generation and use.

The strength of the health workforce is highly significant. Their social legitimacy would greatly benefit the popular support needed to achieve any form of Just Transition, even when it happens in other sectors. There will be a very important increase in demand for healthcare workers in a growingly degraded climate, which will not stop unless runaway climate change is averted by the greatest social transformation in History. Not only do healthcare workers increase the legitimacy

of a Just Transition, they would be a key group to achieve a magnified social acceptability, stressing the need to make visible the health co-benefits of a Just Transition and adding invaluable health inputs on the benefits of a different, slower and less destructive productive system and a humane society. In any case, healthcare workers will need to grow immensely and globally to respond to the climate crisis.

Gorz (1982) affirmed that workers are no longer the key agent of social transformation in rapidly changing world societies. The idealization of workers as industrial labourers and farmers, rather than the existent variety of workers, to which massive unemployment and labour precarity add complexity, prevents society from seeing how other social groups and sectors, and even the more invisible, like caregivers, might help or even lead this revolutionary transformation.

Covid 19 has taught us that governments can make enormous changes and that it is more than reasonable to demand the impossible, because some times it happens the week after and when money is needed, it is there. It has also taught us that society under capitalism is organized to put profit before life, even if it means the sacrifice of health care workers and others that are deemed "essential". The crisis in care, with the burden on healthcare, caregivers and specially women, intensified dramatically and will continue to do so in the Anthropocene.

Health already is a core issue on climate change. The absence of a political expression for this reality is a damaging contradiction for health care workers, for the Climate Justice movement and for all of society.

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João Camargo (1983) has a background on environmental and agrarian sciences and holds a Ph. D. in Climate Change and Sustainable Development Policies from the University of Lisbon, with a thesis titled "Climate Change, new Metanarrative for Humanity: Climate Policy in the western Mediterranean". He was an assistant professor and taught Chemistry, Botany, Scientific Methodology, Plant Taxonomy and Systematics at Universidade Lúrio, in Mozambique. He worked as a journalist and as press liaison and policy advisor for environmental NGOs. During his Ph.D. he participated on projects around climate adaptation, climate policy and forestry, producing conference abstracts and conference papers, and has published two books: Manual de Combate às Alterações Climáticas [Climate Change Combat Manual] (2018 and a Spanish adaptation in 2019), and Portugal em Chamas, como Resgatar a Floresta [Portugal in Flames, how to Rescue the Forest] (2018). He as published peer-review papers on climate policy and the climate justice movement and regularly writes for newspapers and magazines about climate change, forests, environment, energy, labour and social movements. He is engaged in the global climate justice movement and with global climate jobs campaigns.

Use of Biomass Fuels for Cooking and Improved Biomass Stoves in Mexico

Fernando Ariel Manzano, Roberto Ariel Abeldaño Zuñiga, and Gabriela Narcizo de Lima

1 Introduction

In the twenty-first century where technological development advances rapidly and unstoppable across the planet, there are more than three billion people who still cook with traditional wood or charcoal stoves (Concha et al. 2015). This large part of the world population that depends on solid fuels for cooking and heating the home is mainly found in developing countries (Smith 2006).

In Africa it is estimated that about 83% of rural households and 60% of urban households use solid fuels for cooking. India has the highest number of biomass users, after Sub-Saharan Africa, with around 71% of its population using solid fuels. In China, approximately 423 million people use biomass for cooking. In other Southeast Asian countries, such as Cambodia, Lao People's Democratic Republic, Mongolia, Vietnam, and especially Indonesia and the Philippines, the number of people using biomass is also high (Ekouevi and Tuntivate 2012).

In the case of Latin America, the areas with the highest consumption of firewood per inhabitant are concentrated in rural areas and/or with families living in poverty. It is estimated that in Central America more than 20 million people cook with

F. A. Manzano
Instituto de Geografía, Historia y Ciencias Sociales (CONICET/UNCPBA) y Centro de Investigaciones Geográficas (FCH/UNCPBA), Pinto 399, 7000 Tandil, Buenos Aires, República Argentina
e-mail: fernandoarielmanzano@fch.unicen.edu.ar

R. A. Abeldaño Zuñiga (✉)
University of Sierra Sur, Guillermo Rojas Mijangos SN, Colonia Ciudad Universitaria, 70800 Miahuatlán de Porfirio Díaz, Oaxaca, Mexico
e-mail: rariel@unsis.edu.mx

G. N. de Lima
Department of Urban and Environmental Studies, The College of the Northern Border, Jalisco 1505, Colonia Nísperos, 26020 Piedras Negras, Coahuila, Mexico
e-mail: glima@colef.mx

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biomass in open stoves, or rudimentary stoves, out of a total of around 45 million inhabitants in the region (Economic Commission for Latin America and the Caribbean [ECLAC] 2009; Wang et al. 2013).

In urban areas, gas emissions are one of the main triggers of respiratory diseases. In areas further away from urban agglomerations—especially in the most vulnerable communities (Arbex et al. 2012)—households tend to use solid fuels more frequently for cooking and heating (Kurmi et al. 2012), due to conditions of poverty, cultural issues, or proximity to natural resources such as trees.

This use of solid fuels such as firewood, coal and agricultural residues, among others, both for cooking and heating homes, is the most important source of household, or domestic, air pollution. Since the 1980s, it has been recognized that this is a true public health problem (Smith 1987; Smith et al. 2003), however, the health situation still has not been improved (Arbex et al. 2012).

In these homes, open fireplaces or stoves that are not functioning well are mostly used (Smith 2006), and as a consequence incomplete combustion causes a dispersion of smoke and particles of harmful components inside the home, generating eye irritation and a higher consumption of firewood (Lara Ponce et al. 2013). Such polluting particles are classified, according to the Intergovernmental Panel on Climate Change (IPCC) (2021), as black carbon (BC) or soot.

There is evidence that indoor wood smoke pollution increases the risk of acute respiratory infections during childhood, chronic obstructive pulmonary diseases, and lung cancer (Soares 2006). It is estimated that intramural contamination generates 1.9 million premature deaths per year, being the fourth leading cause of mortality worldwide, and it has also been associated with a number of morbidity evaluation criteria, of which the most serious are chronic and acute respiratory diseases (World Health Organization 2005).

Concentrations of BC remaining in homes can reach levels 10–100 times higher than those recommended by the World Health Organization (WHO) (World Health Organization [WHO] 2005), exposing large numbers of populations to the risk of respiratory diseases. Another problem associated with the use of wood stoves is deforestation caused by extraction of fuel (González 2015).

Various studies reveal that efficient technologies, such as wood-saving stoves, can reduce toxic pollutants, the consumption of biofuels and the time and distance to collect them, and provide other benefits such as reducing the degradation of forest resources, and mitigating gas emissions and the greenhouse effect (UNEP, Division of Early Warning and Assessment, GEO Section 2006).

According to Smith (2006), the differences in BC emissions between species of firewood and other biomass fuels are not as relevant in relation to other factors such as fuel humidity, combustion rate, ventilation and type of kitchen, with the inadequate conditions which are found (Concha et al. 2015). Thus, well-chopped, dry firewood, and stoves with chimneys to collect smoke, radically reduce pollution, making it possible to consume clean firewood and charcoal, as well as other types of biomass (Smith 2006).

But in poor rural and urban areas, despite the many projects that have been implemented around the world since the early 1980s, these conditions have not

been achieved. Among these programs, those related to the clean combustion of fuel, biomass fuels, improved stoves, and renewable fuelwood consumption stand out (Wang et al. 2013). In relation to its low level of success in terms of scale and sustainability, mention can be made of the deep roots of culinary traditions and the accentuated social and spiritual significance, in many cultures, of having a fire in the home (Smith 2006). On the other hand, improved stoves do not completely replace the multiple functions that open fireplaces or traditional stoves provide, such as heating the home, cooking certain types of food, lighting, and insect control, therefore, it is common to find that different types of stoves coexist in a home (Wang et al. 2013).

Given that the levels of domestic use of solid fuel will continue to be high, it is essential to increase the efficiency of kitchens, and advance in the incorporation of ventilation to expel smoke to improve the quality of the air in homes (Smith 2006). The objective of this chapter is to analyze the trends in the use of biomass fuels for cooking and improved biomass kitchen appliances in Mexico between the years 2000 and 2018.

2 Use of Solid Fuels and Their Impact on Health

It has been suggested that gas emissions in the urban environment is one of the main triggers of respiratory diseases in urban areas, but the pattern of pollution in remote areas of the megalopolis is different. Households that are located in communities further away from the megalopolis, either due to conditions of poverty, or cultural reasons and their proximity to natural tree resources, tend to use solid fuels more frequently for cooking and heating homes (Kurmi et al. 2012).

This use of solid fuels such as firewood, coal, and agricultural residues, among others, both for cooking and heating homes, is the most important source of household, or domestic, air pollution (Smith et al. 2003). Since the 1980s, it has been recognized that this is a true public health problem (Smith 1987), however it is a health situation that has not yet been solved, especially in the most vulnerable communities (Arbex et al. 2012).

Usually, studies on air pollution and its impact on health focus on urban ambient air, due to its impact on more developed countries and regions (Pascal et al. 2013; Nadadur and Hollingsworth 2015). But the poorest communities have a different pollution pattern than that seen in more developed urban areas (Smith et al. 2003). Specialized literature describes that due to household air pollution, families can be exposed to respirable particles of carbon monoxide, nitrogen and sulfur oxides, benzene, formaldehyde, 1,3-butadiene, and polyaromatic compounds such as benzopyrene (Smith 1987; Smith et al. 2003).

It has been described that, in rural communities, the inappropriate use of firewood as fuel for cooking and/or heating homes causes a dispersion of smoke and its particles, known as black carbon (BC), into the home (Lara Ponce et al. 2013).

BC is part of the short-lived climate pollutants (SLCP), which have a significant global warming potential and a short life span in the atmosphere. These particles are also associated with an increased risk of respiratory diseases, strokes, various heart diseases and lung cancer, as the most frequent health problems, as well as they may cause premature deaths, with the people most at risk being women and children due to their prolonged presence in the home (Vázquez Calvo and Cruz León 2015; WHO, Climate and Clean Air Coallition 2015; Instituto Nacional de Ecología y Cambio Climático [INECC] 2021).

According to Janssen et al. (2012), the association of BC with these conditions focuses mainly on suspended particles with diameters less than 2.5 μm (PM2.5). These particles seem to be a better indicator of the health impacts generated by urban and intramural pollution, since, unlike PM10 particles, the reduced size of PM2.5 allows them to reach into deeper areas of the respiratory system, such as the bronchial region, increasing the incidence of the aforementioned conditions.

Estimates from the World Health Organization (WHO) indicate that around 4.3 million premature deaths in 2012 could have been caused by exposure to PM2.5 particles (WHO, Climate and Clean Air Coallition 2015). It is known that the population most affected by exposure to the smallest BC particles globally are women (with an average annual exposure of 337 $\mu g/m^3$) and children (285 $\mu g/m^3$), while men are exposed to relatively lower concentrations (204 $\mu g/m^3$), values that exceed up to 20 times the annual average recommended by the WHO of 10 $\mu g/m^3$ (WHO, Climate and Clean Air Coallition 2015).

In general, it has been observed that low- and middle-income sectors of the population have generally been found to be the most vulnerable to BC exposure due to their dependence on biofuels for cooking or heating homes (WHO, Climate and Clean Air Coallition 2015). In the case of Mexico approximately 19% of the population used charcoal or firewood for cooking in 2014 INECC 2021), therefore, they were at risk of suffering from diseases derived from BC exposure.

As part of the actions aimed at reducing health problems derived from air quality deterioration, in particular due to the effects of BC, and also in order to reduce the emission of greenhouse effect compounds that contribute to climate change, Mexico has committed to reduce its BC emissions by 51% by 2030. One of the instruments used to monitor the country's progress is the National Inventory of Greenhouse Gas and Compound Emissions. Its last update occurred in 2015, presenting the emissions of BC, carbon dioxide, methane, nitrous oxide, hydrofluorocarbons, perfluorocarbons, and sulphur hexafluoride (represented as CO_2eq) in the period 1990–2015 (Instituto Nacional de Ecología y Cambio Climático 2021).

The inventory is carried out in accordance with scientific and technical criteria established by the IPCC and divides emissions by sectors, categories, sources and sub-sources. If the data referring to the burning of fuels for the generation of energy for the "residential" sub-source are observed, it is possible to verify that throughout the 25 years of measurements, BC emissions have suffered fluctuations, presenting peaks, such as that of 1998, which could have been due to a considerable depreciation of the national currency, which led to a slowdown in economic activity and

an increase in poverty in the country (Banco de México 2021), causing many Mexicans to return to the use of biomass fuels for cooking and heating their homes.

In subsequent years there was a constant decrease in BC and CO_2eq emissions which remained until 2015, when the lowest values of the entire period can be observed (Fig. 1). This reduction was in line with the commitments signed by Mexico with the United Nations Framework Convention on Climate Change (UNFCCC) and is related to the implementation of mitigation measures and policies by the states to promptly serve different sectors, and to the economic recovery of the country from the year 2000 (Banco de México 2021; INECC 2021). The trend observed is that these values continue to decrease, but the lack of more recent data (2015–2020) makes it impossible to accurately analyze the current situation in terms of BC and CO_2eq emissions.

In Mexico, there is abundant literature on the health impacts of air pollution throughout the Valley of Mexico (Bravo-Alvarez and Torres-Jardón 2002; Parrish et al. 2011; Sotomayor-Olmedo et al. 2013), but the studies that focus on household air pollution are scarce and in very specific communities. There are only a few studies at the local level in isolated municipalities in a few states in the country, which have focused their efforts on describing the very low penetration of Lorena eco-technology into households (Lara Ponce et al. 2013; Vázquez Calvo and Cruz León 2015; Vázquez Calvo et al. 2016; Sotelo 2016). Eco-technology Lorena is a self-built stove with materials made of mud and sand (Lorena comes from the junction of the Spanish words mud (***lo****do*) and sand (***arena***)), which can reduce the amount of firewood used by up to 50% in cooking, as well as evacuating fumes from the home.

Other studies have focused on demonstrating the concentrations of respirable suspended particles in the air of the homes of some isolated communities in

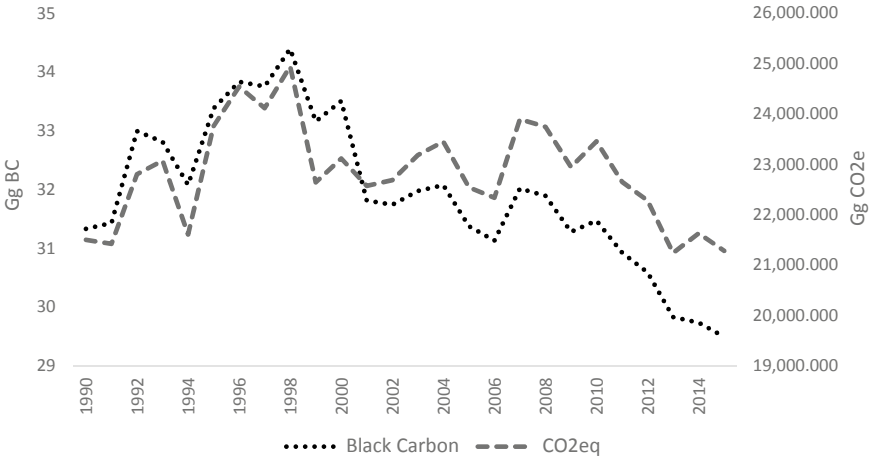

Fig. 1 Black carbon and CO_2eq emissions in Gg/year—category "Energy", sub-source "Residential". *Source* INECC (2021)

Chiapas, Michoacán and the State of Mexico (Brauer et al. 1996; Saatkamp et al. 2000; Riojas-Rodríguez et al. 2001; Masera et al. 2007).

There is only one study published in 2011 which analyzes a trend in the use of firewood as cooking fuel, where it is described that although the rate of use of LP gas increased 4 times between 1965 and 1998, the rate of firewood consumption remained constant in the same period (Pérez Maldonado et al. 2011). The same study described that the states where firewood is used the most as fuel are Oaxaca, Chiapas and Guerrero (Pérez Maldonado et al. 2011).

3 Use of Biomass Fuels for Cooking and Improved Biomass Stoves in Mexico

This section describes the analysis to identify trends in the use of biomass fuels for cooking and use of improved biomass stoves in Mexico between 2000 and 2018. For this, secondary data sources were used from microdata of the "Households" dimension of the National Health and Nutrition Survey (ENSANUT) (Instituto Nacional de Salud Pública 2020), a national health survey applied at 6-year intervals, for the years 2000, 2006, 2012 and 2018.

The variables referring to fuel and the home cooking appliance used were explored.

Regarding cooking fuel, it is observed that in 2000 a total of 3,548,876 households used biomass fuels to cook food. This decreased to 3,137,441 in 2006, and then increased to 4,037,305 in 2012 and 4,533,122 in 2018. This implies that approximately 18 million people in Mexico are currently exposed to the use of biomass fuels in their homes. In relative terms, the use of biomass fuels for cooking fell from 16.2% in 2000 to 13.2% in 2006, and then increased to 13.7% in 2006 and 13.9% in 2018 (Fig. 2).

Regarding the use of improved biomass stoves, there is no data available for the year 2000, but there is evidence of an increase in its use from 501,734 households in 2006, to 551,877 households in 2012 and 772,497 households in 2018. In relative terms, the utilization of improved biomass stoves (IBS) went from 2.1% of households in 2006 to 1.9% of households in 2012 and then increased to 2.4% of households in 2018 (Fig. 3).

As can be seen in Figs. 2 and 3, the states where firewood or charcoal is most used for cooking are Campeche, Chiapas, Guerrero, Hidalgo, Michoacán, Puebla, Oaxaca, Tabasco, Veracruz and Yucatan.

According to Masera et al. (2010), although the total consumption of firewood at the national level will remain relatively constant until 2024, in a significant number of municipalities in the central and south-southeast states of the country it is expected to continue increasing. It is worth mentioning that in these states there is a high proportion of the indigenous population living in poverty and extreme poverty and that the 15 poorest municipalities in the country are located in these regions,

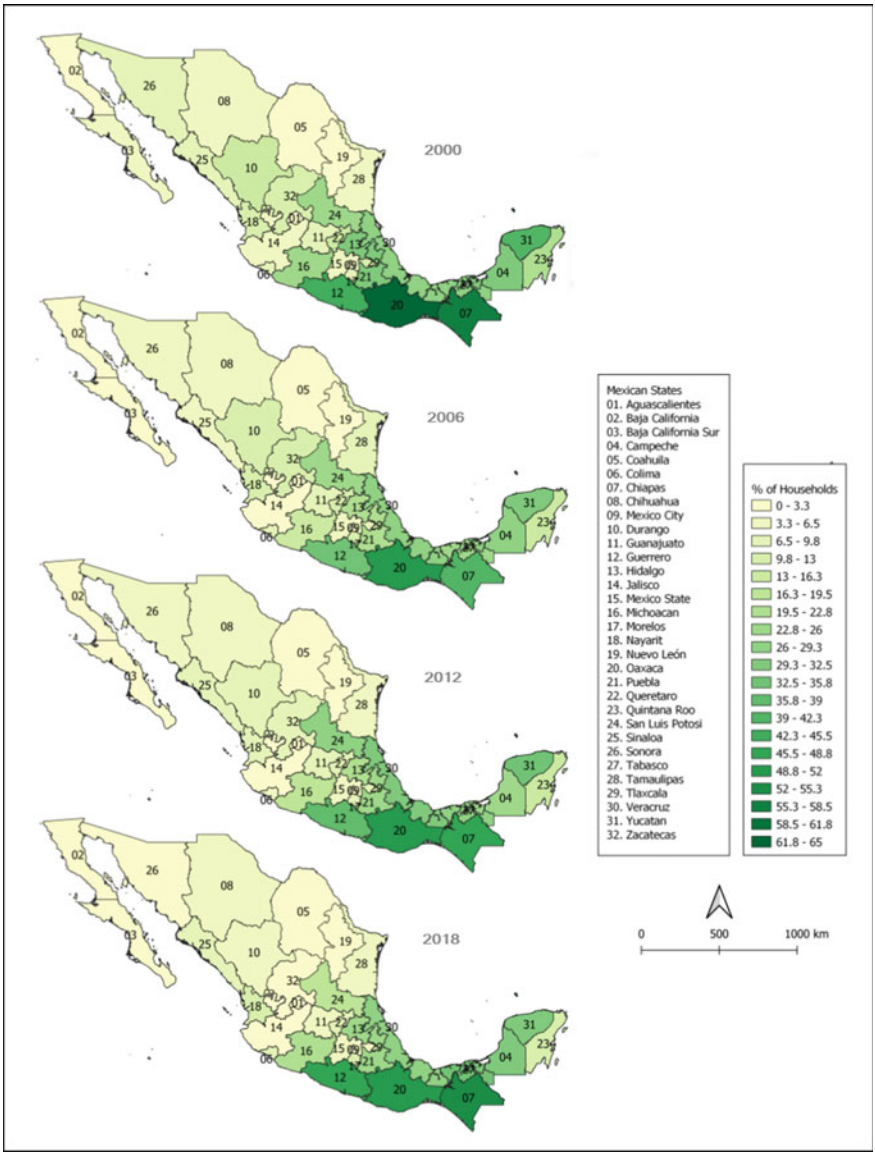

Fig. 2 Percentage of Mexican households that use biomass fuels for cooking. *Source* Elaborated by the authors based on National Health Surveys (ENSANUT)

according to data from the National Council for the Evaluation of Social Development Policy (Consejo Nacional de Evaluación de la Política de Desarrollo Social [CONEVAL] 2021).

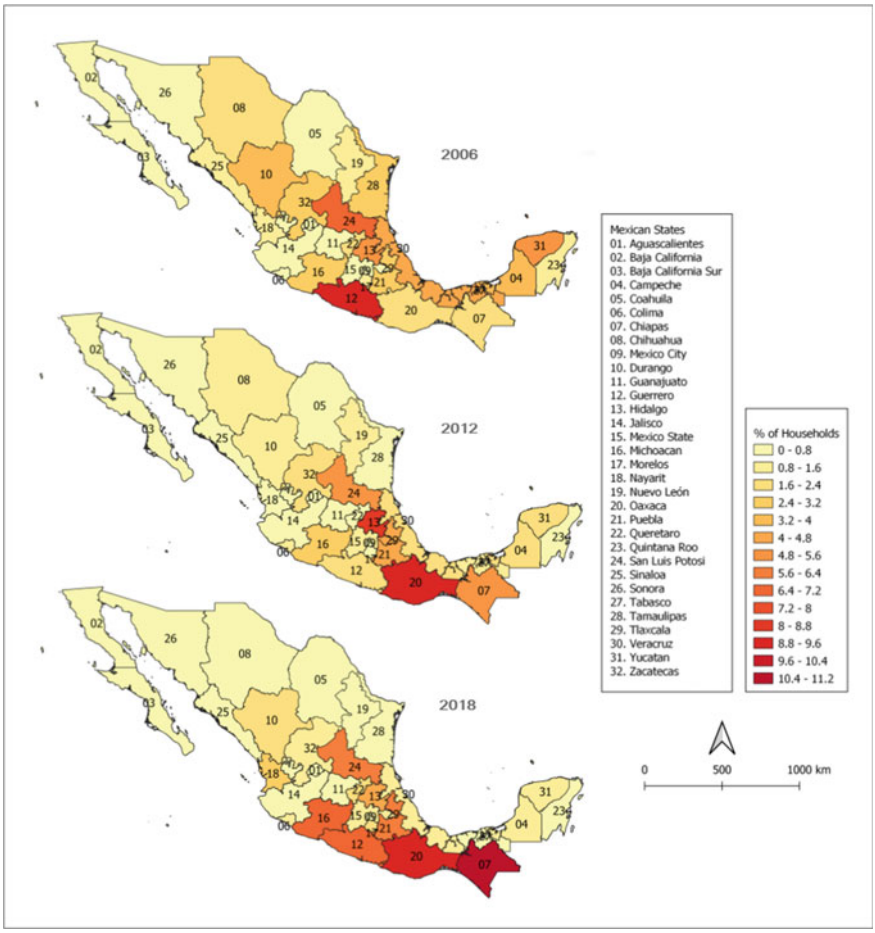

Fig. 3 Percentage of Mexican households using improved biomass cookstoves. *No available data for year 2000. *Source* Elaborated by the authors based on National Health Surveys (ENSANUT)

4 Technological Development of Improved Biomass Stoves

In the 1970s, the development of the Lorena stove, created in Guatemala, became popular in many developing countries (Wang et al. 2013). This stove is built in situ, with a mix of mud and sand, a large griddle or griddle and a fireplace (Vázquez Calvo et al. 2016). Its construction is easy, fast and inexpensive, using materials available in the community, and it has a long duration if put to good use, and the corresponding proper maintenance is carried out (Lara Ponce et al. 2013).

The current Lorena type stoves are called iron stoves, they have a base made of blocks or bricks to create a flat surface. Then three walls are built around the base and an iron sheet (plate) is placed on top—the fireplace is located at one end.

There are no standard dimensions for griddle stoves and most of them do not have a proper combustion chamber. The main improvement of griddle stoves over open fireplaces is the chimney. The fumes from the incomplete combustion of firewood that are harmful to human health are evacuated out of the home by the chimney (Vázquez Calvo and Cruz León 2015; Vázquez Calvo et al. 2016). Although these stoves reduce the negative impact on the environment, they do not necessarily result in firewood savings (Granderson et al. 2009).

A study carried out in the mountains of Guatemala replaced the open hearth of the home with improved wood stoves with a chimney (Bruce et al. 2000; Smith et al. 2005), resulting in a reduction in respiratory and heart diseases (McCracken et al. 2005).

In 2010, the public–private partnership Global Alliance for Clean Stoves (GACC) emerged, which aims to mobilize the support of a wide variety of actors from the public sector, private sector and non-profit organizations to promote the adoption of clean cookstoves and fuels (Global Alliance for Clean Cookstoves 2011). This association is managed by the United Nations Foundation, and expressed the goal of having 100 million homes to adopt efficient improved kitchens by 2020 (González 2015). The GACC offers three guidelines: stoves or fuels that meet or exceed 25% thermal efficiency are required; compliance with emissions of less than 0.49 g/min of CO_2 and 8 g min of particulate materials; and generate global emissions of less than 9 g/MJ of CO_2 and 168 mg/MJ of PM 2.5 particulate matter (Global Alliance for Clean Cookstoves 2011).

The need to provide manufacturers with a new generation of improved biomass stoves (IBMS), specific incentives and support to achieve an increase in production is highlighted. Support can be given in the form of training and capacity building in relation to stove marketing and business management, as has been done by Deutsche Gesellschaft für Internationale Zusammenarbeit GmbH (GIZ) and the European Commission in projects that have been implemented in Africa and Asia (The World Bank 2011; Kees and Feldmann 2011). Financial support is also required in the form of soft loans, tax breaks, or another type of mechanism that allows manufacturers to develop their capital and operate with larger production scales (Global Alliance for Clean Cookstoves 2011).

5 Experiences in the Diffusion of Improved Stoves

Central America is noted for a vast history in the field of improved cook stove innovation. Currently, a new generation of IBMS is available in this region. There are almost twenty IBMS models with significant improvements in design and performance, compared to the stoves disseminated before 2000. By the year 2000, an estimated 150,000 griddle stoves were built, mainly in Guatemala. Their

manufacture was subsidized, and the poor-quality control of the product stands out (Wang et al. 2013).

Given the potential improvements in the living conditions of the inhabitants and the protection of forests and jungles, initiatives have been launched to spread the IBMS in the region (Lara Ponce et al. 2013). However, even with the participation of donor agencies, governments and non-governmental organizations, as well as local entrepreneurs, the penetration of IBMS continues to be less than 10% of the affected population (Wang et al. 2013).

The Ministry of Environment and Sustainable Development of Colombia implemented the National Program for efficient stoves for cooking with firewood in 2015, with the aim of reducing the health and environmental risks caused by these types of devices (González 2015). The Ministry adopted the guidelines offered by the GACC (Concha et al. 2015).

A study on eco-efficient stoves installed in Colombia highlights the changes in the level of efficiency as a function of the altitude at which the wood stoves are located –between 678 and 1976 m above sea level—(Pérez-Bayer et al. 2013). Thus, it is necessary to make adjustments to the kitchens in line with the altitude of the home area of residence.

The low impact, coverage and scope of the National Program for efficient stoves in relation to the number of families involved is highlighted, as well as the lack of efficiency studies of the 15 prototypes of stoves implemented in the Colombia plan (González 2015).

From the social point of view, the benefits related to improved stoves are innumerable, including the costs avoided for the public health system, the preservation of forest resources, the decrease in land use changes, as well as the reduction of greenhouse gases resulting from the reduced use of non-renewable biomass (Wang et al. 2013). The Patsari stove program in the mountainous area of Mexico estimated that the benefit–cost ratio is between 11.4:1 and 9:1 (Masera et al. 2007). Regardless of the intervention scenario, the time period, and the chosen discount rate, the economic returns of investing in IBMS technology are considerable in all the studies carried out in Zimbabwe, Uganda, Malawi and China (García-Frapolli et al. 2010).

It is worth highlighting the use of multiple fuels and cooking appliances—called "mixed use"—in Latin America, as well as in other regions (Wang et al. 2013). At the national level in Mexico, the participation of users of mixed fuels reached 32% in 2000 (Instituto Nacional de Estadística Geografia e Informática [INEGI] 2000). The ECLAC survey (ECLAC 2011) reported that in Honduras more than 20% of households use firewood and at least one other fuel. Likewise, 78% of the stoves in the survey have griddles, while the remaining 22% have ovens.

6 Learning the Use of Firewood in Mexico

In Mexico, around 28 million people use firewood to cook or heat water (Vázquez Calvo et al. 2016). In the mountainous regions of central and southeastern Mexico, 240 municipalities are concentrated with a very intense consumption of firewood, both in private households and in micro-enterprises (Díaz and Masera 2003). These municipalities with a very intense firewood use pattern—concentrate 21% of the total population that uses firewood—have very similar cultural, environmental and social conditions (Vázquez Calvo et al. 2016).

Masera et al. (2010) state that in Mexico the per-capita consumption of firewood is higher where the resource is most abundant, with wetlands and tropical forests being the areas where this resource is most extracted, 2.5 kg/day and 3.0 kg/day respectively.

This context makes firewood an increasingly scarce resource, and far from the area of consumption (Food and Agriculture Organization—Secretaría de Agricultura y Desarrollo Rural [FAO—SAGARPA 2007]), there is a great incentive to promote the use of firewood-saving stoves, due to the potential improvement of the quality of firewood, family life and the significant decrease in greenhouse gases (GHG), including BC (Masera et al. 2007).

Despite the fact that the rate of use of liquefied petroleum gas (LPG) increased 4 times between 1965 and 1998, it is noteworthy that the rate of consumption of firewood as fuel remained constant in the same period. Oaxaca, Chiapas and Guerrero are the states where firewood is most used as fuel (Pérez Maldonado et al. 2011). Studies have provided evidence of the concentrations of respirable suspended particles in the air of the homes of some isolated communities in Chiapas, Michoacán and the State of Mexico (Brauer et al. 1996; Saatkamp et al. 2000; Riojas-Rodríguez et al. 2001; Masera et al. 2007). Wood-saving stove programs began in the 1980s, but the results have not been significant (Vargas 1990). Starting in 2003, the dissemination of wood stoves with efficient technologies was intensified by some organizations, such as research institutes of the National Autonomous University of Mexico (UNAM), government agencies linked to public health, social development and health risks, among others (Masera et al. 2007).

In the municipality of Atempan, in the Mexican state of Puebla, the Rural Development Agency (RDA) "roots of the Mixteca" reports a saving of 70% in the consumption of firewood using the Lorena type stove (FAO—SAGARPA 2007).

A study carried out in the communities of Santa Ana Tamazola and Santa María La Concepción in the municipality of Jolalpan, Puebla, carried out the installation of Lorena stoves in peasant homes. The results obtained were an average firewood saving of close to 25.8% compared to the traditional stove. From 2009 to 2016 the number of trees cut per peasant family that incorporated this device decreased by 40, this means a decrease of up to 25% in tree consumption per year per family (Vázquez Calvo and Cruz León 2015; Vázquez Calvo et al. 2016). Notwithstanding these significant results, the household penetration of Lorena eco-technology has

been very low (Lara Ponce et al. 2013; Vázquez Calvo and Cruz León 2015; Vázquez Calvo et al. 2016; Sotelo 2016).

7 Conclusions and Future Prospects

This chapter concludes with an important finding: between 2000 and 2018, the use of biomass fuels for cooking went from 3.5 million households to 4.5 million households. This increase could be motivated by economic factors related to the increase in the cost of cooking gas, the increase in the price of the dollar and the increase in the price of oil.

The antecedents indicate that the levels of domestic use of solid fuel will continue to be high, and although the use of IBMS in Mexican households is increasing slightly, the volume of use is not enough to cover all households that use biomass fuels in open-fire kitchens without a fireplace. These conditions imply a real risk to the health of Mexicans, since the direct link between the use of biomass fuels with health risks, especially respiratory diseases, has been well demonstrated.

However, despite the increase in the use of these fuels observed in the last two decades in the country, it is interesting to note that the Mexican states where this increase is most marked (Chiapas, Guerrero, Michoacán, Oaxaca and Puebla) are also the ones that have recorded the greatest increases in the use of IBMS, which lead to a reduction in the consumption of firewood or charcoal and the emissions generated by their incomplete burning. This could, in part, explain the trend in the reduction of CO_2eq emissions and BC observed in the data of the National Inventory of Greenhouse Gases and Compounds (Instituto Nacional de Ecología y Cambio Climático 2021) for the category "energy" (sub-source "residential").

One of the greatest benefits of the increase in the use of IBMS in these areas of the country is the reduction of deforestation for the extraction of firewood from forests and tropical jungles, essential ecosystems for the conservation of Mexican endemic species of flora and fauna, which predominate in these states.

Regarding future prospects, more research is needed on the association between the use of these fuels and the presence of respiratory diseases in Mexico. At the same time, action is also needed to promote the spread of the use of improved biomass stoves to a greater number of households.

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Fernando Ariel Manzano PhD in Demography from the National University of Córdoba, Argentina; graduated in Economics and Sociology, both from the University of Buenos Aires, Argentina. Adjunct researcher at CONICET. He has 43 articles published in refereed journals, 3 books and 12 chapters in books by other authors. His main research topics are related to: Interdisciplinary analysis of the labor market; Critical analysis and contributions of demography to social sciences; Geography and quality of life in Argentina; and Economic demographic analysis.

Roberto Ariel Abeldaño Zuñiga PhD in Demography and Magister in Public Health from the National University of Córdoba, Argentina; Research Specialist from the University of São Paulo (USP), Brazil. His research topics are related to health, society, and environment; disasters, mental health and vulnerable populations; and public health in disaster situations. He has been a consultant for the United Nations Development Program and the World Bank. He is a member of the National System of Researchers (SNI) in Argentina and Mexico. Currently, he is a full-time researcher at the University of Sierra Sur in Mexico.

Gabriela Narcizo de Lima Full-time research professor of the Department of Urban and Environmental Studies at The College of the Northern Border. PhD in Science (Physical Geography) from the University of Sao Paulo (USP)—Brazil, with a master's and bachelor's degree in Geography from the São Paulo State University "Julio de Mesquita Filho" (UNESP)—Brazil. Between the years of 2016 and 2018, Dr. de Lima has carried out two postdoctoral research stays in the Department of Territorial Planning and Geoprocessing of the Institute of Geosciences and Exact Sciences of Rio Claro/Sao Paulo (UNESP) and in the Institute of Geography of the National Autonomous University of Mexico (UNAM). Her main lines of research are related to the impacts of anthropic activities on climate at various scales, as well as issues related to the management of water resources and land use planning.