Pardeep Singh · Yulia Milshina · André Batalhão · Sanjeev Sharma · Marlia Mohd Hanafiah *Editors*

The Route Towards Global Sustainability

Challenges and Management Practices

Springer

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Chapter 1
Rethinking Environmental Governance: Exploring the Sustainability Potential in India

Jaydip De

Abstract In recent years, environmental governance, its nature, uses, and modalities are enthusiastically coming into the limelight of the academic and administrative community. The dynamic new approaches to environmental governance have made valuable inroads for sustainable governance. Yet this remained insufficiently harnessed in India, both theoretically and operationally. Not only that, there is a paucity of practicable guidelines to run the existing system holistically. This inductive research examines the nature, dimensions, problems, and idealised situations concerning good environmental governance in the Indian context. Both subjective and objective consideration of the available literature and perception study embodies the foundation of this endeavour. It is debated that governments are no longer the sole agent to ensure good management practice and non-state actors are increasingly coming into the limelight of sustainable community building and coordinated network development. Still, the democratic legitimacy of the private stakeholders is questionable, but the incompetence of public sectors to develop and promote a comprehensive framework for the governance of the environment pushes the system to move forward towards partnership building. This chapter calls for delivering an insightful and adaptable framework capable of identifying, analyzing, and mitigating the issues regarding environmental governance in dissimilar social, economic, political, and ecological ambiences where diverse environmental problems and modes of governance prevail. Therefore, idealised plans, models, and attributes are conceived in this chapter to meet the exhortations of Sustainable Development Goals (SDGs).

Keywords Environmental governance · Non-state actors · Coordinated network development · Partnership building · Sustainable Development Goals

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1 Introduction

The sustenance of the human community on the earth is regulated by factors of the environment. The United Nations Sustainable Development Goals of 2015 looks forward to building sustainable communities and society. This necessitates an overall modification of the approaches and domains of governance. Ever since then, the academicians and bureaucrats are making sincere efforts to monitor and evaluate Sustainable Development Goals (SDGs). Beginning from the local to the global, the approaches of national policies and natural resources are to be addressed in a new way (Paavola, 2007) to attain the objectives of SDGs. Researchers are shedding light on neo-governance to ensure the protection of collective eco-resources. This has also started promoting participatory as well as collaborative forms of governance for conceptualising more sustainable environmental policies (Newig & Fritsch, 2009), the success of which relies upon the realisation and adaptation of policies that consider the functioning of the earth's system and the adaptability of the local community (Knight, 2015). Participatory strategies are preferable to cater for these needs of sustainable development. Notwithstanding the growing anthropogenic pressure on the environment, good governance has become a prime concern to ensure the long and healthy survival of the civilisation. But, it demands a new way forward. So far, the stewardship of governance is confined to bureaucratic decisions and political judgements where the participation of the commons and the policy review at the ground level are not up to the mark. Though the subject matter of environment is nurtured by different disciplines of natural science, social science (Adger et al., 2003), and humanities, it failed to achieve substantial importance among the common people and lower-level administrators.

The natural environment is coming under tremendous pressure from different institutional and non-institutional actors of development. Good governance of the environment is therefore the demand of time to ensure the sustainability of natural resources and ecosystems. Environmental governance is a collection of the regulatory process applying which environmental actions and outcomes can be regulated by authorised organisations and institutions (Lemos & Agrawal, 2006). Practically, good environmental governance is a realisation of community well-being for the long-term availability of natural resources and their maintenance by satisfying the local demand. In other words, it is the collective effort of the community to maintain the health of the environment. Reinterpretation of the theories and concepts is anticipated therefore (Newig & Rose, 2020).

Of late, the mechanism of governance is more concerned about how decisions are made? Who made this? For whom it is made? And what are their impacts? (Graham et al., 2003; Lockwood et al., 2010; Bennett & Satterfield, 2018). In this regard, Mirumachi and Van Wyk (2010) emphasised the ever-changing power relationships among the various actors responsible for dealing with different environmental problems. Environmental governance is largely concerned with the perception of the society and community. Ortolano (2009) highlighted the importance of institutions, good governance, and civil society for an improved environment. Indeed, it is the means to address the complex managerial, behavioural, and technical issues relating to the environment (Bennett & Satterfield, 2018). Its strategic understanding is even more complex (Van Assche et al., 2020) with the addition of new knowledge (Gerlak et al., 2020), ultimately leading to greater pressure from citizens regarding participation in decision-making and sharing of perceived benefits (Loe & Kreutzwiser, 2007; Armitage et al., 2012). Differently, the institutionalisation of environmental awareness beginning from the western world has paved the way for different stakeholders to discuss, debate, and take part in environmental issues. It is all about how government organisations, non-government organisations, voluntary groups, political parties, interest groups, and individuals collaborate to maintain harmony with the environment, thus recognising the legal connotations among different stakeholders (Nallathiga, 2012). It also seeks for an active role and political space for actors other than government, such as civil society and business sector (Bulkeley, 2005; Lemos & Agrawal, 2006; Büsher & Dressler, 2007; Turton et al., 2007; Ali-Khan & Mulvihill, 2008; Mirumachi & Van Wyk, 2010). Hence, new chains of cooperation among the new actors are anticipated (Mirumachi & Van Wyk, 2010). However, in the early stages of collaborative action, there is confusion regarding the role of non-state actors in the entire procedure of governance. Since the private organisations are run by the autonomy of the ownership, their democratic legitimacy is still questionable; hence, initially government organisations were doubtful regarding their incorporation in public affairs. Bulkeley and Mol (2003) spotted that in the beginning, the role of interest groups and the community was minimal, and dialogues and actions were confined to the state and industry only. Later on, the scenario started changing when the hierarchies of government have confirmed social participation in planning and implementation. Nowadays, non-state actors are hypothetically welcomed to enhance democratic legitimacy (Bernauer & Betzold, 2012). But, the ground reality raises some questions. Do they actually participate? And how far the government is interested to accept public opinion? Whatever may be the role of society, the prime concern is always to keep the environment healthy. Lemos and Agrawal (2006) spotted four collateral aspects of environmental governance, i.e. decentralised environmental governance, market and individual-focused instruments, globalisation, and governance across scales.

The technological man often orients their activities towards profit maximisation, which in the long run destroys their harmony with nature. The *United Nations Conference on the Human Environment*, Stockholm, 1972, has recognised the need for common orientation of all stakeholders to adapt joint regulations and guidelines to save and protect the human environment globally. This was the foremost recognised effort to preserve the environment. This conference has given birth to *United Nations Environmental Programme* (*UNEP*) that plays the leading role to establish coordinated networks for global environmental governance involving the UN agencies (Najam et al., 2006). Later on, the *United Nations Conference on Environment and Development* (*UNCED*) or the Earth Summit of Rio de Janeiro, 1992; *Convention on Biological Diversity*, 1993; and the *World Summit on Sustainable Development* (*WSSD*), Johannesburg, 2002, are the most recognisable attempts to protect the human environment involving the governments, NGOs, business organisations, and other interest groups (United Nations Department of Economic and Social Affairs, 2020). Following these global initiatives, there is growing consensus that the public needs are to be addressed properly in the process of environmental decision-making (Owens, 2000; Bloomfield et al., 2001; Davis, 2001; Bulkeley & Mol, 2003).

The relationship of development is somehow dichotomous with the environment (Government of India, Ministry of Environment and Forests, 2006). Socioculturally diverse Indian society is facing continuous challenges from society, economy, polity, and environment (International Centre for Environment Audit and Sustainable Development, 2006). Not only the less-developed world but rather the developed counterpart is also suffering from non-effectiveness of environmental policies (Lenschow, 1999; Jordan, 2002; Knill & Liefferink, 2007; Newig & Fritsch, 2009). Mostly, researchers have focused on some case studies and globally fitted models of environmental governance. But as time flies, the entire system demands context-specific upgradation. The major roadblock for environmental governance in India is the non-empowered local government, which despite the 73rd and 74th constitutional amendments (1992) has not given full autonomy to govern the local environment. Thus, a missing link between the institutional framework and ground-level governance is evident. Unless institutional reforms are imparted, the twin objectives of good environmental governance and supporting natural life cannot be taken forward. Hence, there is an absolute need for identifying proper modalities of governance. In this synthetic study, a comprehensive attempt is so made to identify the existing mechanism of environmental governance in India. It also attempts to answer the following questions – what are the major initiatives taken to ensure good governance of the environment? What are the formal channels of environmental governance? And which is the best fitting way to ensure equitable environmental governance? Presenting a standard operational procedure, this chapter attempts to sum up all possibilities for pro-citizen environmental governance.

2 Objectives of the Study

The nature and attributes of environmental governance are widely studied in developed economies, but studies are scanty in developing countries where the population is always accelerating its pace of growth. This study aims to identify the ideal means for good environmental governance with special reference to India. Hence an in-depth introspection is made to identify the major policies for environmental governance adopted in India. This study also tends to ascertain the main attributes, potential challenges, plan of actions, and consecutive stages to promote good environmental governance. Further, this inquiry focuses on developing a pro-citizen model of good environmental governance.

3 Materials and Methods

In this conceptualisation of environmental governance, introspection of literature and published documents matters a lot. Subsequently, empirical understanding through field observation and unstructured interviews ensure the added realisation of ground reality. Given the insightful thinking of scholarship, it is argued that literature owes a lot of learning lessons and integrate scientific knowledge into actions of reality. This endeavour pays attention to understand what already have done and what could happen from a strategic point of view. Consequently, at first, the complexities of the objectives, attributes, and analytical elements relating to environmental governance were reduced. Because so far, too many academicians have attempted to conceptualise the different dimensions of environmental governance, their improper judgement increases unnecessary confusion. Hence, context-specific and plan-formulating discussions are given priorities. Nevertheless, unstructured perception studies were conducted on government officials, citizens, ward committee members, political activists, and elected representatives to acknowledge the scenario from unalike perspectives.

The literary analysis comprises normative consideration of existing global literature on environmental governance. The objective analysis includes target-specific attitudes, including identifying the number of implemented policies, acts, regulations, a specified number of attributes, working responsibilities, etc. On the other hand, the subjective analysis focuses on in-depth introspection on their modalities and dimensions. A comprehensive attempt is so made to define prime concepts on environmental governance. Research literature, newspaper reports, government websites, web portals of non-government organisations, and other published documents appear to be the main source of information. This research partially followed the PRISMA-Preferred Reporting Items for Systematic Reviews and Meta-Analyses (Moher et al., 2009; Abelha et al., 2020; Huq et al., 2021) approach for systematic evaluation of literature. This meta-analysis covered more than 5000 articles published in reputed repositories including Scopus, PubMed, JSTOR, and Web of Science (Fig. 1.1). The articles were selected based on their relevance to 'environmental governance' and 'environmental governance in India' (keyword search), and this involves the *Identification Phase* (phase 1) of the PRISMA. Since Scopus is the largest repository of the other three, it is to mention that 4497 pieces of literature against 'environmental governance' and 567 literature against 'environmental governance in India' were found in its database. In the *Screening Phase* (phase 2), 354 ($n = 354$) and 230 ($n = 230$) sample literature were shortlisted at a 95% confidence with a 5% chance of error. The sampling of literature was purposive. Simultaneously, government reports and websites were also scrutinised thoroughly for policy recognition and evaluation. In the *Eligibility Phase* (phase 3), these articles and reports were analysed based on their effectiveness to propose policies and means to govern the local environment. A total of 78 and 56 articles were excluded based on the abstract review. 18 articles were added to the database to shed some light on the aspects of e-technology adaptation (*Included Phase* – phase 4).

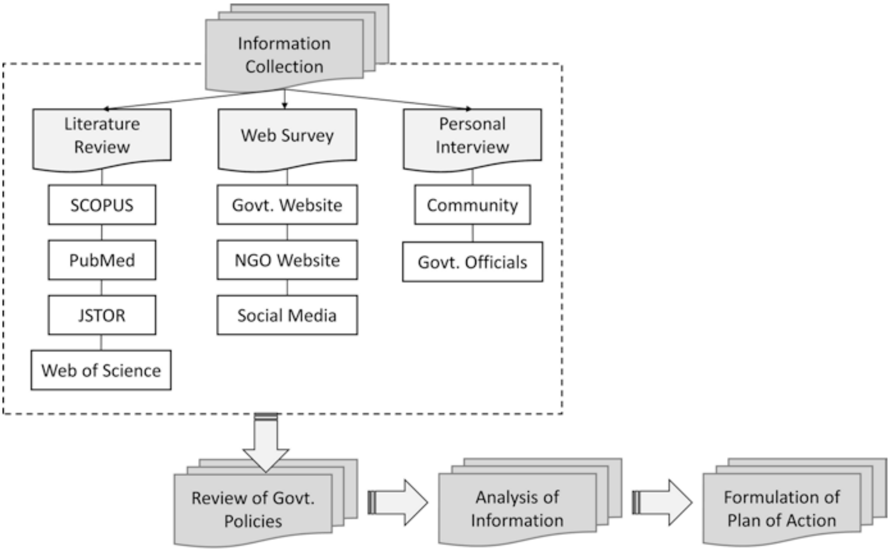

Fig. 1.1 Workflow of the research

Initially, the concepts and potential challenges among themselves were considered; after that the policy initiatives adopted in India were reviewed. Subsequently, the shortfalls to achieve the desired aim were also addressed. This analysis continued by building upon the recent researches that reviewed and summarised fruitful outcomes of government initiatives. Review of literature continued until the conceptualisation of specific thematic goals was achieved. Idealised instances from all over the world in different sectors like the forest, wildlife, waterbody, soil, wastewater governance, etc. were reckoned in this study. Supporting references are provided throughout the text to provide a strong footing to the discussions of this study.

The interviews focused on the perception of government officials, community engagement, the perceived impact of community involvement in government initiatives, and citizens' aspirations. The sample selection for this study was purposive and snowball. The community leaders and political activists were asked how they worked with local people as well as government officials. It was focused to identify how far the citizens feel that local level environment-related programmes are important to participate in and how far the officials are interested in making them aware and provide the opportunity to get involved, particularly to those who have participated in such activities at least once. The opinion of respondents from both rural and urban areas is given due importance. A detailed note of the field observation was considered for ground verification. The data analysis consisted of a thorough interpretation of field experience and qualitative analysis (not directly quantified but incorporated for investigating the ground reality) of information obtained from informal interviews. The interviews were conducted using e-mail and face to face. The observed issues were categorised into two broad groups: level of civic engagement and conflict between government and community. Inductive synthesis was carried out thereafter to promulgate the pro-citizen model of good environmental governance upon both subjective and objective recognition of the prime functions and functionaries of environmental governance. While the literary analysis was conducted from 2016 to 2021, field observation and perception interviews were a snapshot of 2018 and 2019.

4 Major Initiatives to Govern Environment in India

The Indian subcontinent is well-endowed with a wide variety of natural resources. So far, several attempts were taken by governments to conserve pristine nature, but the ever-increasing pressure of population has impacted negatively upon them. The traditional means of resource utilisation and subsistence-based primary practices are also responsible for resource depletion. The growing greed of people, unplanned urbanisation, forest destruction, and non-eco-friendly tourism practices are imposing serious harms to the natural environment as well. Consequently, an urge was felt to put forward some legal measures to protect the air, water, forests, and biological diversity. Article 21 of the Indian constitution ensures the citizen's right to a decent environment. Hence, the Parliament of India has enacted and amended several acts to protect, regulate, and conserve the country's natural resources. The late 1980s and early 1990s could be marked as a watershed. Ever since then governments and interest groups became proactive to conserve the health of the natural environment. Some of the policies adopted in India are discussed herewith.

- Indian Forest Act, 1878, 1927 and Forest Conservation Act 1980, 1988, 1992
- Wildlife Protection Act, 1972, 2002
- Water (Prevention and Control of Pollution) Act, 1974
- Air (Prevention and Control of Pollution) Act, 1981
- Environment (Protection) Act, 1986
- Hazardous Waste (Management and Handling) Rules, 1989
- Noise Pollution (Regulation and Control) Rules, 2000
- Biological Diversity Act, 2002
- National Environmental Policy, 2006
- National Green Tribunal Act, 2010

Besides, some other specific sector-wise projects like Project Tiger (1973), Project Elephant (1992), Namami Gange (2014), etc. were introduced from time to time depending on the prevailing scenario of qualitative deterioration of the environment. Keeping pace with the global scenario and changing community behaviour, the Indian environmental governance requires some contextual modifications too. The misery of Indian citizens is confronted with poverty, hunger, unemployment, malnutrition, illiteracy, and population explosion. Thus, it demands some special attention on socio-economic issues associated with the livelihood and lifestyle of the commons while looking for environmental policies. Future initiatives must try to keep harmony with that.

4.1 Indian Forest Act, 1878, and Forest Conservation Act, 1980

Initially, the *Indian Forest Act* was enacted during the British era to maintain forest cover, regulate entry to the forest, and protect wildlife. Later on, considering the demand of time and international regulations, this act was modified in 1927. This amendment has empowered the government to create Reserve Forest and restrict the use and access to Reserve Forests for government purposes only. After independence (1947), the need for versatile use of forest resources was felt; therefore, the *Forest Conservation Act* was enacted in 1980. In this new act, the earlier income-generating attitude was shifted to conservation orientation (Mondal, 2020). This has recognised the ancillary right over forest resources. To control further deforestation, the said act was amended in 1988. It was further amended in 1992 to allow some controlled non-forest activities.

4.2 Wildlife Protection Act, 1972

As a response to human greed against wildlife, the *Wildlife Protection Act* was enacted by the Parliament of India in 1972. This act ensures the protection of plants, birds, and animals against hunting, cutting down, unscientific extraction of forest resources, etc. This act was amended several times in 1982, 1986, 1991, 1993, 2002, and 2006. The amendment of 2006 made it punishable to hunt or change the boundary of a sanctuary or national park.

4.3 Water (Prevention and Control of Pollution) Act, 1974

Considering this multidimensional importance of water in the sustenance of life and livelihood of people and maintaining the health of water bodies, *The Water (Prevention and Control of Pollution) Act* was enacted in 1974. This act also considers the assignment of boards and statutory bodies to employ a set of responsibilities and power to prevent and control water pollution. Initially, this act was implemented in the States of Assam, Bihar, Gujarat, Haryana, Himachal Pradesh, Jammu and Kashmir, Karnataka, Kerala, Madhya Pradesh, Rajasthan, Tripura, and West Bengal and all the Union territories. The Central Pollution Control Board (CPCB) and the State Pollution Control Board (SPCB) were set up under the guidelines of this act. Later on, this was amended in 1988 which has made provision for the citizens to lodge complaints in the public interest. This amendment has also made some corporate responsibilities to protect water (Indian National Bar Association, 2018).

4.4 Air (Prevention and Control of Pollution) Act, 1981

The Air (Prevention and Control of Pollution) Act of 1981 was meant to preserve the quality of air by preventing and controlling air pollution from both natural and anthropogenic sources. It also made provision for the constitution of boards or statutory bodies to meet the aforesaid objectives. This act was a real response to the awareness generated by the *United Nations Conference on the Human Environment* held in Stockholm, 1972. This act also empowers state governments to put forward zonation of air pollution and prescribe different types of fuel based on spatial variation of air quality. Technological modification and upgradation were also prescribed under this act. The amendment of 1987 to this act has recognised noise as an air pollutant (Laws India, 2000).

4.5 Environment (Protection) Act, 1986

In response to the recommendations of the United Nations Organisation and to prevent any future occurrence like Bhopal Gas Tragedy, the *Environment (Protection) Act* was enacted in 1986. The goal of this act was to form agencies to monitor the environment and control and prevent any kind of adverse activities that may harm the natural environment. This act has also made provision of improving the natural environment all over the country. This act last amended in 1991 provided an umbrella to all the various acts that deal with the quality and availability of natural resources.

4.6 Hazardous Waste (Management and Handling) Rules, 1989

Solid and liquid wastes are generated from the housings, agricultural fields, factories, hospitals, markets, etc. Scientific disposal and management of this waste are essential to prevent land, air, and water pollution. For the eco-friendly disposal and management of hazardous wastes, the *Hazardous Waste (Management and Handling) Rules* was introduced in 1989 and amended in 2003. This has identified the hazardous wastes and recommended the proper way to handle them. For that purpose, this rule exercise jurisdiction, including other acts that tend to control air, water, and land pollution. This has made it obligatory for the operator of the waste-generating organisation to collect, store, treat, and dispose of hazardous wastes as specified by government authorities, thereby preventing all the potential harm to the human and physical environment.

4.7 Noise Pollution (Regulation and Control) Rules, 2000

To prevent the adverse impact of excessive noise on physical and psychological well-being of human being, under the executed power of the *Environment (Protection) Act* of 1986, the *Noise Pollution (Regulation and Control) Rules* was put forward to regulate the ambient noise level from various sources like construction, industry, generator machines, loudspeakers, public address systems, music systems, vehicular horns, and other mechanical devices in a public place (Central Pollution Control Board, 2000; Laws India, 2000). The ambient noise level for different land-use zones was determined under this rule.

4.8 Biological Diversity Act, 2002

The survival of all living beings on earth is dependent on the existence and preservation of biodiversity. The *Biological Diversity Act* was enacted to regulate access to genetic resources and protect biological diversity along with an opportunity for their sustainable use (National Biodiversity Authority, 2003). This was enacted under the obligation of the *Convention on Biological Diversity*, 1993. The *Biological Diversity Act* empowers the government to constitute statutory bodies for that purpose. This act also made provision of preservation of indigenous knowledge about bio-resources including Intellectual Property Rights (IPRs) as well as sharing of information, developing a knowledge base, promotion of research activities, and provisioning economic benefits to the local communities. In reality, this act was implemented through the constitutionally recognised three-tier government set-up of India. This has empowered local bodies to notify and monitor biologically heritage sites in consultation with the State government.

4.9 National Environmental Policy, 2006

At the beginning of the new century, an urgent need was felt to bring all the environment-related acts under one umbrella and put forward comprehensive policy to conserve critical environmental resources ensuring balanced socio-economic development. Thus, the Ministry of Environment and Forests developed this policy for quality control of environmental resources. The main motto of this policy was to conserve natural resources and provide livelihood security for the poor (India Water Portal, 2010). This policy consisted of seven major objectives that focus on conserving natural resources, intra- and intergenerational equity, balanced development, efficient use of environmental resources, and proper governance environment (Government of India, Ministry of Environment and Forests, 2006). This policy is a true outcome of consultation among different ministries, elected representatives, NGOs, researchers, and civil society (India.gov.in National Portal of India, 2019).

4.10 National Green Tribunal Act, 2010

The *National Green Tribunal Act* was framed to establish a tribunal for dealing with legal activities associated with environmental protection and protection of forests and other natural resources (India Code, 2010). This was a delayed response to the exercise of the Stockholm Conference, 1972 and the Earth Summit of 1992. Under this act, the central government issued notification for the establishment of the National Green Tribunal to exercise the jurisdiction, powers, and authority. This tribunal also aims to reduce judiciary pressure from higher courts and tend to ensure speedy environmental justice under its jurisdiction (National Green Tribunal, 2019).

In India, all the environment-related policies emerged and were modified time to time depending on the then socio-economic context. However, these policies were formulated quite optimistically to restrict all sorts of anthropogenic activities that degrade the natural resources and environment. But, owing to the ever-increasing pressure of the population and prevalence of poverty, good environmental governance remained a sweet dream to achieve. In many cases, the achievement of the documented objectives was hindered by political intervention and the absence of autonomy of the urban and rural local bodies. The surging pressure of basic infrastructure is also adding some hurdles to overcome. The actual involvement of non-state actors is limited to policy guidelines only. As a result, the policies framed so far only become able to reach the goals partially. Local beneficiaries are also made aloof of the initiatives at the ground level. Hence, in most cases, the initiatives failed to acquire consensus. This necessitates a complete reform of the administration and incorporation of non-state actors for planning and project implementation. Keeping these drawbacks in mind, this endeavour idealises the situation and formulates plans of action to develop community involvement and build sustainable communities.

5 Attributes of Good Environmental Governance

In more recent times, ‘good’ governance is credited for its ability to maximise the participation of citizens in the decision-making process. Not merely that, it inculcated transparency, morality, accountability, and responsiveness to the entire system of governance. In the context of environmental governance, the term ‘good’ is applied differently. Where management and preservation of the physical environment are not sufficient at all, qualitative upgradation of human enterprise is also critical to promote balanced development in the Anthropocene. The establishment of good governance is mutually linked to the existence of a democratic political environment. The attributes, key concerns, government responsibilities, and non-government responsibilities in this context are discussed thoroughly (Table 1.1) with the help of earlier initiatives made by Bennett and Satterfield (2018).

The nature of management of individual behaviours and collective actions determines environmental well-being and sociocultural outcomes (Armitage et al., 2012;

Table 1.1 Attribute, key concern, government responsibility, and non-government responsibility for good environmental governance

Attribute	Key concern	Government responsibility	Non-government responsibility
Coordinating factors			
Participation	Participation of all for good and effective governance. Formulate appropriate mechanisms to maximise the participation of stakeholders Presently the rate of participation is very low in India. Local people are kept apart from the decision making process	Pro-citizen initiatives are needed to adopt. The traditional 'command and control' approach should be shifted to a 'cooperative approach' (Harrison, 1998)	Take part in community activities, providing feedback to the government, interact with elected representatives. In rural India Gram Sabha and urban areas, Ward Committees are the interface to raise the demand of citizens. Proper consumer education is required
Cooperation	Bridging the gaps among various actors. Both vertical and horizontal networking is required to minimise social distance and distance among line departments. Cooperation is absent even among the line departments	Listening to the people. Showing a positive attitude towards the subordinates	Building community organisations, interest groups, and voluntary organisations. Cooperating with government officials
Connection	Inter-connectivity among stakeholders both horizontal and vertical. Bridging the gaps and building social solidarity and resilience to support collective movements; Governments mostly relying upon traditional communication channels	Establishment of channels and networks of communication	Smoothing government activities by responding to the communication process. Active communication with neighbouring communities
Dialogue	Effective dialogue makes the room for balanced development Opportunities are limited by political interference	Ascertain proper persons to initiate active dialogues among interest groups	Convey direct ground-level experience about problems, conservation practices, future requirements
Responsiveness	Responsiveness to the community enhances the trust of the society Delay and non-accountability of government bodies	Response to the needs and aspirations of the common people	The non-state organisation should try to mobilise people. Individuals and families must convey their needs properly

(continued)

Table 1.1 (continued)

Attribute	Key concern	Government responsibility	Non-government responsibility
Accountability	Elected representatives, bureaucrats, and governments have to possess accountability to the queries of commons. It facilitates the betterment of the performance of the entire system. Recently governments are trying to increase by use of electronic media	Timely accounting of financial statements, budgetary disclosure, public audit of important activities	Raising questions regularly to the authorities about their claims
Knowledge-enhancing factors			
Capacity	Knowledge and skill are abundant, but their nurturing is needed to build context-specific capacities	Capacity building initiatives, skill enhancement programmes are to be organised frequently	Nurturing with the inherent capacities. Focusing on skill development in a single dimension, so that efficiency can be achieved
Learning	Continuous learning from monitoring, evaluation, and modification of existing mechanisms. Platforms are to be built to share learning outcomes	Learning from the field and dissemination of obtained knowledge	Helps to develop context-specific knowledge. Voluntary participation of individuals and groups are encouraged to enable them to act as a facilitator in different areas
Innovation	A robust framework for innovative thinking, technical innovation, and logistic support. Experiments, examinations, and innovations encourage the recording of success and failure. In long run assisting to raise tolerance levels	Innovative knowledge generation and communication. Provision for research and development	Knowledge generation according to community necessities. Context-specific technology development and ways to protect natural resources
Efficiency	Expertise to be developed to enhance efficiency. Needed to concentrate on sector-wise and class-wise capabilities. Government should focus on harnessing individual potentials	Developing the expertise to take care of pro-poor development and conservation of natural environment protecting the rights of indigenous people	

(continued)

Table 1.1 (continued)

Attribute	Key concern	Government responsibility	Non-government responsibility
Social equity factors			
Information	Non-state participants are commonly considered as the receptor of information. Their role for information generation needs proper recognition. Sharing of information is either absent or very limited with little scope to interact	Citizens are not to be considered passive recipients of information only. Rather, proper information dissemination to mobilise them is needed	Conveying community demands, experiences
Trust	Mutual trust and understanding are obligatory. This leads to sharing of duties, responsibilities, and opportunities	Developing mutual understanding among all the stakeholders	
Justice	Laws and policies are to protect the rights and sentiments of the local people. Pro-poor approaches are necessary to stop the exploitation of nature. Social justice is necessary	Proper identification of beneficiaries, enactment of the law, preserving legal rights. Looking after sensitive areas	Responding to the government orders, supporting them to protect the environment and establishing social justice
Responsibility	Planned initiatives are to be adopted to share responsibilities. Not only the state, rather the non-state actors should limit their activities that could harm nature	Distribute responsibilities among different departments and various stakeholders	Taking up the burden of government and building community resilience to protect the ecosystem

Note: Attributes are modified after Bennett and Satterfield (2018)

Termeer et al., 2010; Bennett & Satterfield, 2018). All the attributes of coordinating, knowledge enhancing, and social equity are intermingled within the superstructure of environmental governance and can be driven by the top of the hierarchy (government) as well as by the bottom (people). However, a shared plan of action and continuous dialogue is crucial to save the environment and communicate the same from local to global. It involves formulation of laws, articulation of community demands, development of institutional mandates, conflict resolution, and policy formulation, thus leading to the indigenisation of governance in the environmental regime. Understanding the factors and dimensions of spatial scales is decisive to the performance and outcomes of environmental governance (North, 1990; Young, 1997; Bennett & Satterfield, 2018).

6 Dimensions of Environmental Governance

Mother Earth and its environment is the creator, holder, and carrier of human civilisation. Still, in the era of rapid technological innovation, man is unable to invent a mechanism to control the environment to the fullest extent. The realisation of the fact that anthropogenic activities are dominantly responsible for alteration and degradation of the natural environment has developed concern about environmental management. But with the passage of time management resembles authoritarian moves towards environment conservation, which appeared to neglect the voice of local dwellers and the rights of indigenous people who are dependent on the natural resource by customary rights. Scholarly practices are continuously dealing with different dimensions of environmental governance. While developing the practical framework for understanding the nature of environmental governance, Bennett and Satterfield (2018) focused on institutional, structural, and process elements of governance involving robust, responsive, equitable, and effective attributes. This takes into account a system of enhanced responsibilities through an interactive structure. Quite alike, complex interaction among government regimes and environmental resources is recognised as key for environmental governance by Paavola (2007). Market economics, land ownership, wildlife policies, and other institutional factors relating to the local physical and social condition are crucial. Armitage, Loe, and Plummer (2012) were concerned about knowledge, scale, adaptiveness to learn, accountability, legitimacy, and actors of society. Simultaneously, balanced participation of civil society, state and non-state stakeholders, is having a significant role to protect the environment, but the present administrative framework of India is not supporting the absolute empowerment of local governments.

Furthermore, the tactic knowledge and expertise of non-state actors open up new dimensions of urban governance (van der Heijden, 2016). The horizontal and vertical dimensions of environmental governance also obtained significant attention in global governance literature. Effective networking of both state and non-state actors is to be introduced. This networking may take place through both formal and informal channels. The formal channels mostly involve vertical linkages among the various hierarchical levels. On the other hand, informal channels involve casual modes of interactions, mostly horizontal among individuals and groups. Horizontal linkages may also take place in the top part of this superstructure (Fig. 1.2). In this context, concrete policies are required for *supply management*, identifying the need of the society; *demand management*, depending on cost-benefit analysis; and *soft path*, identifying psychological characteristics of the society and political nature of democracy (Brandes & Brooks, 2007). The soft path moderates the policy decisions by leaving opportunities to modify global or national regulations depending on local aspirations and practices. Four distinct dimensions of environmental governance are identified by Theys (2002: 224) which are mutually dependent based on the demand of the situation. These dimensions include:

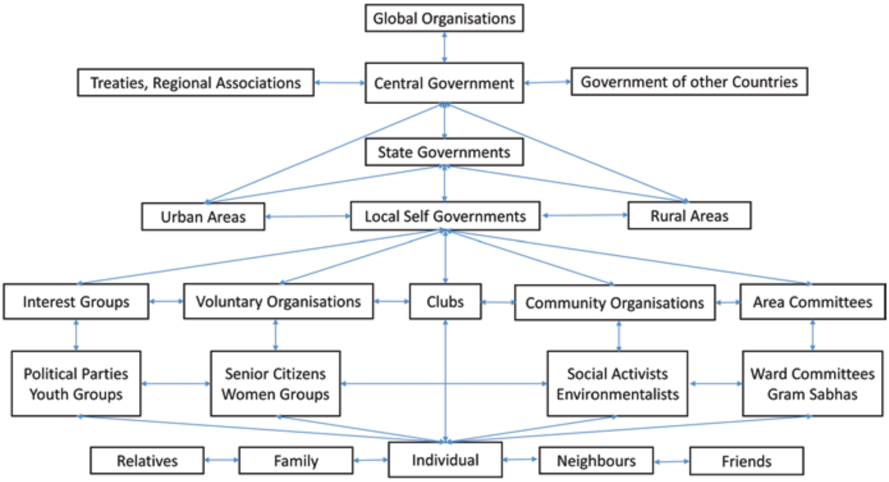

Fig. 1.2 Vertical and horizontal integration of environmental governance (Indian context)

> "modernizing public action and increasing its credibility or legitimacy, developing non-authorian devices for coordinating and regulating collective action, expanding reflexive and procedural rationality, and shifting power."

Based on this discussion and experience of field empiricism, four major facets of environmental governance are identified; those are environmental researchers, state actors (government organisations), non-state actors, and local people. Interdependency of these four dimensions endorsed the formulation of a pro-citizen model of good environmental governance (Fig. 1.3). This model explains that equal involvement of all the four dimensions would not only open up opportunities for individuals to express their needs but also enable the state to implement, evaluate, and modify the planning initiatives from time to time through voluntary engagement. It also unveils opportunities for research and development in new horizons. Environmental governance initiates with the realisation of the need and sentiments of local people. Even so, it is also important to realise the power politics and environmental economy of the area concerned.

Any policy cannot become fully successful unless it addresses the economic challenges of the local dwellers. It would be an overestimation that following the path of this pro-people model (Fig. 1.3) all environment-related problems can be solved, rather it leaves an opportunity to follow new ways to address these issues. However, the connotation 'good environmental governance' sounds very interesting and optimistic but seems very complex and recalcitrant to achieve in reality. While talking with the common people, it was felt that their voice remained unheard in many cases. But, they are the actual sufferer of environmental degradation. The immediate beneficiaries can only address these complexities.

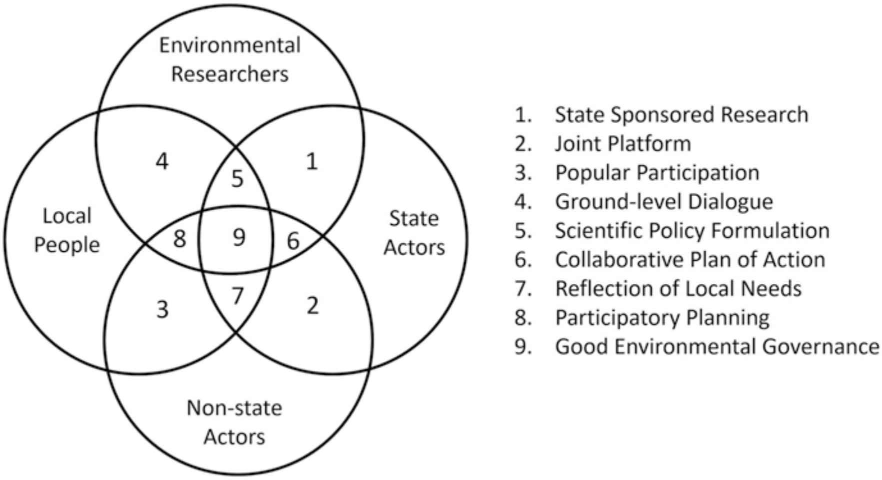

Fig. 1.3 Pro-citizen model of good environmental governance

7 In Search for Proper Plan of Action

Over so many years, the environment has appeared as a '*laboratory*' to test and invent new forms of governance (Theys, 2002: 213; Pellizzoni, 2004). But the result is not impressive for environmental performance and the ability to regain the trust of the society and institutional legitimacy (Pellizzoni, 2004). Presently we are living in a society where globalisation and technological interventions are shaping human life. While the world is becoming more scientific, its scientific tools are destroying the environment alarmingly. Local institutions are becoming obliterated by cosmopolitan values. State authorities are having problems arranging funds to restrict unscientific exploitation and making people educated enough to develop intangible value judgement. Though it is difficult to formulate any universal plan of action to address the varied issues of environmental governance, an attempt can be made to idealise some plans of action (Table 1.2) that are modifiable according to the demand of the situation.

The only identification of probable challenges is not sufficient enough to formulate an acceptable plan of action, rather this also leaves room for the promotion of many strategies involving the different stakeholders. A pro-citizen plan of action requires the identification of demands at the household level considering the diversities of class, caste, religion, and cultural attributes. In many states of India, caste-based discriminations are found in political participation. Sometimes the unprivileged section of the society is kept apart from any community actions, on the contrary, during the election; they are treated as vote banks. This attitude of the political powerhouse gives birth to democratic dualism, where the ground-level government workers get confused. Thus, arises the need for structural reform involving voluntary participation. At the same time, spatio-temporal changes of

Table 1.2 Major challenges of environmental governance and problem-specific plan of action

Challenge	Plan of action
Globalisation	Conservation of indigenous traits of environment. Innovative technologies to reduce, reuse, and recycle. It can foster knowledge gathering and skill enhancement through sharing of information and exemplifying ideal situations from distant areas
Uncertainty	The uncertainty to predict the paths of development, in the long run, creates an asymmetry between short-term and long-term policy interventions. Action researches for short-term and experimental pilot projects for long-term policy interventions are the fittest way out
Capital	Availability of capital for physical infrastructure development, providing compensations, zoning of sensitive areas, demarcating boundaries, employing manpower, technological upgradation is pivotal. Sometimes, incentives are required for increasing participation among the poor
Awareness	Adaptation to the new challenges and context-specific mitigation is required. Awareness cannot be developed overnight even not within a month. Learning through interaction and involvement is necessary. Administrators should arrange campaigns, but development of inherent consciousness must be prioritised
Dependency	Dependency over the environment teaches the people to conserve its trait for long and healthy survival. This dependency mostly arises from the supply of means of livelihood. Indigenous people and ultimate neighbours' right over the environment should be protected legally. Together with, outsiders' access must be restricted, because in most cases, they tend to exploit nature unscientifically and make locality unproductive
Consistency	The planning and decision-making process is often well known for inconsistency in participation and time management. This ultimately mentally detaches the non-state stakeholders from the entire programme. The resulting concentration of decision-making power to the bureaucrats. Such initiatives must be consistent enough to grow interested and maximise the participation of the local community
Power politics	Power politics at the ground level have a crucial role, be it political or class-based society. The beholders of power can motivate as well as can demoralise people to protect the natural environment. Sometimes they exert control over elements of the environment forcefully for economic benefit. A democratic environment up to the lowest level of society is a necessity for the good governance of the environment
Stake and right	Adaptation of cooperative approaches for negotiated rulemaking. This generates the feeling of stakeholders among the commons. Not only that, willingness of government to address all stakeholders including business, corporates, individuals, local groups, persons having specialised skills, etc. Voluntary involvement of experts and retired persons. The right of the beneficiaries is to be protected legally

Note: Challenges are modified after Underdal (2010)

locally available resources can serve as an important indicator to gauge the level of environment governance required. For example, water resource mapping is crucial for cultivation for household purposes in rural areas. Similarly, in urban areas, community participation is essential for green and open space governance. In all these cases, participatory mapping could be helpful. Externally, GIS mapping could be done by professional experts and local capacity building programmes. Here the application of different modes of e-technologies could be handy. For example, two

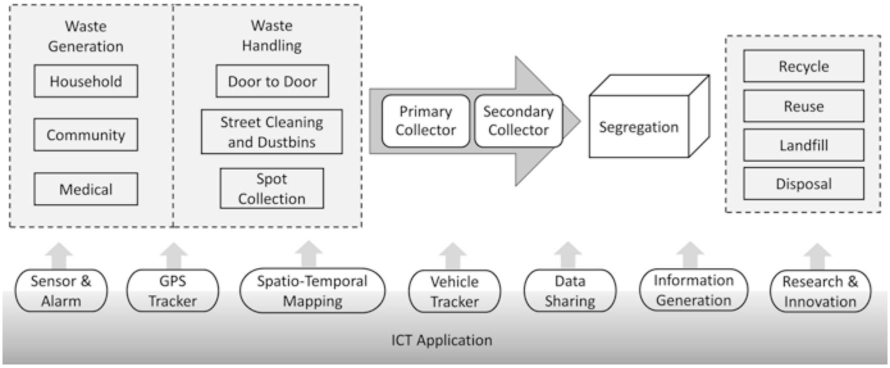

Fig. 1.4 Incorporation of e-technologies in an urban solid waste management system

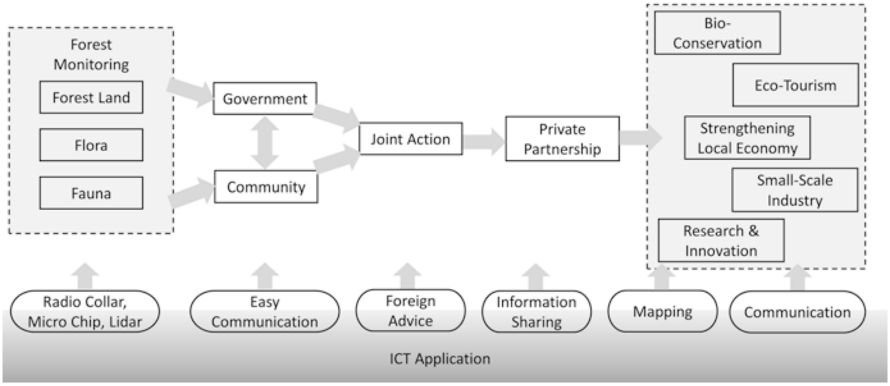

Fig. 1.5 Incorporation of e-technologies in a forest management system

different cases are presented here to show how virtual media can help the local administration in the management of household waste (Fig. 1.4) and forest resources (Fig. 1.5). Here, different technological applications are incorporated with the traditional system of management. In the case of waste and forest management, Information and Communication Technologies (ICTs) can accelerate the pace and inculcate transparency. These applications are a little costly for initial installation, but maintenance is not so difficult and most importantly can create job opportunities for local youth through initial capacity building initiatives. At the same time, the entire operation of the system can be monitored by the local community using some designated website or applications. It also facilitates complaint lodging service thus increasing the system accountability.

Whenever any area or region is considered for adoption of an environmental improvement plan, several stages are to be followed (Fig. 1.6). Here the role of old documents, population-related information, geological maps, and multi-temporal satellite imageries play an important role for zoning and criticality analysis. Proper training of youth for skilled and semi-skilled works is a precursor to assure

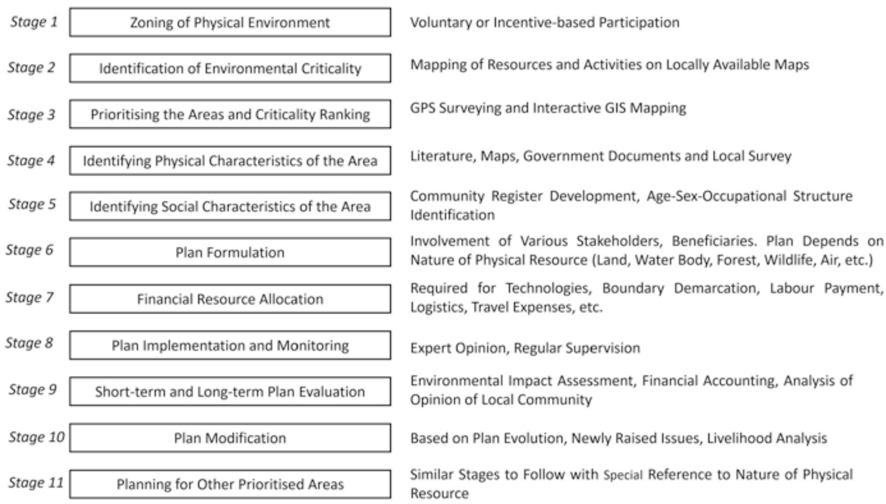

Fig. 1.6 Ideal stages for the development of environment improvement plan

enthusiastic participation of the local people. Youth should be trained properly to operate machinery, GPS equipment, GIS and statistical software, and online applications and keep a record of the database, etc. This not only protects the environment at once but also opens up new job opportunities for the next generation. Therefore, while looking for a sustainable environment, the process of sustainable community building is also fortified.

8 In Conclusion: The Way Forward

The analysis of this research highlighted the need for enhanced attention to the understanding and reforming of the myriad systems of environmental governance in the prevailing federal structure of India. The unstructured interviews conducted during this study reveal that the local youth and the grassroot-level administration play an important role to educate the community and mobilise the locally available resources. In India, community participation in conserving greens, water bodies, economically important resources, maintaining air quality, reducing pollutants, etc., is marginalised in the true sense. Because in a federal framework, implementation of national-level plans is handicapped by resistance from state machinery and poor capacity of local governments.

The framework presented in this analysis offers improved comprehension of environmental governance in a dynamic socio-economic-political-ecological milieu. This study raises a strong demand to create statutory bodies that can operate independently and take decisions involving different stakeholders. These legally recognised bodies should act as the custodian of the environment. Indian constitution has promoted devolution of power through Gram Panchayats and Urban Local

Bodies, but these institutes are neither financially nor politically powerful enough to govern the local environment independently. Sharing of responsibilities among state and non-state actors under the guidelines of UN Organisations and bilateral and multilateral treaties should be helpful to bridge the socio-economic gaps. This would accelerate the opportunities to form a platform for joint action to ensure community mobilisation through collective involvement. The deepening of democratic representation is decisive in such a context.

This research argues that the distribution of responsibilities is absent in many instances. Joint action-based activities are best fitted for resource mapping, temporal change detection, necessity identification, economic benefit analysis, threat detection, and impact assessment involving the people having immediate contact with nature. This will also create diversified employment opportunities for the local youth through capacity building in mapping, management, promotion, and protection of locally available resources. Academic linkages like university-community tie-ups are already having important success stories in both urban and rural areas. Formation and nurturing of networks for information acquisition from the grassroot level, not a policy imposition from upper tiers of administration, is the foremost priority. Hence, an adoption of small-area-based hybrid approaches and integration of them into larger ones following the hierarchies of space appear to be effective for long-term environmental governance. In such efforts, non-state actors must have a direct stake in policymaking; not only as recipients of information, rather their active role in regulation and implementation is anticipated (Lemos & Agrawal, 2006; Underdal, 2010). The planning machinery of the national government should act accordingly. Therefore, structural modification of the administration is required.

This study also draws attention to utilise electronic media and mass media for awareness generation. Mobile app and portal-based communicative channels can be developed for gathering, verification, validation, and dissemination of information. It would help to obliterate middlemen, and people can establish one-to-one and one-to-many communication with peers, administrators, and elected representatives. GPS-based mobile phones and web-GIS platforms are handy in such cases. Local people can easily capture data and upload geotagged information on web servers, thus, higher-level officials can gather information consistently. These practices are effective for the daily monitoring of solid wastes in urban areas. But how far the present framework supports this upgradation? These practices are almost absent, presently. The government must make efforts to involve private partners. What already has worked in developed economies may not work here, but local leaders must make efforts to modify them depending on the ground-level scenario.

With the reform agenda put forward here, the traditional 'cowboy economics' of natural resources should be eliminated. This means that a wealthier person keeps on investing capital to exert control over resources regardless of the necessities of others and limitations of availability. Although the concept of the cowboy was initiated in the mining camps of the American west, this idea was introduced in the field of natural resources by Shiva (2002: 22) in the context of water resources. Hence, the need-based approaches of natural environment conservation vis-à-vis environmental governance are appropriate for practising good governance. Certainly, the global context of environmental governance pursues attention towards decentralised governance and pluralistic strategies (Underdal, 2010) to adopt policies for improved partnership and develop sustainable community resilience. In India, a shortage of financial resources is the prime constrain for sustainable policy adaptation. Still, indigenous area-based perspectives are to be more acceptable and economically gainful for robust environmental governance.

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Chapter 2
The Role of Local Governments in Encouraging Participation in Reforestation Activities

Seda H. Bostancı

Abstract Among the critical issues for a sustainable future are anthropogenic climate change and its consequences. Sustainable development goal (SDG 2030) 13 is climate action, and some of the other goals are also related to this area. The most important consequences of climate change are the danger of biodiversity decrease, drought, and water security. Reforestation is an important tool in tackling these problems. This tool can be achieved through central and local government strategies that will mobilize citizen participation and voluntary participation. So the aim of the study is to discuss the role of local governments in public participation in reforestation activities. In this study, reforestation activities will be examined based on SDG15. The role of local governments and the effects of local participation in these activities will be discussed. In this study, which basically includes a literature review, some numerical indicators will also be used.

Keywords Sustainability · 2030 SDG · Reforestation · Local governments · Public participation

1 Introduction

During the Earth's long geological period, there are eight phases which can be defined as environmental crises. Among these phases, the last one is the Anthropocene era which causes by human influence and conclude to global warming and environmental crisis (Bjornerud, 2018). With the industrial revolution, human activities started a period of which the most rapid effects were felt among the environmental crises experienced by the world. In this Anthropocene era, which is expressed as the human age, there have been effects such as deforestation, rapid depletion of fossil fuels, and decrease in biodiversity with land use changes (Crutzen, 2006). These

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effects are also the main reason for the increase of greenhouse gas emissions. The demand by people for natural resources and agricultural and forest products results in overuse of the environment which in turn disturbs the ecological balance of the planet (Ulucak et al., 2021). Countries around the world carry out reforestation activities, but the ancient past of forests is critical for a sustainable future. The oldest trees release the most carbon because they have absorbed the most over time (Tremmel & Robinson, 2014). According to IPCC 2019 data, approximately 12 percent of total greenhouse gas emissions are caused by the combined effects of deforestation (Chomsky et al., 2020). In 2020, 31.1% of the world's continents consists of forest areas. However, this statistical information includes reforestation activities, and the data on ancient forest destruction should not be overlooked. Afforestation makes an important contribution to more rain in cities and to make agricultural lands productive. Reforestation is an ecosystem integration process that is completed not only by planting trees but also by arranging the habitats of animals and carrying them to these forest areas (Reyer et al., 2009; Numata et al., 2010; Jaramillo-López et al., 2015). At the same time, the transportation of animals to reforested areas provides a great advantage for biodiversity and sustainability of the earth ecosystem. So the issue is the restoration of biodiversity.

Sustainable future of the world is possible by reducing fossil fuel consumption as well as protecting forest areas and increasing afforestation activities. For this reason, great importance is given to afforestation and forest management issues in the sustainability literature. Established on a voluntary basis in 1990, Forest Europe was established with the support of 46 countries and developed an SFM (sustainable forest management) strategy (Edwards & Kleinschmit, 2013). In 1990, this voluntary organization held its first conference, The Ministerial Conference on the Protection of Forests in Europe (MCPFE). In 1993, the Helsinki Process hosted this conference (Parviainen & Frank, 2003; Rametsteiner & Mayer, 2004). The Global Legislators Organization for a Balanced Environment proposed at the Rio Conference in 1992 a legally binding international mechanism specifically targeted at regulating forests. The National Forest Vision and Local Agenda 21 are the international implementation tools of the 1992 Rio Summit, where sustainable development tools, determined as the main goal of the twenty-first century, were put forward. The national forest system becomes applicable as governments develop participation and stakeholder systems (Bell & Evans, 1998). For this, central governments need to cooperate with local governments. The EU forest strategy was developed in 1998, and after this, the FAP (Forest Action Plan) was held in 2005. The Green Paper on Forest Protection on Information Europe was launched in 2010, where these two approaches were discussed together (Edwards & Kleinschmit, 2013). In 2000, the first sustainable development goals, the Millennium Development Goals, were developed (International Institute for Sustainable Development (IISD)). The seventh of the millennium development goals, which was put forward by the UN in 2000, "ensure environmental sustainability," also includes approaches on forests. In the United Nations Sustainable Development Summit held on 25

September 2015, 17 sustainable development goals have been determined, and nations are trying to achieve these goals until 2030. Among these targets, SDG 17 life on land has a content largely dependent on the protection of forest areas. So the reforestation issue fundamentally linked to SDG 15 "life on land". Along with these, the EU has also launched the New Forest Strategy for 2030. The building blocks of this process are 2019 publication of the European Green Deal, 2020 publication of the EU biodiversity strategy for 2030, and 2012 publication of the new EU forest strategy for 2030 (New EU Forest Strategy for 2030). All these international decisions contribute to the development and funding for forest protection strategies around the world.

The protection of forests and ecological balance is also a matter of justice. In general, this issue can be expressed as ecological justice (Bostancı, 2021a). (Baxter (2004) advocated ecological justice by stating that nonhuman species also have a right to the earth's resources (Baxter, 2004). From this point of view, it is different from human-centered sustainability approaches. Today, wildlife is also looking for ways to survive in cities (Johnston, 2008). However, the important thing is to find strategies to give them back the lands lost by wildlife through reforestation activities. This area creates a conflict in the understanding of sustainable development. Because there is a philosophy that people can narrow their life moments and approach, the process of shrinking in their living habits is called degrowth (Kallis, 2018). In this aspect of the work, there is a link between ecological justice and environmental justice discourse, which includes the approach of equitable protection of the environment for more human life and sustainable future (Bostancı, 2021a). Among the environmental justice disputes, issues such as mineral and building material extraction, forest, soil, agriculture, and livestock disputes, biodiversity are also directly related to the protection and reforestation of forests worldwide (Environmental Justice Atlas). The Environmental Justice Atlas shows how global corporations are causing environmental conflicts by their investigations on polluting industries and mining activities in various countries around the world. This issue and the environmental problems created by the industrial activities that developed Europe in the past are also discussed as the ecological debt of the developed countries to the developing countries (Laurent, 2011). In this context, NGOs and environmental activists are also taking action. This pursuit of environmental justice and the idea of acting on behalf of the world future with environmental awareness that reaches beyond borders are related to the concept of ecological citizenship as defined by Dobson (Dobson, 2003; Bostancı & Yıldırım, 2019).

This research, which discusses the concept of reforestation in the context of international environmental organizations, local governments, and public participation, consists of two main contents that examine the numerical data of the continents about forests and the examples of reforestation in the world. In the study based on the literature review, numerical indicators also created data for evaluation purposes. The policy content on the local government systems of the countries has been left out of the scope of this study because it has a very wide context.

2 General Conditions of the Forest Areas Around the World

Globally, the problems that threaten the worlds human's future, air quality, climate change, clean water resources, and food security depend on the protection of forest areas. While forest areas are decreasing due to economic reasons in developing countries, global warming and carelessness cause large forest fires. Conservation of biodiversity and the health of people are closely linked to the ability of all countries of the world to protect forest areas as much as possible. In this section, numerical information about the amount of forests in the world and the conditions of forests in general will be given.

When the World Development Indicators are examined, the Middle East and North Africa gain 16.4% forest area, South Asia gains 5.7% forest area, Europe and Central Asia gain 2.3% forest area, East Asia and Pacific gain 2.1% forest area, and North America gains 1.0% forest area between 1990 and 2015. But Latin America and Caribbean lose 9.5% forest area, and sub-Saharan Africa loses 11.9% forest area between 1990 and 2015 (World Development Indicators). When this percentage information is shown as change in thousands of km^2, forest loss is seen as 830 km^2 in sub-Saharan Africa and 970 km^2 in Latin America and Caribbean. However, in the same period, a total of 510 km^2 of forest was gained in other continents and regions. From this point of view, it is seen how dramatic the forest loss is worldwide. It also indicates the need to develop urgent reforestation activities for sub-Saharan Africa and Latin America and Caribbean Regions.

In order to enrich this strategic assessment, tables and diagrams related to the continents were created by examining the Global Forest Resources Assessment data from the Food and Agriculture Organization (FAO) of the United Nations data report in order to see the changes related to the continents based on time periods. Thus, change data on forests in Africa, Asia, Europe, North and Central America, Oceania, and South America 1999–2020 periods were compiled. The subjects of these tables are; forest area (% of land area); total carbon stock (Gt); naturally regenerating forest (million ha); planted forest (million ha); of which plantation forest (million ha) (FAO). The main goal of FOA is to improve nutritional conditions and eliminate hunger. Founded in 1945 in Quebec-Canada with the participation of 42 countries (FAO), it became a part of UN in 1946. Food and agricultural productivity depends on the effective fight against climate change and the protection of forest areas. FAO provides important data for academic studies to a wide range of forests with its important database (Keenan et al., 2015; Kindermann et al., 2008). In this section, thematic tables related to the continents will be created from FAO information and interpreted. Table 2.1 lists some world forest statistic area with the information from 236 countries and territories.

Table 2.1 shows that from 1990 to 2020, 177 million hectares of forest areas were destroyed worldwide. The dramatic result of the effects of industrialization and urbanization on forests, especially in the world, in 30 years can be seen with this data. This data shows that there is 1.4% forest loss worldwide. Considering the scarcity and the total hectare, it is seen that the distribution is not balanced. Gt

Table 2.1 Some world forest statistic area with the information from 236 countries and territories

	1990	2000	2010	2020
Forest area (million ha)	4236	4157	4106	4059
Forest area (% of land area)	32.5%	31.9%	31.5%	31.1%
Total carbon stock (Gt)	668	663	663	662
Naturally regenerating forest (million ha)	4039	3919	3815	3737
Planted forest (million ha)	170	211	262	293

Source: Created by the author with https://fra-data.fao.org/WO/fra2020/home/ data (FAO)

Table 2.2 Forest area (million ha) (data availability 100%)

	1990	2000	2010	2020
Africa	743	710	676	673
Asia	585	587	611	623
Europe	994	1002	1014	1017
North and Central America	755	752	754	753
Oceania	185	183	181	185
South America	974	923	870	844

Source: Created by the author with https://fra-data.fao.org/NA/fra2020/home/ data (FAO)

(Grade Carbon Pro frame) of total carbon stock from forest areas seems stable with 6 Gt loss. The world in 30 years lost 302 million ha naturally regenerating forest. In the world tradition, there is a planted forest area next to the natural forest areas. These areas are part of human intervention into forest areas. The planted forest area has increased to 123 million hectares worldwide. There are risks of constructing various facilities in the zoning laws of various countries regarding these areas. Then, tables and figures were created with information about the continents of the world with FAO data. Table 2.2 is about forest area (million ha).

When Table 2.2 and Fig. 2.1 are examined together, it is seen that there is a remarkable decrease in forest areas in Africa and South America in 1990–2020 period. This data is also compatible with the World Development Indicators and draws attention to a significant forest loss for the world. It is seen that forest areas have increased in Asia and Europe. In North and Central America and Oceania, the forest areas seem to have remained almost constant. Table 2.3 gives the percentage values of the forest areas covered by continents.

When Table 2.3 and Fig. 2.2 are examined, it is seen that the continent with the least part of the forest area is Asia. But Asia increases the amount of forest. With this aspect, it was decided to deal with the reforestation activities in China in the case study within the scope of the study. While Africa and Oceania have close percentages, it is seen that forest areas in Africa are decreasing. With this aspect, it was decided to make a study on the Great Green Wall of Africa within the scope of the study. Table 2.4 gives the total carbon stock information in Gt.

Forest areas are the main source to protect the world's air quality. For this reason, the future of forests has a common destiny for the healthy future of the humans. From this aspect, Table 2.4 and Fig. 2.3 total carbon stock (Gt) show that Europe is

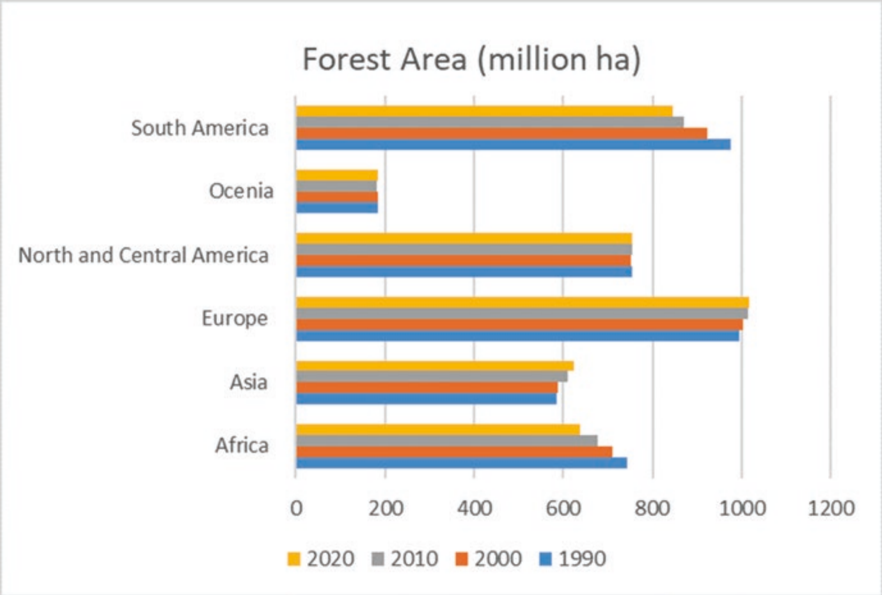

Fig. 2.1 Comparison of forest area

Table 2.3 Forest area (% of land area) (data availability 100%)

	1990	2000	2010	2020
Africa	24.9	23.8	22.6	21.3
Asia	18.8	18.9	19.7	20.0
Europe	44.9	45.3	45.8	46.0
North and Central America	35.4	35.3	35.4	35.3
Oceania	21.8	21.6	21.3	21.8
South America	55.8	52.8	49.8	48.3

Source: Created by the author with https://fra-data.fao.org/NA/fra2020/home/ data (FAO)

the densest continent. This value, which remains constant in Oceania, decreases in Africa and South America. Table 2.5 presents the naturally regenerating forest area information.

When Table 2.5 and Fig. 2.4 are examined, it is seen that there is a worldwide decrease in terms of naturally regenerating forest areas. While Europe and Oceania generally remain constant at this value, the greatest decrease was seen in South America with 143 million ha and Africa with 109 million ha in 30 years, and 24 million ha in Asia. There is a decrease of 26 million ha in North and Central America. Table 2.6 includes planted forest area information.

Table 2.6 shows an overall increase in planted forest area on each continent. There is conflict in the interpretation of this data. First of all, this data means a human intervention in forest areas. In this respect, planted forest areas differ according to the countries in which they are decided for functions. At the same time, this

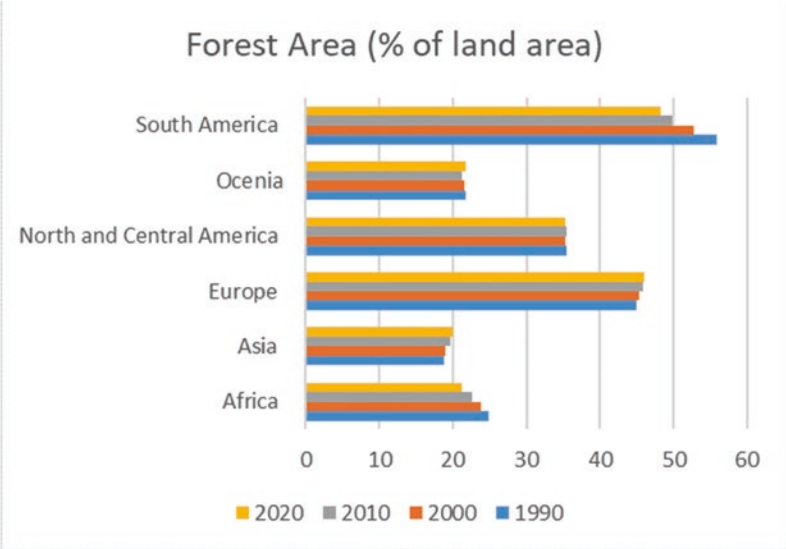

Fig. 2.2 Comparison of forest area (% of land area)

Table 2.4 Total carbon stock (Gt) (data availability 100%)

	1990	2000	2010	2020
Africa	94	90	86	81
Asia	77	79	82	85
Europe	159	162	168	172
North and Central America	143	144	146	146
Oceania	33	33	33	33
South America	162	155	148	145

Source: Created by the author with https://fra-data.fao.org/NA/fra2020/home/ data (FAO)

data shows human activities related to forest areas. From this point of view, this data can be interpreted in the context of people making a worldwide effort to increase forest areas. In this respect, Asia is seen as the continent that has increased its planted forest area in 30 years at most, with an area of 61 million hectares.

While all these tables and figures draw attention to the general decrease in natural forest areas and also show that there are critical problems in Africa and South America, Figs. 2.1, 2.2, 2.3, and 2.4 draw more attention to the differences between continents in the data in general. At the same time, activities to increase forests in Asia, which experienced forest loss in the 1990s with the effect of industrialization, also draw attention in these numerical indicators. In light of these data, first of all, how the world has developed strategies to regain forest areas in the 2030 SDG targets around the world is discussed than how this is reflected in the policies of governments and local governments will be presented. The numerical data of the study presented a data on the importance of sustainable forest management and protection

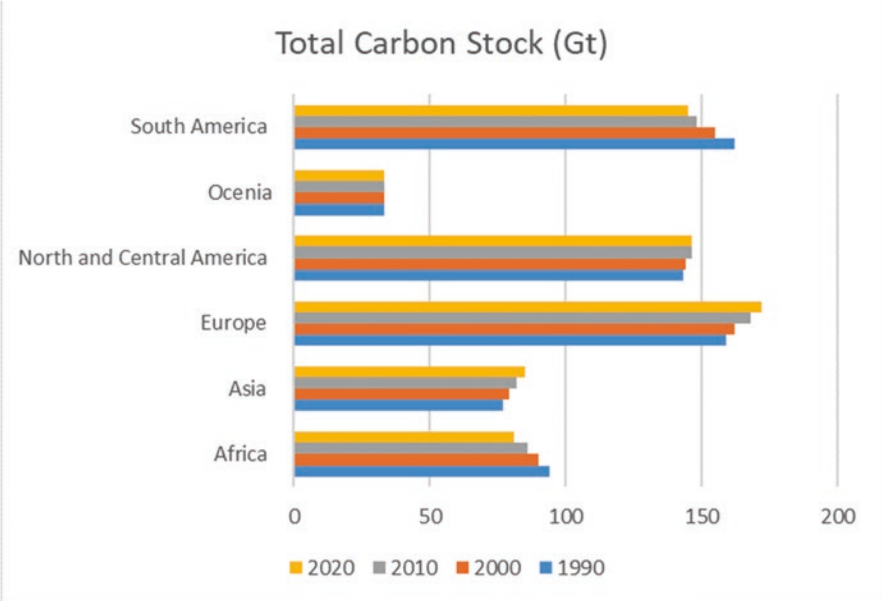

Fig. 2.3 Comparison of total carbon stock (Gt)

Table 2.5 Naturally regenerating forest (million ha) (data availability 100%)

	1990	2000	2010	2020
Africa	734	701	665	625
Asia	511	493	491	487
Europe	913	913	914	915
North and Central America	732	720	714	706
Oceania	182	179	176	180
South America	967	913	855	824

Source: Created by the author with https://fra-data.fao.org/NA/fra2020/home/ data (FAO)

of forests for the people of the world. With this approach, it focuses on reforestation activities in China and the Great Green Wall of Africa project in order to draw attention to good practices in reforestation activities.

3 SDG 2030, Climate Change, and Forest Fires

The idea of sustainable forest management (SFM) was founded in 1975 during Helsinki process (Siry et al., 2005). Forest Europe founded in 1990 had strategies for SFM. The targets of sustainable forest management are the importance of forest resources; biodiversity; forest vitality and health; developing the forest resources;

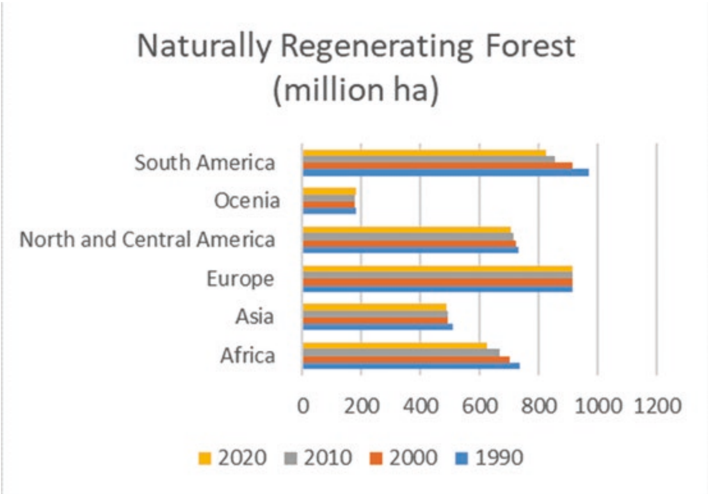

Fig. 2.4 Comparison of naturally regenerating forest

Table 2.6 Planted forest (million ha) (data availability 100%)

	1990	2000	2010	2020
Africa	8.5	8.9	10.6	11.4
Asia	74	94	120	135
Europe	54	62	72	74
North and Central America	23	33	41	47
Oceania	2.8	3,8	4.5	4.8
South America	7.0	9,4	14.9	20.2

Source: Created by the author with https://fra-data.fao.org/NA/fra2020/home/ data (FAO)

protective functions of forest resources; economic and social functions of forests; and political, legal and organizational framework for forests (Von Gadow et al., 2001). The issue of rainforest protection was discussed at the Toronto summit in 1988 (Andersen, 2020). As a continuation of this approach, the forest certification system was established in the 1990s to support sustainable forest management (Rametsteiner & Simula, 2003). 1992 UN Conference on Environment and Development Rio, 2000 millennium development goals, and international resolutions on the protection of forests have become more diversified by the 2030 SDG.

If SDG 2030, resolutions are not sufficiently implemented worldwide; today, world societies will fail in the fight against climate change, the effects of which are more common in natural disasters. This failure shows that today's habitual life will become more difficult for humans and other species in the coming years. This process will lead to an increase in major disasters such as the 2019–2020 Australian wildfires. Another dimension of such disasters is the issue of climate refuges (Bostancı & Yıldırım, 2021). Some parts of the Asian region, the Caribbean, the Pacific Islander, Africa, and Central America are experiencing climate change problems intensely. This process also causes climate refugees debates about those who migrate from these regions (International Organization for Migration (IOM), 2020).

The aim of SDG 15 is sustainable forest management; combat desertification; restore, promote, and protect sustainable use of terrestrial ecosystems; and increase and reverse land degradation and increase biodiversity loss. These are the targets of SDG 15 “life on land” in SDG 2030.

- Conserve and restore terrestrial and freshwater ecosystems.
- Restore degraded land and end desertification.
- End deforestation and restore degraded forests.
- Protect mountain ecosystems.
- Promote access to genetic resources and fair sharing of the benefits.
- Prevent invasive alien species on land and in water ecosystems.
- Protect natural habitats and biodiversity.
- Eliminate poaching and trafficking of protected species.
- Finance and incentivize SFM.
- Integrate ecosystem and biodiversity in governmental planning.
- Increase financial resources to conserve and sustainably use ecosystem and biodiversity.
- Combat global trafficking and poaching (The Global Goals for Sustainable Development).

Rainforests in the world are the main determinants in the fight against water cycle and biodiversity and drought problems. In this area, the problems of the world countries regarding the reduction of forest areas create a need for partner solutions. From this point of view, SFM dynamics are at the heart of the success of SDG 15 targets.

Sustainable development has become more strategic than ever for governments. With this aspect, cooperation with local governments, which develop participatory mechanisms with Local Agenda 21 targets, is of great importance in order for governments to implement international decisions (Yıldırım et al., 2017). The 2030 Agenda for Sustainable Development brings so many responsibilities to local and regional governments. UCLG (United Cities and Local Governments) is the largest local government network and source of finance (UCLG, 2007). ICLEI is one of the leading regional and local government foundations for sustainable development, working on sustainability and carrying out conferences and reports in this area.

Forest fires are a problem area that comes to the fore in terms of threats to living things, drought, and water security around the world. There are critical links between global climate change and forest fires. First of all, climate change is the cause of forest fires. However, the loss of forest areas also accelerates global climate change. The increase and change in the fire regime are one of the most important threats for a sustainable future (Flannigan et al., 2000). In order to be able to evaluate the increase in these fires today, information on the forest areas affected by fire in 2000 and 2017 of various countries from Europe, Asia, Africa, South America, and North America is given in Table 2.7.

Table 2.7 Land area affected by fire of which on forest: 2000–2017 some selected countries (km^2)

	2000 (km^2)	2017 (km^2)
Finland	2.70	4.70
Germany	5.80	3.90
Italy	582.30	1135.70
Russian Federation	13286.00	32821.00
United States of America	29921.50	40575.60
Canada	6653.30	3178.30
Argentina	9440.00	5510.00
Brazil	39299.00	296093.60
Nigeria	420.00	50.00
China	901.20	245.00
India	29200.00	37310.00

Source: Created by the author with https://fra-data.fao.org/WO/fra2020/areaAffectedByFire/ data (Global Forest Resources Assessment)

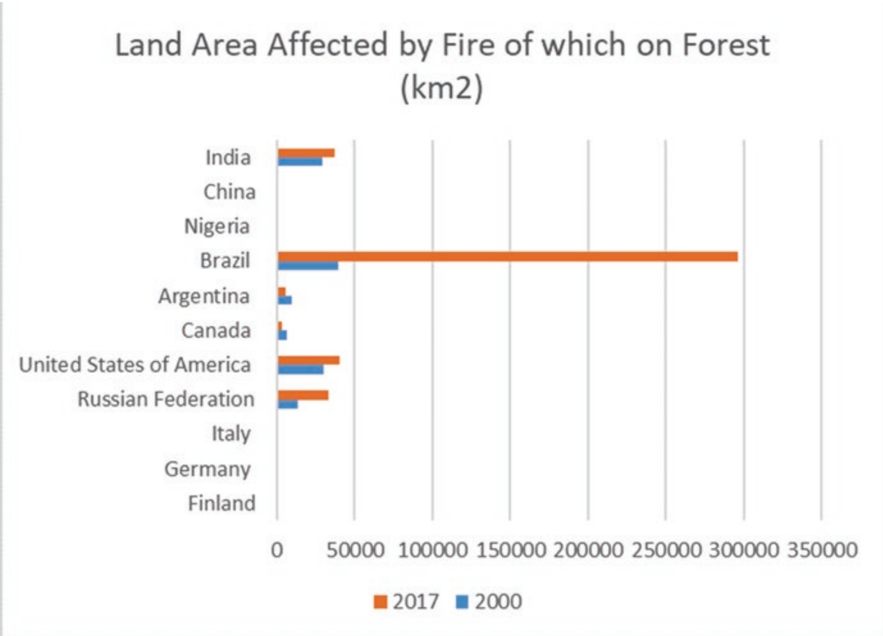

Fig. 2.5 Comparison of naturally regenerating forest

When Table 2.7 is examined together with Fig. 2.5, the size of the forest area affected by the fire in Brazil in 2017 can be seen quite strikingly. But the current data for Brazil and the Amazons are more worrying. “The Amazon is a vital carbon store that slows down the pace of global warming. A total of 11,088 sq km (4,281 sq miles) of rainforest were destroyed from August 2019 to July 2020. This is a 9.5% increase from the previous year" (Brazil's Amazon). It is seen that Italy, which is included in the table among European countries, is more affected by forest fires than Germany and Finland. The fact that the areas of the countries included in the comparison are quite different affects Fig. 2.5, but it is seen that some countries lost less forest area in 2017, such as China. This is also related to mitigation strategies. After examining forest fires, it would be appropriate to examine the information by country on how these areas are compensated by countries. With this approach, the reforestation area information of these countries was created on the basis of FAO data. Although the evaluation systems of the two data are different, the two can be interpreted together for various results. Table 2.8 gives information about the reforestation areas of the selected countries between 2010–2015 and 2015–2020.

When Table 2.8 and Fig. 2.6 are examined together, it is seen that the country that carries out the most extensive reforestation activities is the Russian Federation, followed by the United States of America. However, considering how wide and protected the forest areas are in Europe, it is seen that Finland and Germany attach importance to this area when considering the opening of new areas and country areas. For Brazil, which draws attention in Fig. 2.5, it is seen that it needs to create more reforestation areas, and as stated in the news, more sensitivity should be shown in this area in the country's policies. Despite the population density, China attaches importance to reforestation activities. However, there was no data on reformation for India.

This information shows that the importance given to the protection of forest areas in different countries in the world is quite different from each other. The most notable distinction is generally the Global North and the Global South. This is also the distinction between developing and developed countries. In this research, which

Table 2.8 Some selected countries reforestation areas (1000 ha/year) between 2010–2015 and 2015–2020

	2010–2015	2015–2020
Finland	122.44	122.44
Germany	48.00	48.00
Italy	5.70	
Russian Federation	848.10	944.80
United States of America	656.04	690.87
Canada	396.12	427.16
Argentina	6.0	16.63
Brazil	521.93	257.13
Nigeria	16.33	16.33
China	305.37	272.74
India		

Source: Created by the author with https://fra-data.fao.org/WO/fra2020/annualReforestation/ data (Global Forest Resources Assessment, Reforestation)

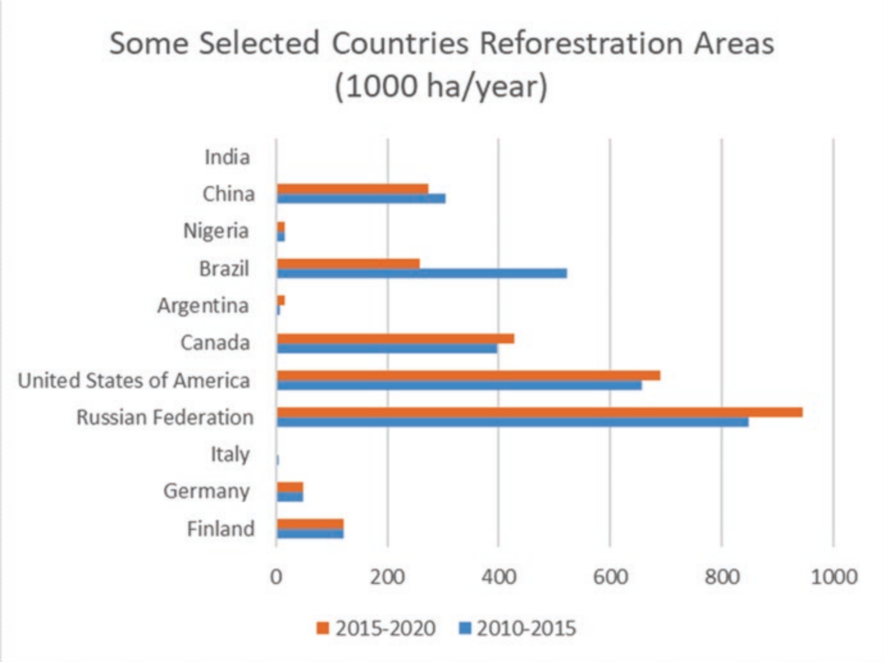

Fig. 2.6 Comparison of some selected countries reforestation areas

generally tries to evaluate the public management strategies of countries regarding forest areas around the world, numerical indicators have been guiding. These data show that there is a great need for financial support for international reformation activities for Africa and South America.

4 Local Government Role in Forest Areas and Reforestation

As explained in the Introduction, many strategies and action plans regarding forests have been developed in international sustainable development conferences and conventions. Today, more institutions are giving grants and support in reforestation activities. In the 1990s, developing countries had to take on more debt for their reforestation activities. The effective contribution of local people to reforestation activities in developing countries depends on the financial support they can get from this process. For example, the Philippine government big borrowed from the Overseas Economic Cooperation Fund and Asian Development Bank for reforestation activities in 1988–1992. In this process, the government paid citizens for planting trees on public lands (Pasicolan et al., 1997). The role of local governments in forest protection and reforestation activities is closely related to both the approach of governments to local governments and the funds and supports to be given in these areas. NGOs also funded local governments in the forestry sector (Cook et al., 2017). From this point of view, while Africa and South America, which draw attention in the numerical data of the study, have large forest areas of the world in terms of their geological structures, they have turned into continents where forest loss is most common today. International funds and projects to be created for the purpose of reforestation for these scars are of great importance both for the sustainable future of the world and for preventing climate migrations that will quickly exceed the thresholds that can be planned. The Green Climate Fund (GCF), established in 2010, provides support in this area (Cui & Huang, 2018). Reducing Emission from Deforestation and Forest Degradation REDD+ is a framework established by the Conference of the Parties (COP). REDD+, which is also an action of the Paris Agreement, has 31 national action plans (What is REDD). In addition to these, FAO, whose data were shared in the previous sections, provides both documentation and support in the field of forest protection. Other important support institutions in this field are the United Nations Development Program (UNDP) and UNEP, the Forest Carbon Partnership Facility, and the Forest Investment Program of the World Bank (FAO and UNEP, 2020). Global Forest Watch is also a web application which is for monitoring global forests in near real time (Global Forest Watch). FAO has an important program as United Nations Decade on Ecosystem Restoration 2021–2030 (UN Decade on Ecosystem Restoration).

The inclusion of forestry in international agreements is an important strategy for climate-friendly land use. The International Panel on Climate Change (IPCC) is the main authority in the field of climate change. Forestation and reforestation are among the main tools of combating climate change (Thomas et al., 2010). LULUCF (land-use change and forestry) is one of the main subjects of the Intergovernmental Panel on Climate Change (IPCC). “The complexities inherent in land use, land-use change and forestry (LULUCF) activities have led to contentious and prolonged debates about the merits of their inclusion in the 2008–2012 first commitment period of the Kyoto Protocol” (Schlamadinger et al., 2007). “The Kyoto Protocol has three mechanisms—Clean Development Mechanism (CDM), Joint Implementation (JI) and Emission Trading (ET)” (Lim & Lam, 2014). Clean Development Mechanism (CDM), which is applied in both developed and developing countries, provides significant gains to developing countries as it includes technology transfer. This process can be beneficial in providing finance for local governments of developing countries to work in the ecological issues.

When the literature on the role of local governments in reforestation activities in developing countries is examined, there are generally evaluations that local governments cannot contribute enough to these activities due to budget constraints (Yu & Wang, 2013). However, especially the participation of citizens in these activities provides very important contributions to the improvement of their agricultural activities and tourism-increasing effects in their living spaces. This process creates an accelerating effect for local development. In various countries of the world, forest areas are destroyed and agriculture is carried out in these areas. Wildlife areas are thus disappearing and species that are in danger of extinction are also affected by this process. “Drivers of deforestation in Indonesia vary from agricultural expansion, logging and operations like mining, and infrastructure expansion" (Deforestation in Indonesia). Marliana and Rühe drew attention to the fact that the natural forest areas in Dieng Maintains (Java, Indonesia) were destroyed by agricultural use, and the local authority could not show sufficient effectiveness in the protection of forest areas (Marliana & Rühe, 2014). As a result of their studies, the importance of the participation and support of the local people in the sustainability of the reforestation activities was emphasized. Considering these aspects, it is of great importance that local governments take a role and work together with central governments on these projects. Since local governments also know the local people, they can better organize the means of encouraging them to this process.

5 Public Participation in Protecting Forests and Being a Part in Reforestation Activities

Public participation has an important place in the understanding of democracy in countries. Public participation in governance includes the direct or indirect participation of stakeholders in decision-making about plans, policies, or programs (Quick & Bryson, 2016). In terms of participation, local governments are advantageous as the closest institutions to the public. In these processes, Agenda 21 and Local Agenda 21 processes were initiated in order to support the effectiveness of this public participation in the administrations of the 1992 Rio conference and to accelerate the sustainable development policies of the countries. This system aims for countries to realize both government and local government policies in a participatory process that considers environmental values and public interest (Lafferty & Eckerberg, 2013). Today, the Local Agenda 2030 process is also discussed as an extension of the SDG 2030 approach. The opening of sustainability offices and more effective NGO participation are on the agenda in these discussions (Bostancı, 2021b). Systems of citizen participation, also linked to Local Agenda, include city councils and tools such as various volunteer activities and NGOs. For forest areas, there are also various movements and activism actions in these voluntary organizations and NGOs. Citizens can participate in reforestation activities both voluntarily and depending on various economic gains.

6 Examples of Reforestation Activities with the Contributions of Local Governments and Public

CDM (Clean Development Mechanism) registered with UNFCCC (the United Nations Framework Convention on Climate Change) and some of them A/R (Affor estation/Reforestation) projects, and they include governance, administrative, and financial issues (Thomas et al., 2010). Thomas et al. (2010) defined CDM A/R projects as the Moldova Soil Conservation project in Moldova; the Guangxi Watershed project in China; the Cao Phong Reforestation project in Vietnam; and the Haryana Cooperative Afforestation project in India (Thomas et al., 2010). Stakeholder and public involvement is crucial to the success of these projects. There are tree planting activities in every continent in the world. However, reforestation projects have started to take place on a scale that will open up places where extensive wildlife will also return. In each of these projects, the local people have a great responsibility both by taking an active role and ensuring their sustainability. In this section, reforestation activities from China and Africa will be briefly discussed, limited to only two examples.

6.1 China Reforestation Activities

China is an example worth considering in terms of determining the public dimensions and public participation tools of reforestation projects. The establishment of the China Northeast Asia Forest Forum and the government support of nongovernmental organizations initiated a large-scale reforestation activity in the country (Moon & Park, 2004). The reason for the acceleration of reforestation and afforestation activities in China is the deep deforestation resulting from industrialization. This mass industry has also caused air pollution and serious public health problems. China has carried out its reforestation activities in a wide area with different approaches and strategies in government policies. Grain for Green: the Slope Land Conversion Program (SLP) is the important tool for reforestation activities in China. SFA (State Forestry Administration) pays rural households to plant trees on their cultivated land (Yu & Wang, 2013). This system encourages citizens to participate in reforestation activities.

There is a compatibility problem between the Chinese central and local governments in reforestation activities. While the central government wants to accelerate the activities, local governments cannot provide sufficient financial support to this process (Yu & Wang, 2013). Trac et al. state that more emphasis should be placed on local ecology in reforestation projects in China, and more strategies should be developed to meet the needs of local farmers and shepherds (Trac et al., 2007).

The Guangxi Watershed project in China is about facilitating reforestation for Guangxi Watershed Management in Pearl River Basin is a UNFCCC project (Project 0547). The aim of the project is to increase the livelihoods of the local people and to protect the natural environment through reforestation activities in the catchment areas (Project Design Document form for Afforestation and Reforestation Project Activities (CDM-AR-PDD)). In the context of the information discussed here, China seems to have ensured public participation in reforestation activities with various policies.

6.2 The Great Green Wall of Africa

Today, Africa is the key point in the search for solutions to combat climate change and balance the intense migration flows. In general, together with water projects in Africa, reforestation projects are also an important component of the solution. The Guangxi Watershed project in China is about facilitating reforestation initiative to reduce poverty and desertification and to address the effects of climate change. This initiative has been envisioned by African leaders and is led by the African Union. It is being implemented in targeted countries between Senegal and Djibouti (Niang & Ndiaye, 2021). It provides advantages to the countries within the scope of the project. While providing job opportunities to those involved in the projects, it also creates fertile agricultural areas. In Senegal, the project is under the responsibility of the "Agence sénégalaise de la reforestation et de la grande muraille verte (ASERGMV)," a reforestation agency created in response to climate change and increasing poverty of local populations (Niang & Ndiaye, 2021).

GGW project which can save Africa's present and future against climate change has received significant funds from international organizations and governments. This project aimed to prevent climate change and drought by agricultural productivity through afforestation of the 7775 km middle lane from 20 African countries (Bostancı & Yıldırım, 2021; The Great Green Wall).

7 Conclusion

This study discusses the effects of local governments and public participation on reforestation. Every study on forests draws attention to the loss of forest areas and its environmental consequences. The biggest challenge in this area is the abundance of data and the difficulty of data selection. As this study includes a worldwide assessment, it analyzed and schematized forest data for continents from FAO's publicly available data. These indicators have shown how necessary it is for the whole world to feel responsible and take a role in the solution of forest losses in South America and Africa. In the numerical data evaluation part of this study, very general evaluations were made on continents and countries. However, the domestic politics and economic dilemmas of each country, which are examined in a very narrow scope, affect the approaches to protecting forest areas. However, considering the global industrial companies and mining activities, the forest values of the countries are also under threat internationally. This can be expressed as an ecological justice problem created in developing countries by developed countries that protect and develop forest areas in their own countries. Again at this point, in addition to criticizing the policies of developing countries that put the economy instead of forest areas, how developed countries take the responsibility of funding reforestation of the world should be discussed.

Today, the effects of global climate change are felt more in daily life, and consequently, reforestation activities come to the fore more. Although developed countries try to be effective in decision-making process in the management of these processes, they are not sufficient enough in the implementation and financial support. In most developing countries, governments are looking for ways to sustain their environmental values. Reforestation activities can be carried out on a voluntary basis. There are important initiatives of major international organizations in the creation of this voluntary system. The management and ownership structures of countries differ. But in general, providing financial support incentives to citizens living in rural areas for tree planting and forest protection activities accelerates these activities considerably. In most developing countries, this cost can be covered by international organizations and the central government. However, local governments also have an important role in monitoring this process and determining the means of participation. Local governments' structures are based on communication with citizens and participation in general, and this provides them significant advantages in solving local problems. In the relevant literature, it is stated that in some of the developing countries, financial resource inadequacies of local governments limit their effectiveness in reforestation activities. Generally, tensions and rivalries are experienced in most countries in the relations between central government and local governments. When it comes to the common future of the world, the key task in reforestation activities falls to the citizens of the world. These defined world citizens are all volunteers who feel and act as ecological citizens.

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Chapter 3
Accessing Regional Liveability by Indicators: A Case Study of Mumbai Metropolitan Region

Aparna Phadke and Nikhil Gawai

Abstract The quality of urban life emerges to be the most pertinent issue in the globalising metropolitan regions of India. The rapid pace of urbanisation is found to be associated with the fierce global competition between the global and globalising metropolitan cities and their regions across the world to attract exhaustive financial and other types of investments. To fine tune with the mandates of international capital, there has been a major restructuring of metropolitan spaces in terms of economy, infrastructure, land use, and so on. Such restructuration of metropolitan regions has also fundamentally reshaped the spatial structures of availability and accessibility of civic, infrastructural and governance-related facilities to decide who will get what, where and how. The structures of availability and accessibility would decide the quality of life and liveability. In fact, the structures of liveability are the final culminations of political economy of structuring availability and accessibility.

There have been several frameworks produced to propose a comparative literature on urban liveability in the form of ranking, benchmarks and indices. Most of the frameworks have used the 'availability' structures to substantiate their theoretical assumptions on liveability and have grossly ignored the structures of accessibility. The research aims at measuring the availability, accessibility and liveability in Mumbai Metropolitan Region and emerges with various methods to analyse the patterns of liveability.

Keywords Urban liveability · Mumbai Metropolitan Region · Quality of urban life · Liveability assessment

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1 Introduction

With the anticipation about the unprecedented levels of urbanisation in India, the concerns over the quality of urban life are emerging as most vital. The metro and megacities and their regions in India are experiencing exponential growth in terms of population, land transformations and real estate, infrastructural development. By 2025, 46% of Indian population is expected to live in million cities, i.e. cities with more than 1 million people. By 2030, the number of million cities is anticipated to grow from 42 to 68 (McKinseyGlobalInstitute, 2010). Four of India's cities, namely, Ahmedabad, Bangalore, Chennai and Hyderabad, with currently 5–10 million inhabitants are projected to become megacities in the coming years. A total of seven megacities and their regions would emerge as most populated city regions in the country by 2030 (UNDSA, 2014). By the year 2050, 60% Indian population would shift to urban India (UNDSA, 2014). The core feature of the present and future urbanisation in India would be emergence and development of huge urban regions, developing in and around the megacities. The immediate, inner and outer peripheries of megacities would be subsumed for the future urban growth provoking the size of the regions between 5000 sq. km. and 40,000 sq. km. As per the 2011 census, the top ten metropolitan regions in India constitute 35% of total urban population. As per the revised data in the year 2020, the National Capital Region (NCR) has been expanded to cover the area of 55,083 sq. km. from the adjoining state of Uttar Pradesh, Rajasthan and Haryana. By the year 2021, NCR is projected to house 64 million people (Sharma, 2019). Mumbai Metropolitan Region has also been expanded to cover 6328 sq. km. with staggering population of 23.6 million in the year 2020 (MMRDA, 2021). It would be interesting to note that in the last two decades, metropolitan regions are recording faster pace of population growth and concentration rather than the mother city. For example, Mumbai City has recorded a sluggish population growth rate since the 1990s as compared to the small and medium cities and towns in the inner and outer periphery like Thane, Kalyan Dombivali, Vasai, Virar, Nalasopara, etc.

The emergence of such metropolitan regions is a major trend in the urbanisation process of India. This process is described as 'new regionalism' (Scott, 2001) and prescribes 'new centralism' (Scott, 2001). These regions are indeed making their appearance as major elements in the current world scene, and their advent is intrinsically related to intensifying the levels of globalisation (Scott, 2001). Petrella (1995) states that the map of the world system in the times ahead would be dominated by a hierarchy of thirsty city regions linked more to each other than the territorial hinterlands to which the nation state once bounded them.

The new centralism comes with several challenges. The major challenges emerge in the form of development and provision of basic infrastructural facilities to the residents (irrespective of their living status as legal or illegal as per the Constitution of India) followed by various amenities that would allow the citizens to have a metro life with specific cultural and social consumption. Primarily, to provide such a huge population with even basic civic facilities becomes challenging for the urban local bodies. The modern life cannot be satisfied with the provision of basic facilities alone. There are more higher order needs and demands in modern life pertaining to lifestyles and aspirations. It is not enough to just provide with basic facilities but also to distribute the facilities to ensure a fair quality of life. The quality of life can only be enhanced by improving the availability and accessibility of resources, and accessibility, in turn, would lead towards liveability if the better quality of services is provided to citizens. The unprecedented levels of population concentration in these urban areas continue to threaten the balance of resource base and population and lead to complicated and tenuous spatial relationship between the core city and the inner and outer peripheries within the metropolitan region and also between the metropolitan region and rest of the areas in terms of procuring resources for development. For example, to feed the mother cities with water, water is extracted from the peripheries by constructing dams. The right to this dam water emerges to be a complicated question as most of the time the source regions are kept away from receiving any benefits of dam.

With expansion of these urban regions in terms of population concentration and geographical coverage, distant resource-rich areas are also networked for the provision of resources by strengthening the tangible means of communication and networking. The increasing size of the urban region would require more complicated and wide networks for the provision of resources and services, at a time international in their geographical reach. As the needs and demands in urban regions would be varied with several in-house economic and social classes and cultural backgrounds, varied type of economic activities and the built environments required for their smooth functioning, the structure of urban needs and demands would be further complicated. The more complexities would be introduced with the choices shaped by multiple aspirations and lifestyle options in urban regions due their interconnectedness with the processes of cultural and economic globalisation. In the contemporary globalised urban, the production of urban space reflects complex repositioning of individual global urban regions with strategic interconnections vis-à-vis the urban systems. The globalised urbanisation has also introduced a complex space relationship and tenuous power relations amongst different sub-spaces, communities, people, governing bodies, and so on (Banerjee-Guha, 2010; Harvey, 1990). The transformation of urban economic base from industrial to finance-driven economy and subsequent penetration of newer economic activities have introduced socio-economic segregations along with spatial segregation of people as per their inclusion and exclusion in the new urban economy. The finance capital has emerged as a decisive actor in shaping the process of urbanisation and making of urban spaces, specifically in terms of developmental projects that are penetrating in the megacity regions. Most of the studies (Sassen, 1991; Harvey, 1990; Bannerjee-Guha, 2002; Dupont, 2004; Scott, 2001; Castells, 1997; King, 1996) have pointed that the contemporary form of globalised urbanisation is characterised with growing polarisation along class, gender and ethnic lines depending on the respective socio-cultural set-up of cities and increasing displacements – from homes, jobs and livelihoods pertaining to the process of globalised urbanisation. The same is responsible for bringing in various questions regarding 'right to the city' (Harvey, 2010). The mega urban regions are emerging as the seats of culmination of global-local-urban interlinkages with megacities identified as GEMs (Generators of Economic Momentum) and global urban node supposedly participating in the global urban competition (Banerjee-Guha, 2010). The question of 'who gets what, where and how' becomes most pertinent with the claim and counterclaims over resources, facilities, spaces, and so on (Bannerjee-Guha, 2002).

At this backdrop, structuring the patterns of availability and accessibility of services and resources along the principles of equity and equality and ensuring a liveable life to all emerge to be major tasks. Unless liveability is achieved, there cannot be any step towards achievement of sustainability. Spatial sustainability could be the final step in this link to achieve a sustainable development at various spatial, social and economic scales.

2 Context

In India, National Indicator Framework (NIF) has been created as an adoptive response to Sustainable Development Gaols (SDGs) where 302 national indicators under 17 SDGs have been selected to create the baseline data (GOI, 2020a). It is expected that the baseline data would also serve as benchmarks to guide the governing bodies at various levels to emerge with a sensitive spatial planning keeping the SDGs at its core. These indicators, in fact, propose the framework to access liveability and not sustainability as measurement and analysis of sustainability would require selection of specific indicators like alternate source of energy, rainwater harvesting practices, carbon consumption and emission, carbon footprint, etc.

The evaluation of reports on baseline data (GOI, 2019) for 306 indicators for the year 2016 and subsequent publication of progress report in the year 2020 (GOI, 2020a, b) with inclusion of 13 indicators for goal 17, reducing the total indicators to 302 indicators, suggest that India has still a long way to go in setting its spatial development on the paths of sustainable development. In both the reports, the baseline data for almost half of the national indicators is not available or under compilation. The data compilation is completed for rural spaces but is still under compilation for urban space. The unavailability of data suggests that there is lack of proper framework and system to collect data indicative of particular level of socio-economic development. It also means that the data sets to be compiled or available do not satisfy the criteria set by the international data standardisation. It could be interesting to note that the snapshots on both reports (GOI, Data Snpshots on SDG National Indicator Framework, 2020a) indicate that out of 15 indicators designed for goal 11 (Sustainable Cities and Communities), data is available only for 7 indicators. For remaining eight indicators, no data is available at national level and/or it is under compilation. At state and city-region level, there have been more constraints on data availability (GOI, 2020a, b). The indicators selected are inadequate to represent the particular aspect on liveability and sustainability. For example, the section on climate change adaptation, mitigation and resilience with special reference to cities has only one indicator, and that is disaster risk reduction.

In the absence of proper data on various aspects of urban life, the planning mechanisms emerge to be highly faltering and ineffective. There are severe lacunas in the equitable distribution of provision of even basic civic facilities to all in urban regions. The spatial variation in the quality, quantity and affordability emerges to be a major challenge. At this backdrop, urban sustainability sounds to be a utopian dream. There is an urgent need to emerge with a proper framework for collating a baseline data for urban regions. The datasets need to be flexible enough to capture the environmental, sociocultural and politico-economic heterogeneity of each city region to reflect on liveability and/or sustainability. The metropolitan regions have tremendous variation in terms of social and economic class, ethnicity, regional and lingual identity and placements of different social and economic classes in the urban socio-economic hierarchy within the urban region and at a larger scale. The same has also introduced spatial segregations and hierarchies in the mega urban regions. This very much shapes the patterns of inclusion and exclusion of people and communities and influences the life choices and lifestyles of citizens living in urban regions.

The mega urban regions are experiencing massive scale of spatial development. The major challenge is to assure the equitable distribution of benefits to all who reside within these regions. The quest on sustainability must navigate through the patterns of spatial and socio-economic availability, accessibility and liveability.

3 Discourses on Liveability

The present research attempts at exploring the interconnections between availability, accessibility and liveability in urban regions with specific reference to Mumbai Metropolitan Region and Pune Metropolitan Region. The prime query revolves around how the structures of availability are shaped by different local to global processes at various scales and in various spaces. The impact of neoliberal governance in restructuring the availability of services and facilities spatially would be the first query to understand the patterns of liveability. The spatiality of structures of availability is then filtered through the structures of accessibility. Accessibility is defined in simple terms as the quality of being able to be reached or entered or obtained easily (Cambridge-Dictionary, Acessed in, 2021). Accessibility also could be approachability and a quality of being available when needed. Interestingly, the very 'quality of being available' is controlled and conditioned by various socio-economic and political forces and processes that create different sets of situations which decide the access to an individual. To elaborate further, accessibility is strongly rooted in spatial structures and social relations of production (Harvey, 1990). Accessibility thus emerges to be a social construct, governed by power hierarchies.

The structures of accessibility govern the structures of liveability as the quality of life would be determined by who (economic and social class) gets what (quality of the facilities and services), where (within the vicinity or at a distance), when (waiting period), why (identity, hierarchical positions) and how (employment and means of living). Inaccessibility, in fact, has been more common in Indian scenario. The structured inaccessibility pushes an average individual to the bottom of the hierarchy. These structures of inaccessibility play a decisive role to shaping the pattern of inclusion and exclusion of an individual in urban scenario.

What could be liveability in Indian scenario at the backdrop of extreme inequalities in urban society? Liveability is absolute as well as relative. The physical infrastructure of civic facilities and services would create an absolute form of liveability where everyone is expected to have the share of resource, wealth and urban facilities and amenities. Relative liveability is perceptual and hence emerges to be subjective. A person residing in slums would have a different conceptualisation of liveability than the one who belongs to upper income group. The concept of liveability subsumed in the developed countries is entirely different from the developing countries like India as there is a major gap between the levels of development, life choices and perceptual divide in viewing life. As Wheeler proposes, liveability is the subjective experience of leading a life in particular time-space and place (Wheelar, 2001–2004). Hence, one has to go to the microlevels to understand inhabitants' perception about liveability and which are the socio-economic, cultural and political ingredients that make their life better. Identification of such attributes can be useful in assessing the microlevel liveability which otherwise is not at all measured. Most of the liveability studies are done at a macroscale – leading to generalisation of observations. Liveability is referred as the living conditions of a place that reflects on 'quality of life', 'well-being' and 'life satisfaction' all across (Lyndhurst, 2004). Pacione suggested liveability as an expression of behavioural responses to environmental characteristics and personal characteristics (Pacione, 1990). Veenhoven (1999) referred liveability as habitability that assures the degree of provision to which the citizens are provided with their needs and requirements (Veenhoven, 1999).

While analysing the existing literature, three major approaches could be seen in dealing with liveability – indices, ranking and benchmarks. The first approach is based on calculation of liveability by selecting a set of socio-economic indicators and deriving a 10-pointer scale by applying the statistical techniques. Human Development Index (HDI) is one of the common indices to express the quality of life based on selected socio-economic indicators. HDI creates a basic understanding about the level of socio-economic development of a particular country and allows for a comparative analysis. The HDI is calculated by assigning weights, and hence it is more illustrative than evaluative (Chowdhury, 1991). HDI emerges to be an abstract and generalised kind of index and often sets standards that are culminated on the experience of development standards from the developed world. In most of the developing countries, systematic and methodological compilation of data is missing, and there is a weak effort to have standardised datasets representing the quality of life. There have been several reports published by government and non-governmental agencies globally and locally listing out various dimensions of quality of urban life in the form of indices. In spite of such efforts, it has been observed that various dimensions of urban liveability could not be grasped efficiently with reference to Indian cities and their complexities. Ranking is another expression of encoding the quality of life globally. In fact, there have been at least 500 different types of rankings available globally (Acuto et al., 2021). The sudden upscaling in ranking cities globally is suggestive of the intra-urban global competition amongst the cities from Global North and Global South to attract the foreign direct investment and/or international financial capital. Mercer's Quality of Living Ranking is exclusively used by the international business corporate houses for deciding on the overseas investments and compensation packages for employees for international assignments (Global, 2019). The ranking is also used for quality assessment of a space to ensure the well-being of the professionals and employees. In the year 2021, Mercer also offered a new safety ranking for the cities which analyses cities' internal political and social stability, level of crime, lawfulness, personal safety, freedom of space, and so on (Global, 2019). It would be interesting to note that these indicators are thus used as face values for a comparative performance measurement (Acuto et al., 2021) for comparative analysis of cities across the world. The current city rankings are captivated and fashion statements, specifically constructed for the international finance capital. They remain quite superficial and less useful for giving direction to inclusive socio-economic development. In fact, 'comparative gestures' (Robinson, 2011) in the form of global ranking encourage the 'face lift' of the megacities. The term that is used to describe various urban regeneration processes in India is 'beautification'. This term itself is suggestive of the 'face values' of the cities and concomitant face uplifts that are expected in the built environment of the city to emerge as 'smart' not necessarily accessible and liveable. There are around 30 prominent global city ranking mechanisms based on economic competitiveness, quality of life and quality of services – civic facilities and amenities, conventional and advanced producer services, advanced economic activities and international linkages, infrastructure and communication networks, disaster management, happiness index, ease of doing business, governance, e-governance, laws and regulations, safety and security, etc. (Giap et al., 2012). Global Competitive Report, World Competitiveness Yearbook, Eurostat Structural Indicators, Economic Freedom of the World, Quality of Living Survey, Key Indicators for Asia and the Pacific, the Environment Sustainability Index, Report on Environment Statistics and Climate Change, Developing Urban Indicators for Managing Megacities, Global City Indicator Programme, the Millennium Development Goals Reports, Sustainable Development Goals Reports, Sustainable Transportation Indicators, Federation of Canadian Municipalities Quality of Life Reporting System, Measuring Progress, Strengthening Governance and Positive Change, Gross National Happiness Index, Organisation for Economic Co-operation and Development (OECD) Indicators, Sustainable Development in the European Union, Sustainable Governance Indicators, World Development Indicators and Urban Indicators for Managing Cities (Giap et al., 2012) are few of the many important frameworks that impinge on quality of life assessment at a macroscale. The present research work has considered the above-mentioned frameworks while formulating the understanding of the concept of liveability.

Benchmarks are the third way of expressing the quality of life and liveability. The benchmarks are generally in the form of common socio-economic indicators representing the economic and social life of a particular country in its most generalised form, i.e. abstract number. For example, 135 litres per capita per day (lpcd) has been suggested as a national benchmark for urban water supply (Ministry of Jal Shakti, 2020). Most of the benchmarks are national in their origin. In case of India, there are hardly any benchmarks that are calculated at a city level. For a country like India that has huge geographic diversity, a national benchmark would be insufficient to represent the varied nature of life conditions shaped by the structures of availability, accessibility and liveability. It could be interesting to note that almost 25% of the benchmarks are configured by the professional service firms like McKinsey that are necessarily global and offer consultancies in transforming cities into global cities (Acuto et al., 2021). Such firms set the global benchmarks in local scenario and enforce the city governments to redirect the finance to the priority services for global businesses rather than to people.

With cities emerging global, they are expected to be international tourists' hotspots. Another 15% of the city benchmarks are offered (Acuto et al., 2021) by the global media and travel groups to allow the international tourists to choose their tourist city destinations. Such benchmarks are absolutely superficial as they consider a particular economic and social class when it comes to communities and upper circuit of the economy and producer services. Around 8–10% of all benchmarks generated are calculated by the public institutions and government-led organisations (Acuto et al., 2021) which may emerge relevant to calculate benchmarks that would be used in spatial planning and development. As suggested by Kitchin (2015), the present benchmarking decontextualises cities from their histories, geographies and socio-economic and environmental interrelationships and cultural associations in the larger context of spatial development (Acuto et al., 2021).

Recently, there has also been increasing international attention to environmental issues and urban resilience while assessing the liveability and sustainability (Acuto et al., 2021). For the year 2020, the United Nations Development Programme has introduced a new metric to reflect the impact caused by each country's per capita carbon emissions and its material footprint. The index measures the amount of fossil fuels, metals and other resources used to make the goods and services it consumes. The new matrix thus enforces different countries to appear very clearly on sustainability. Following this, India has dropped by two ranks as compared to 2019, i.e. from the rank 129 to 131 out of 189 countries as compared to year 2020 (TheHindu, 2020). The point to be noted here is that in international frameworks, now the element of sustainability weighs much higher than ever (TheHindu, 2020). Moreover, the relation of liveability is more connected with increasing pollution levels and that too specifically are pollution. A report presented by NITI Aayog on air pollution, 'Breathe India: An Action Plan for Combating Air Pollution' (NITIAAYOG, 2018, 2020) can be sited as one of the representative researches on above-mentioned connection. Another important policy document by TERI (The

Energy and Resource Institute) also falls in the similar line. In a report titled as 'Policy Brief 2018: Making Liveable Cities: Challenges and Way Forward for India' (Singh, 2018), a similar proposition has been made by the institute.

Globalisation and World Cities Research (GaWC) adds another very important dimension to city competitiveness. It claims that the world has emerged as a city-centric world of flows as compared to the conventional state-centred world boundaries. GaWC offers categories of the cities in the form of classification into 11 categories for the year 2020 on the basis of external linkages of the cities (GaWC, 2020). Alpha ++, Alpha +, Alpha and Alpha, Beta +, Beta, Beta −, Beta, Beta −, Gamma +, Gamma, Gamma −, high sufficiency and sufficiency are the categories of cities based on the economic activities of 175 global firms offering their advanced producer services in 707 cities worldwide (i.e. the input is 175 × 707 = 123,725 pieces of information) (GaWC, 2020). They claim that there has been lot of research and literature produced on internal structuring of the cities but very limited literature on cities and their networks. This categorisation is novel as it grasps the financial investments, city's global connectedness and infrastructural specifications required to support the advanced producer's activity set as benchmarks for categorisation. But the research does not speak much about the quality of life and how the global cities networks contribute towards improving quality of urban life in general as it is not their focus.

To conclude, a complete absence of academia emerging independently with such benchmarking system is noticeable not only in Global South but also in Global North. Academia is peripherally present in such studies as consultants or expert nominees. The same indicates a very restricted influence of academia in construction of factual benchmarks that would represent social and economic complexities of the cities. Nonetheless, such researches remain highly restricted in their objective and get trapped into the quagmire of attractive policies of urban development and regeneration and divorce from the basic understanding of city making. Cities are made by people. So, city liveability is definitely associated with the city people and their perceptions of liveability.

4 Methodology on Liveability and Sustainability

To address the issues discussed regarding understanding the patterns of liveability, a comprehensive methodology has been experimented.

1. To grasp the heterogeneity of the metropolitan region by applying spatial approach.
2. Instead of taking a common representative benchmark, it is preferred to emerge with benchmarks that are specific to particular micro-spaces as a representative benchmark set for a macroregion would simply homogenise all the differences and inequalities. For example, 135 mld/per person/per day water supply cannot be a benchmark for all urban spaces vis-à-vis water availability as the regions are

placed differently geographically, socially and culturally. Such representative number remains extremely inadequate to reveal the inequalities and incidences of polarisation.

3. Through primary data, scores for each socio-economic, political and cultural indicators have been collected on the basis of availability and accessibility. These scores emerge as a major base for calculating the liveability score. *Z*-score, coefficient of correlation and simple measures of central tendency have been used to express the pattern of availability and accessibility and to understand the relationship between availability, accessibility and liveability scores.
4. Quantitative analysis is not enough to represent the different dimensions of liveability and sustainability. Qualitative analysis through ethnographic surveys and community involvement has allowed comprehensive research analysis. Perception studies have been central to data generation for qualitative analysis. The perceptions of people are rooted in their cultural and social structures and embedded into the core philosophy of life. The present research has successfully attempted at establishing a discourse that creates a space for community centric liveability assessment, accounting and management through the modern technology like android-based mobile application.
5. The data has been collected through Open Data Kit application. The same allows to collect the exact location of the sample surveyed with the qualitative and quantitative data attached with it. In GIS software, it is possible to visualise the geographical location of the sample survey with its attributes. As the data collected through ODK is transferable and compatible with QGIS, the spatial query and visualisation become quite easy.
6. An android-based mobile application named as *My Liveability* has been prepared to create the local benchmarks. The objective is to involve community in collecting data about their own liveability status through the application. The same allows the community members to emerge with a spatial data that allows them to have better understanding of the distribution of basic facilities in terms of available and expected degree of provision and supply.
7. COVID-19 situation has pushed the panic button especially in our urban systems. It has triggered the researchers to indulge into the search of alternate discourses to manage our spatial (urban) systems with more emphasis on balanced growth influx. Definitely the proposed methodology would contribute substantially towards the future understanding on liveability.

5 Observations from the Study Region

Mumbai Metropolitan Region has been selected for conducting research on liveability. Mumbai City has secured third position in the reports published by the Ministry of Urban Development, GOI. Mumbai, being a primate city, plays a decisive role in shaping the socio-economic development and metropolitan regional planning. Being primate city, the metropolitan region of the city so far has faced backwash effects rather than the spread effect. Within these cities also, there are stark differences in the quality of life of different socio-economic groups. The whole city cannot have a uniform rank when it comes to liveability. The social and spatial polarisation and economic stratification within the cities and metropolitan region are a major concern when it comes to measurement of liveability.

5.1 Mumbai Metropolitan Region

Mumbai Metropolitan Region (MMR) is not only one of the most populated metropolitan regions in the world but also records highest density of population in some of its sub-spaces like Dharavi. As per the 2011 census, the population of MMR is 20,998,395 making it one of the top ten most populated urban agglomerations in the world. Mumbai Metropolitan Region extends over an area of 4355 sq. km. and comprises municipal corporations of Greater Mumbai, Thane, Kalyan and New Mumbai incorporating 16 municipal towns, 7 non-municipal urban centres and 995 villages. Its administrative limits cover Mumbai City and Mumbai suburban districts and parts of Thane and Raigad districts. There are 40 planning authorities responsible for the regional and sectoral development and microlevel planning of the region. Alibag marks the southern and Virar, the northern limits of MMR. Recently, the metropolitan region has been expanded further to include more areas from Raigad and Thane districts (Fig. 3.1). The metropolitan spaces selected from MMR for liveability study are as follows:

1. Kalyan-Vitthalwadi – Ulhasnagar-Ambernath and Badlapur
2. Vasai-Virar-Nalasopara
3. Greater Mumbai Municipal Corporation
4. Rest of MMR

The whole Mumbai Metropolitan Region is highly complex and diverge in nature in terms of income gaps, economy, society and culture. In spite of strong presence of various public sector utilities like public hospitals, public mass transport, government and municipal schools, etc., the patterns of availability and accessibility are peculiar and change across spaces, economic class and social class. The concerns over urban sustainability in the region are most vital as the region is predicted to be one of the worst-hit with reference to climate change. The region has established networks of governance through which the efforts of altering the discourse of urban development to urban sustainable development can be initiated. How sustainability can become the central discourse in planning and development of region would be the key question.

In all, 621 samples from various sub-spaces of MMR have been collected to represent different socio-economic groups and communities. The extensive interviews have been carried out through questionnaire survey to emerge with the substantial research. The primary data has been collected through the interviews. The detailed data was collected to calculate the percentile and then reflect a weightage

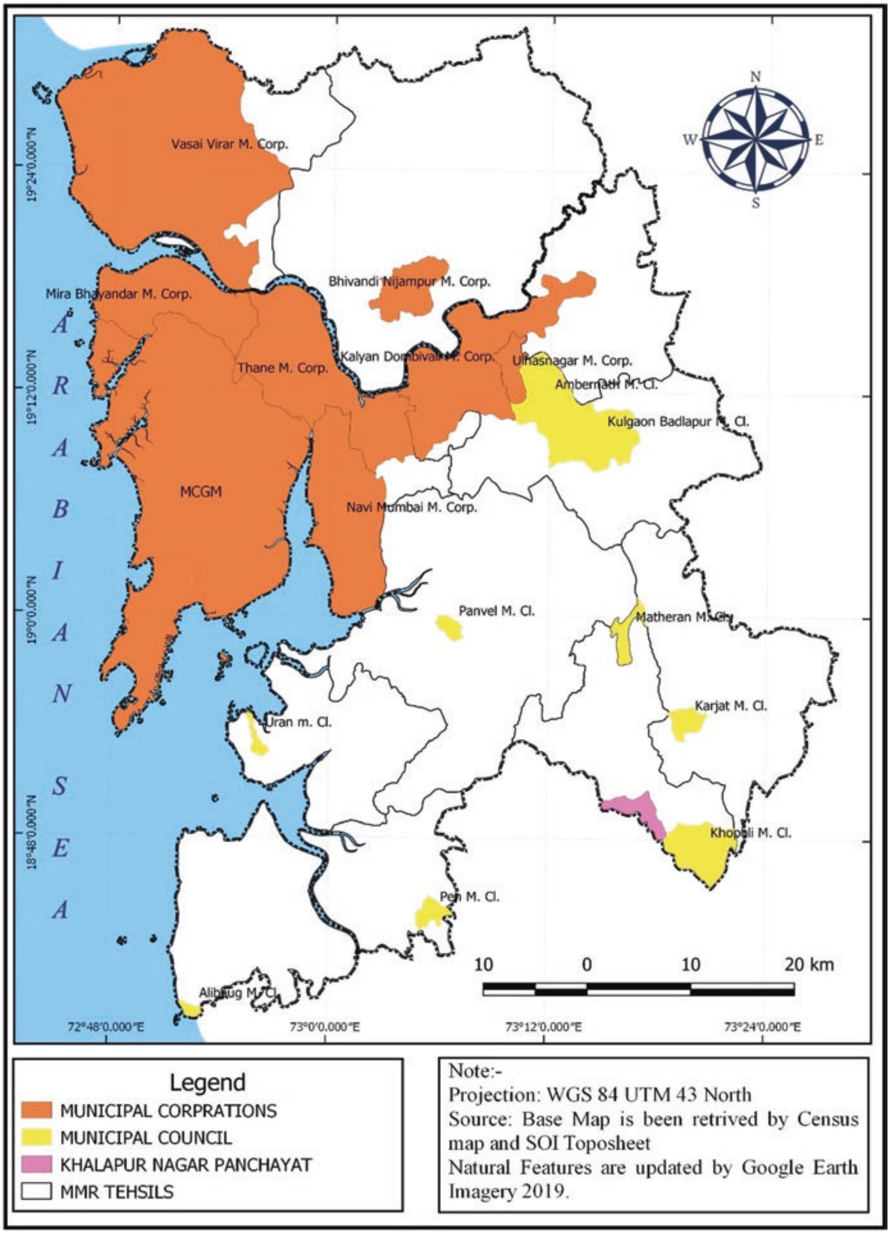
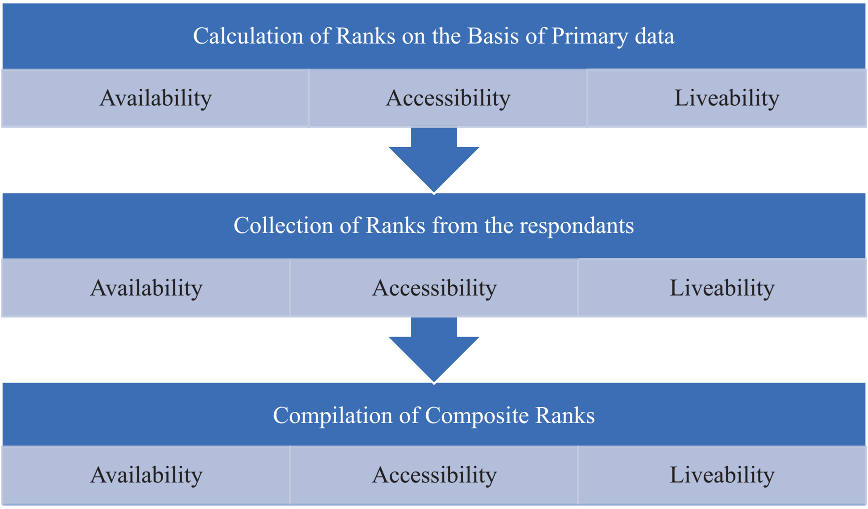


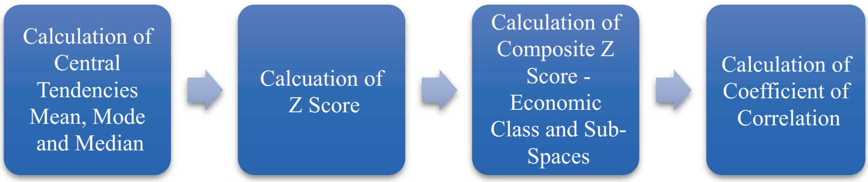
Fig. 3.1 Mumbai Metropolitan Region. (Source: MMRDA, 2021 (prepared by Mr. Nikhil Gawai))

to it out of 10. The respondents were also asked to give direct weightages for their areas for AALS. Both the weightages then have been merged to get an aggregate weightage for liveability.

Step I: Calculation and compilation of ranks at individual level, sub-space level and economic class level.



Step II: Calculation of central tendency and standard deviation leading to Z-score for individual economic class and sub-spaces.



Step III: Visualisation of the data in the form of maps for spatial analysis.

The methodology has been devised to get the real scenario of availability and accessibility of various civic and infrastructural facilities. As shown in Chap. 3, weightages were derived from the primary data collected. The respondents were also asked to give aggregate weightages for all the 22 facilities that were discussed in detail. It was found that there is a discrepancy in the answers specially in case of PMR where in spite of limited availability and accessibility, the respondents gave higher weightages in the last section of the survey where they were expected to give the weightages on the basis of what they have answered in the earlier sections that were meant for capturing the details. The same initiated a change in the proposed methodology where introduction of *Z*-score became extremely important. *Z*-score is a measure of how many standard deviations below or above the mean of a given data distribution is. After application of *Z*-score, the results were revealing in MMR, and a deal of regional variation could be seen in the availability, accessibility and liveability of the 22 select indicators (These are 14 broad indicators. They are further divided on the basis of mode of provision into 22.).

As suggested in *Step I*, the following tables represent that how on the basis of responses from the respondents, a percentile, has been derived. The questionnaire has been structured to get direct responses in the form of quantity, quality, duration, cost, etc., from which the scores could be calculated. The second verification of the availability, accessibility and liveability structures has been derived from the scale points 1–10. The respondents at the end of the interview were asked to give score for each facility collectively. The same allowed double verification about the structures of availability, accessibility and liveability (Tables 3.1, 3.2, 3.3, 3.4, 3.5 and 3.6).

It could be seen from the above excerpts that the benchmarks and real availability and accessibility differ grossly. Initially, the researcher had decided to calculate the gap between the benchmarks available and the actual level of provision. Ironically, there has been a complete absence of benchmarks at MMR level. Some benchmarks are available for New Mumbai and Mumbai City, but these figures too are ambiguous. In the absence of proper benchmarks, a gap between benchmarks and the actual level of provision, i.e. availability and how far they are used, i.e. accessibility to the services could not be calculated. Whatever benchmarks were available; they were national-level benchmarks. Considering those benchmarks as proxy for comparative analysis could have been detrimental to the research findings.

In *Step II*, the scores were derived from the respondents as a culmination of interview and questionnaire survey. The measures of central tendency, coefficient of correlation and *Z*-score technique have been applied to understand the pattern of liveability. The following tables represent the same (Tables 3.7, 3.8 and 3.9).

The coefficient of correlation is calculated between the availability and accessibility and accessibility and liveability. The correlation indicates the strong relationship between availability and accessibility, but there is a substantial reduction in the value of coefficient of correlation between accessibility and liveability. The same indicates that even though facilities are accessible, they are not adequate enough to offer better quality of life. There is a major variation in the distribution of select facilities and amenities in select spaces of MMR. It is also revealed that the liveability is getting compromised in the main city of Mumbai and its suburbs as compared to select spaces in metropolitan region. The coefficient of correlation has its own limitation in this exercise as it is purely based on the scores and responses

Table 3.1 Status of water: Availability and accessibility

		Water provision		Composite weightage	
Region MMR	Seasonal variation	Quality	Duration	Water	Score
	Yes	Good	<10 h	%	
Percentage of respondents	35.22	50.81	43.99	43.34	4

Source: Primary data

Table 3.2 Electricity supply: Availability

		Electricity supply	Composite weightage	
Region MMR	Seasonal variation	Load shading	Electricity	Score
	Yes	Weekly	%	
Percentage of respondents	38.14	12.17	25.155	3

Source: Primary data

Table 3.3 Sanitation: Availability

	Sanitation			
Region MMR	Solid waste management		Composite weightage	
	Availability	Frequency	SWM	Score
	Yes	Good	%	
Percentage of respondents	60.71	24.35	42.53	4

Source: Primary data

given by the respondents. To understand the pattern of liveability, *Z*-score has been calculated. The results of *Z*-score are revealing. A major degree of variation could be seen in the liveability of lower-income groups, middle-income groups and upper-income groups. The disparity is vast, and it also has a spatial context. Ironically, the worst level is observed in Mumbai and its suburbs. Such results were derived because a representation sample from each economic class has been considered for calculating the liveability of sub-spaces. The tables and maps would represent and justify the observation made here. In fact, MMR *Z*-score for all the sub-spaces as well as Economic Class is either 0 or negative. Hardly in one of the indicators of network connectivity, the *Z*-score is positive. Positive *Z*-score indicates better levels of performance in that specific indicator. Zero value of the *Z*-score indicates a low level of performance wherein the negative values of *Z*-score suggest poor performance. It would be interesting to note that the liveability is comparatively better in other sub-spaces of MMR and worst in Mumbai (Fig. 3.2).

Tables 3.7 and 3.8 clearly indicate the deviation in the provision of services to each economic class. The application of *Z*-score technique allows a clear representation of deviation and unequal distribution of services not only spatially but also in term of economic class (Fig. 3.3).

The use of ODK facilitates the representation of point location data with its spatial and non-spatial attributes. In fact, data locations can be visualised on the maps with their liveability status. The same facilitates the understanding of micro-spaces and their status of liveability. The maps displayed and offer a comprehensive understanding of the pattern of liveability spatially and on the basis of economic class as well (Fig. 3.4).

The techniques like spatial autocorrelation can be used in GIS to emerge with the demarcation of spaces representing the liveability standards. From both the maps, one can clearly understand the individual's liveability for each selected indicator as well as the collective liveability standards. This can be of great use to planning

Table 3.4 Health facilities: availability and accessibility

		Health facilities			
Region MMR	Doctors	Medicines	Specialist doctor	Composite weightage	
	Cost analysis	Cost analysis	Cost analysis	Health facilities	Score
	Proper costing	Proper costing	Proper costing	%	
Percentage of respondents	18.5	22.72	6.49	15.90333333	2

Source: Primary data

Table 3.5 Status of education: accessibility

	Education			
Region MMR	Primary	Higher secondary	Composite weightage	
	Quality	Quality	Education facilities	Score
	Good	Good	%	
Percentage of respondents	60.87	66.88	63.875	6

Source: Primary data

authorities as a detailed account of availability, and accessibility can be produced as an output. The same can be used as input for future planning. It could be interesting to note that in the report published by the Ministry of Urban Development, Government of India on *Liveable Cities*, Mumbai ranks third. The present research clearly indicates that in spite of third all India ranking, the liveability standards of people continue to be compromised and deteriorated. There is a major variation across MMR in terms of liveability standards indicating unequal access and availability of facilities and services. There is an urgent need to generate data at the scale of micro-spaces in the form of local benchmarks, expectations and local area planning.

6 Generation of Local Benchmarks Through Community Participation

It is a Herculean task for any governmental or non-governmental agency to emerge with a detail mapping of liveability. In the present research, involvement of community for measuring their own liveability was also experimented. An android-based mobile application has been developed titled as *My Liveability*. The application is freely downloadable from Google Play. The application collects data about the expected and actual provision of basic services and allows user to visualise their status of liveability on map. The data given by user is also presented in the form of

Table 3.6 Safety and security: availability

	Safety and security			
Region MMR	Frequency criminal activity	Criminal threat	Composite weightage	
	Always	Sometimes	Safety and security facilities	Score
			%	
Percentage of respondents	10.22	28.08	19.15	8

Source: Primary data

graphs. The data at the backend collected on a server and becomes available for analysis to the researcher (Figs. 3.5, 3.6 and 3.7).

Kamshet was selected from Pune Metropolitan Region for analysing the effectiveness through community participation. Around 20 volunteers were present to whom proper demonstration and explanation regarding application were provided. Volunteers, dominantly women participants, from different backgrounds came forward to learn this application to gather more accurate spatial as well as non-spatial data of their area. Proper 2-h training was provided to all volunteers. It was interesting to know that they didn't know the actual benchmarks of the facilities which they are consuming from the government as well as through the public-private partnership organisations. So in the beginning itself, an understanding was given about what is benchmark and how to calculate the facilities in availability and accessibility form. The further explanation was given on what actual expectation was meant to them. It was interesting to know that they were provided with very limited facilities like the water was provided to them once in 2 days, that too for an hour. The same forced them to keep their expectations so compromised that even a little more supply of water was enough to satisfy their daily water consumption-related needs. This phenomenon can be considered as the dyeing expectations of the community as local governments maintain the rate of facilities as limited as it could be. So, the community has been receiving 15 l of water per day per capita for the last one decade. Even if it increases to 25 l per day per head, it is considered as good water liveability, and better weightage could be given. In reality, the per capita per day water supply benchmark is 135 l. An increase in the water supply by even 10 l of water would make them happy. Such false expression also leads to the wrong calculation of the weightages; hence, the application is trying to avoid such a scenario on the actual field-based analysis by considering the gap between the availability and expectation of the facilities by the community to understand their liveability and also the comparison of their neighbourhoods liveability.

The application, when explained, could be seen as strengthening the community to demand proper quantity and quality of the facilities from the concerned authority. Application provided the great hand to collect the ground reality data regarding facilities available and expected at individual level which can further club at

Table 3.7 Coefficient of correlation – availability and accessibility and accessibility and liveability

Indicator	Rest of MMR	Mumbai	Kalyan-Dombivali-Ulhasnagar-Ambernath-Badlapur	Vasai-Virar
Water accessibility	0.86697	0.84516	0.865452	0.811488
Water_liveability	0.805763	0.697972	0.858976	0.875814
Public-trans_accessibility	0.868845	0.766333	0.886837	0.932079
Public-trans_liveability	0.626258	0.521272	0.652856	0.862595
Private_trans_accessibility	0.848767	0.841581	0.831046	0.869791
Private_trans_liveability	0.805712	0.787383	0.916925	0.888063
Energy_conventional_accessibility	0.800189	0.835505	0.904491	0.76931
Energy_conventional_liveability	0.651472	0.662134	0.680786	0.697495
Sanitation_accessibility	0.753413	0.881288	0.843454	0.814685
Sanitation_liveability	0.614245	0.834363	0.774032	0.885504
Public_health_accessibility	0.705352	0.792808	0.793453	0.907496
Public_health_liveability	0.658187	0.721374	0.740756	0.798683
Private-health_accessibility	0.733735	0.821818	0.865213	0.639648
Private-health_liveability	0.65865	0.87287	0.812295	0.754106
Public-education_accessibility	0.680413	0.652617	0.867379	0.942004
Public-education_liveability	0.806613	0.784953	0.571163	0.949892
Private-education_accessibility	0.757973	0.739477	0.879551	0.926101
Private-education_liveability	0.779813	0.879657	0.913839	0.947873
Safety-and-security_accessibility	0.795513	0.881803	0.872847	0.91473
Safety-and-security_liveability	0.722138	0.795602	0.966954	0.915674
Public-housing_accessibility	0.518407	0.685478	0.786667	0.824181
Public-housing_liveability	0.556911	0.80104	0.801063	0.848869
Private-housing_accessibility	0.798864	0.840439	0.849311	0.864163
Private-housing_liveability	0.773878	0.794573	0.910675	0.885739
Public-spaces_accessibility	0.726149	0.83775	0.804911	0.933396
Public-spaces_liveability	0.651167	0.869059	0.816132	0.921486
Leis-recre_accessibility	0.767858	0.791415	0.709831	0.962242
Leis-recre__liveability	0.858651	0.896912	0.926185	0.955369

(continued)

Table 3.7 (continued)

Indicator	Rest of MMR	Mumbai	Kalyan-Dombivali-Ulhasnagar-Ambernath-Badlapur	Vasai-Virar
Entertainment_accessibility	0.742222	0.80841	0.865959	0.965017
Entertainment_liveability	0.542066	0.809613	0.814345	0.968712
Net-connect_accessibility	0.776646	0.796888	0.764944	0.933973
Net-connect_liveability	0.842999	0.807221	0.80623	0.91106
Employment-opportunities_liveability	0.776648	0.823971	0.850291	0.797298
Community-life_accessibility	0.656498	0.696791	0.766177	0.726684
Natural-environment_accessibility	0.858067	0.851716	0.702321	0.896878
Natural-environment_liveability	0.62857	0.836955	0.943923	0.920986
Governance_accessibility	0.722998	0.681219	0.862682	0.860104
Governance_liveability	0.677942	0.698679	0.894074	0.790373
Quality-of-life_liveability	0.561622	0.871628	0.916882	0.875873

Source: Primary data

community level or regional level to create local benchmarks for the planning purpose. Such huge data collecting is a very tedious job even for the government; hence, it is better to generate such data from the community level and provide to the government for taking appropriate decisions.

7 Suggestions and Conclusion

Liveability calculation is a highly complex and subjective affair. As already discussed, most of the liveability calculations are superficial and have very limited application in terms of spatial planning and development. The methodology offered in this present research has various applications in terms of local area planning.

(a) Spatial planning approach is applied to understand the individuality of micro-spaces in terms of their liveability status. For example, the samples selected for study represent almost every economic class in the study region. The samples have been collected from Govandi-Mankhurd slum area, middle-income groups from the City of Mumbai and suburbs, Vasai and Virar that is a fastest growing area in MMR in terms of population on Western Railway and Kalyan, Dombivali and nearby towns on the Central Railway. As the samples represent all economic classes, it was possible to have a proper representation.

Table 3.8 Measures of central tendency and *Z*-score for lower-income groups in MMR

				Lower-income groups					
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite *Z*-score
Water_availability	5.00	5.00	5.43	2.15	2.00	10.00	0.00	9.00	−128.58
Water_accessibility	6.00	6.00	5.43	2.36	1.00	10.00	7.00	8.00	−121.78
Water_liveability	5.00	5.00	5.75	1.83	2.00	10.00	0.00	2.00	−166.68
Public-trans_availability	3.00	5.00	5.03	1.79	2.00	10.00	0.00	2.00	−143.03
Public-trans_accessibility	5.00	5.00	5.34	1.81	1.00	9.00	1.00	0.00	−159.74
Public-trans_liveability	4.00	5.00	5.30	1.45	3.00	10.00	0.00	1.00	−197.24
Private_trans_availability	5.00	5.00	5.33	1.82	2.00	10.00	0.00	2.00	−149.48
Private_trans_accessibility	4.00	5.00	5.18	1.78	2.00	10.00	0.00	1.00	−160.03
Private_trans_liveability	7.00	5.00	5.41	1.87	1.00	9.00	1.00	0.00	−158.89
Energy_conventional_availability	6.00	6.00	5.42	1.68	1.00	9.00	1.00	0.00	−164.40
Energy_conventional_accessibility	6.00	5.50	5.47	1.63	2.00	9.00	0.00	0.00	−200.87
Energy_conventional_liveability	6.00	5.00	5.22	1.82	1.00	10.00	1.00	1.00	−166.21
Energy_non-conventional_availability	4.00	4.00	4.57	2.27	1.00	9.00	11.00	0.00	−106.56
Energy_non-conventional_accessibility	3.00	5.00	4.67	2.42	1.00	10.00	11.00	1.00	−113.94
Energy_non-conventional_liveability	8.00	4.00	4.68	2.50	1.00	9.00	14.00	0.00	−112.43
Sanitation_availability	7.00	6.00	5.57	1.82	1.00	10.00	1.00	2.00	−156.04
Sanitation_accessibility	7.00	6.00	5.58	1.93	1.00	10.00	1.00	2.00	−153.42
Sanitation_liveability	6.00	6.00	5.67	2.04	2.00	10.00	0.00	2.00	−147.09
Public_health_availability	5.00	5.00	5.28	1.89	2.00	10.00	0.00	2.00	−142.31

Public_health_ accessibility	6.00	5.00	5.19	1.67	1.00	10.00	1.00	1.00	−165.19
Public_health_liveability	5.00	5.00	5.26	1.66	2.00	10.00	0.00	1.00	−167.59
Private-health_availability	5.00	5.00	5.23	1.83	2.00	10.00	0.00	1.00	−154.60
Private-health_ accessibility	5.00	5.00	5.27	1.76	2.00	10.00	0.00	1.00	−167.64
Private-health_liveability	6.00	5.00	5.37	1.69	2.00	9.00	0.00	0.00	−181.15
Public-education_ availability	6.00	6.00	5.45	1.65	3.00	10.00	0.00	3.00	−175.27
Public-education_ accessibility	4.00	6.00	5.57	1.60	2.00	10.00	0.00	2.00	−190.95
Public-education_ liveability	4.00	5.00	5.49	1.60	2.00	10.00	0.00	2.00	−184.72
Private-education_ availability	4.00	5.00	5.27	1.82	2.00	10.00	0.00	2.00	−147.38
Private-education_ accessibility	6.00	5.00	5.11	1.89	2.00	10.00	0.00	1.00	−143.34
Private-education_ liveability	4.00	5.00	5.25	1.90	2.00	10.00	0.00	1.00	−152.08
Safety-and-security_ availability	3.00	5.00	5.31	1.93	1.00	10.00	2.00	1.00	−143.39
Safety-and-security_ accessibility	5.00	5.00	5.39	1.88	1.00	9.00	2.00	0.00	−154.52
Safety-and-security_ liveability	6.00	5.00	5.38	1.78	1.00	9.00	1.00	0.00	−162.88
Public-housing_ availability	5.00	5.00	5.07	1.61	2.00	8.00	0.00	0.00	−176.28
Public-housing_ accessibility	4.00	5.00	4.86	1.65	2.00	9.00	0.00	0.00	−162.43

(continued)

Table 3.8 (continued)

				Lower-income groups					
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite *Z*-score
Public-housing_liveability	7.00	5.00	4.99	1.72	2.00	8.00	0.00	0.00	−159.30
Private-housing_availability	5.00	5.00	4.98	1.70	1.00	10.00	1.00	2.00	−149.78
Private-housing_accessibility	4.00	5.00	4.73	1.60	1.00	10.00	2.00	1.00	−156.48
Private-housing_liveability	4.00	5.00	4.93	1.73	1.00	10.00	1.00	1.00	−150.61
Public-spaces_availability	3.00	5.00	4.84	1.95	1.00	8.00	3.00	0.00	−128.91
Public-spaces_accessibility	3.00	5.00	5.13	2.03	1.00	9.00	2.00	0.00	−136.54
Public-spaces_market_liveability	3.00	5.00	4.99	2.13	1.00	9.00	3.00	0.00	−126.33
Leis-recre_availability	6.00	5.00	5.06	2.12	1.00	9.00	4.00	0.00	−121.75
Leis-recre_accessibility	6.00	5.00	5.04	2.12	1.00	9.00	4.00	0.00	−126.15
Leis-recre__liveability	5.00	5.00	5.12	2.24	1.00	9.00	3.00	0.00	−120.78
Entertainment_availability	4.00	5.00	5.02	1.96	1.00	10.00	3.00	2.00	−133.39
Entertainment_accessibility	5.00	5.00	5.01	1.87	1.00	9.00	2.00	0.00	−147.54
Entertainment_liveability	5.00	5.00	5.12	1.90	1.00	9.00	2.00	0.00	−150.62
Net-connect_availability	5.00	5.00	5.30	1.76	3.00	10.00	0.00	2.00	−153.82
Net-connect_accessibility	5.00	5.00	5.17	1.89	2.00	10.00	0.00	1.00	−150.37
Net-connect_liveability	5.00	5.00	5.29	1.79	2.00	10.00	0.00	1.00	−165.18
Employment-opportunities_availability	4.00	5.00	4.78	1.88	2.00	8.00	0.00	0.00	−132.12

Employment-opportunities_accessibility	6.00	5.00	5.10	1.64	1.00	8.00	2.00	0.00	−170.69
Employment-opportunities_liveability	5.00	5.00	5.18	1.64	1.00	8.00	1.00	0.00	−173.66
Community-life_availability	5.00	5.00	5.22	1.46	2.00	9.00	0.00	0.00	−182.30
Community-life_accessibility	7.00	5.00	5.15	1.64	2.00	9.00	0.00	0.00	−166.64
Community-life_liveability	5.00	5.00	5.04	1.50	3.00	9.00	0.00	0.00	−184.54
Natural-environment_availability	6.00	5.00	5.00	1.83	1.00	9.00	3.00	0.00	−139.23
Natural-environment_accessibility	5.00	5.00	4.91	1.98	1.00	9.00	1.00	0.00	−138.85
Natural-environment_liveability	3.00	5.00	4.73	1.86	1.00	9.00	2.00	0.00	−137.31
Governance_availability	6.00	5.00	4.93	1.59	2.00	10.00	0.00	1.00	−158.13
Governance_accessibility	6.00	5.00	4.85	1.63	2.00	10.00	0.00	1.00	−157.73
Governance_liveability	5.00	5.00	4.98	1.52	3.00	10.00	0.00	1.00	−173.30
Quality-of-life_availability	7.00	5.00	5.19	1.76	2.00	9.00	0.00	0.00	−153.70
Quality-of-life_accessibility	7.00	5.00	5.25	1.60	2.00	9.00	0.00	0.00	−174.25
Quality-of-life_liveability	6.00	6.00	5.21	1.87	2.00	9.00	0.00	0.00	−147.44

Source: Primary data

Table 3.9 Measures of central tendency and Z-score for middle-income groups in MMR

	Middle-income groups								
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite Z-score
Water_availability	5.00	5.00	5.90	1.86	1.00	10.00	9.00	29.00	−31.56
Water_accessibility	6.00	6.00	6.26	1.68	2.00	10.00	0.00	22.00	−52.13
Water_liveability	5.00	6.00	5.89	1.76	2.00	10.00	0.00	17.00	−46.80
Public-trans_availability	5.00	5.00	5.36	1.73	2.00	10.00	0.00	6.00	−31.72
Public-trans_accessibility	4.00	5.00	5.42	1.73	2.00	10.00	0.00	9.00	−40.38
Public-trans_liveability	5.00	6.00	5.69	1.56	2.00	10.00	0.00	3.00	−50.49
Private_trans_availability	5.00	5.00	5.35	1.94	1.00	10.00	24.00	12.00	−39.46
Private_trans_accessibility	6.00	6.00	5.63	1.94	2.00	10.00	0.00	14.00	−40.10
Private_trans_liveability	7.00	6.00	5.74	1.89	1.00	10.00	9.00	6.00	−41.49
Energy_conventional_availability	6.00	6.00	6.01	1.34	1.00	10.00	1.00	10.00	−63.68
Energy_conventional_accessibility	6.00	6.00	6.06	1.35	2.00	10.00	0.00	10.00	−102.21
Energy_conventional_liveability	5.00	6.00	6.10	1.49	3.00	10.00	0.00	15.00	−103.56
Energy_non-conventional_availability	5.00	5.00	5.45	2.07	1.00	10.00	19.00	4.00	−53.87
Energy_non-conventional_accessibility	5.00	5.00	5.48	1.93	1.00	10.00	7.00	5.00	−82.30
Energy_non-conventional_liveability	4.00	5.00	5.43	1.94	1.00	9.00	10.00	0.00	−77.42
Sanitation_availability	5.00	6.00	6.22	1.77	1.00	10.00	10.00	10.00	−41.95
Sanitation_accessibility	7.00	7.00	6.54	1.57	1.00	10.00	1.00	11.00	−61.67
Sanitation_liveability	7.00	7.00	6.66	1.39	1.00	10.00	2.00	11.00	−67.47

Table 3.9 (continued)

				Middle-income groups					
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite *Z*-score
Public_health_availability	6.00	6.00	5.79	1.33	1.00	10.00	1.00	2.00	−52.68
Public_health_ accessibility	5.00	6.00	5.80	1.33	3.00	10.00	0.00	5.00	−64.48
Public_health_liveability	5.00	6.00	5.80	1.34	2.00	10.00	0.00	1.00	−72.69
Private-health_availability	5.00	5.00	5.74	1.75	1.00	10.00	1.00	10.00	−209.95
Private-health_ accessibility	5.00	6.00	6.05	1.59	1.00	10.00	1.00	5.00	−251.35
Private-health_liveability	6.00	6.00	6.12	1.57	2.00	10.00	0.00	5.00	−257.94
Public-education_ availability	5.00	6.00	5.80	1.43	1.00	10.00	1.00	3.00	−48.53
Public-education_ accessibility	6.00	6.00	5.86	1.34	1.00	10.00	1.00	2.00	−62.22
Public-education_ liveability	5.00	5.00	5.88	1.45	1.00	10.00	1.00	2.00	−53.82
Private-education_ availability	5.00	5.00	5.78	1.85	2.00	10.00	0.00	15.00	−41.48
Private-education_ accessibility	6.00	6.00	5.95	1.68	2.00	10.00	0.00	9.00	−50.80
Private-education_ liveability	7.00	6.00	6.03	1.73	2.00	10.00	0.00	9.00	−57.61
Safety-and-security_ availability	6.00	6.00	6.16	1.46	1.00	10.00	5.00	7.00	−51.56
Safety-and-security_ accessibility	6.00	6.00	6.24	1.46	2.00	10.00	0.00	7.00	−81.45

				Middle-income groups					
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite *Z*-score
Safety-and-security_ liveability	6.00	6.00	6.13	1.59	1.00	10.00	2.00	4.00	−58.04
Public-housing_ availability	5.00	5.00	5.55	1.45	1.00	10.00	2.00	2.00	−57.34
Public-housing_ accessibility	4.00	5.00	5.43	1.49	1.00	10.00	3.00	2.00	−57.17
Public-housing_liveability	5.00	5.00	5.60	1.44	1.00	10.00	2.00	1.00	−45.49
Private-housing_ availability	5.00	5.00	5.81	1.69	2.00	10.00	0.00	16.00	−48.95
Private-housing_ accessibility	5.00	5.00	5.74	1.68	1.00	10.00	1.00	16.00	−68.30
Private-housing_ liveability	4.00	6.00	5.86	1.82	2.00	10.00	0.00	15.00	−49.48
Public-spaces_availability	5.00	5.00	5.64	1.62	1.00	10.00	2.00	2.00	−45.14
Public-spaces accessibility	5.00	5.00	5.95	1.53	1.00	10.00	2.00	5.00	−57.75
Public-spaces_liveability	5.00	6.00	5.65	1.80	1.00	10.00	1.00	1.00	−53.03
Leis-recre_availability	5.00	6.00	6.07	1.61	1.00	10.00	3.00	10.00	−56.71
Leis-recre_accessibility	6.00	6.00	5.81	1.93	1.00	9.00	2.00	0.00	−59.96
Leis-recre__liveability	5.00	6.00	5.79	2.00	1.00	10.00	2.00	1.00	−54.04
Entertainment_availability	5.00	6.00	5.92	1.50	1.00	10.00	1.00	7.00	−68.24
Entertainment_ accessibility	5.00	6.00	5.99	1.47	2.00	10.00	0.00	1.00	−73.24
Entertainment_liveability	5.00	6.00	5.77	1.78	1.00	10.00	5.00	1.00	−65.40
Net-connect_availability	5.00	5.00	5.71	1.46	1.00	10.00	1.00	6.00	−50.98
Net-connect_accessibility	5.00	6.00	5.74	1.64	1.00	10.00	1.00	2.00	−77.70

				Middle-income groups					
Indicator	Mode	Median	Mean	Standard deviation	Minimum score	Maximum score	Frequency of the minimum score	Frequency of the maximum score	Composite *Z*-score
Net-connect_liveability	5.00	6.00	5.68	1.84	1.00	10.00	1.00	2.00	−44.26
Employment-opportunities_availability	5.00	5.00	5.47	1.53	2.00	10.00	0.00	3.00	−46.74
Employment-opportunities_accessibility	5.00	5.00	5.73	1.51	1.00	10.00	1.00	4.00	−54.36
Employment-opportunities_liveability	5.00	5.00	5.49	1.59	1.00	10.00	3.00	4.00	−59.86
Community-life_availability	5.00	5.00	5.60	1.35	1.00	9.00	1.00	0.00	−53.93
Community-life_accessibility	4.00	6.00	5.70	1.45	1.00	10.00	1.00	1.00	−53.86
Community-life_liveability	5.00	6.00	5.83	1.34	2.00	10.00	0.00	1.00	−94.06
Natural-environment_availability	5.00	6.00	5.68	1.54	1.00	10.00	3.00	6.00	−48.34
Natural-environment_accessibility	5.00	5.00	5.69	1.67	1.00	10.00	2.00	7.00	−42.58
Natural-environment_liveability	6.00	6.00	5.88	1.51	1.00	10.00	2.00	2.00	−55.66
Governance_availability	4.00	5.00	5.32	1.40	1.00	10.00	2.00	1.00	−40.09
Governance_accessibility	5.00	5.00	5.45	1.42	1.00	10.00	1.00	2.00	−52.71
Governance_liveability	5.00	5.00	5.61	1.36	1.00	9.00	1.00	0.00	−57.45
Quality-of-life_availability	4.00	5.00	5.74	1.65	1.00	10.00	1.00	2.00	−43.69
Quality-of-life_accessibility	5.00	5.00	5.88	1.54	1.00	10.00	1.00	2.00	−58.47
Quality-of-life_liveability	6.00	6.00	6.16	1.50	1.00	10.00	1.00	3.00	−64.85

Source: Primary data

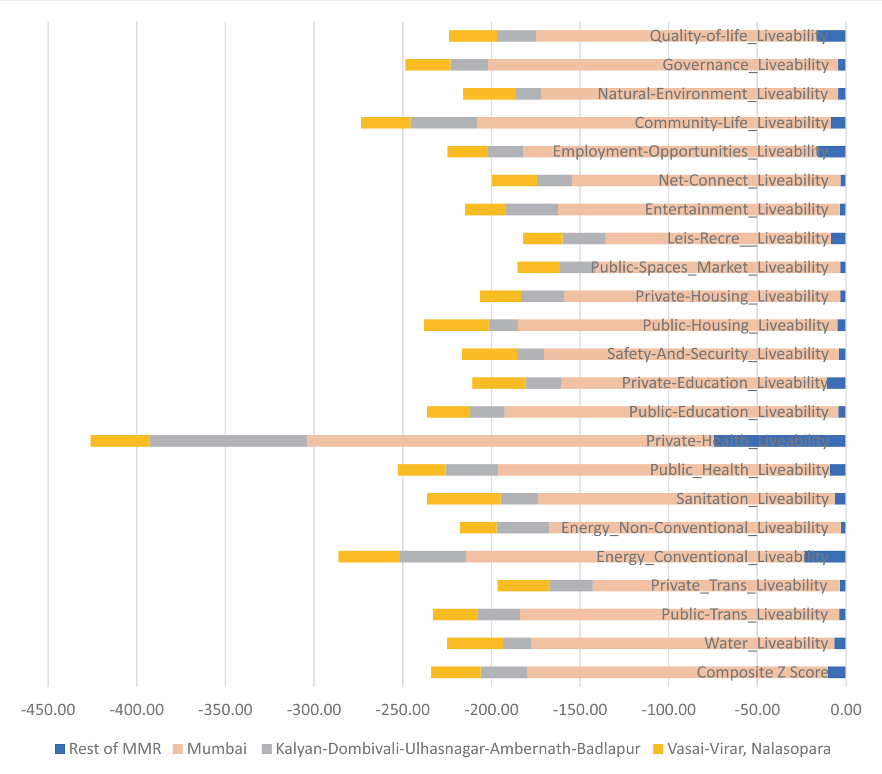


Fig. 3.2 Representing liveability through *Z*-score. (Source: Primary data)

(b) Simple statistical techniques have been applied to emerge with liveability score. It is not ranking as one particular wider area has tremendous internal variation. There cannot be one ranking for each area. One wider area like Mumbai City has scores for micro-space within it.
(c) The use of *Z*-score allows the user to identify the disparity within economic class as well as within the wider metropolitan regions. It becomes easy to understand the spatiality of liveability.
(d) With the help of geospatial technologies, it is possible to emerge with a very powerful visualisation of liveability. Maps with geolocations and their qualitative characteristic features can give good visualisation regarding understanding the distributional aspects of the services and facilities provided. Preparation of communicative maps allows the user to have understanding of individual spaces in terms of availability, accessibility and liveability status.
(e) The major lacuna in current liveability research is regarding the complete mismatch between the benchmarks set by the state and actual level of service availability and accessibility. This has been addressed in the present research well.

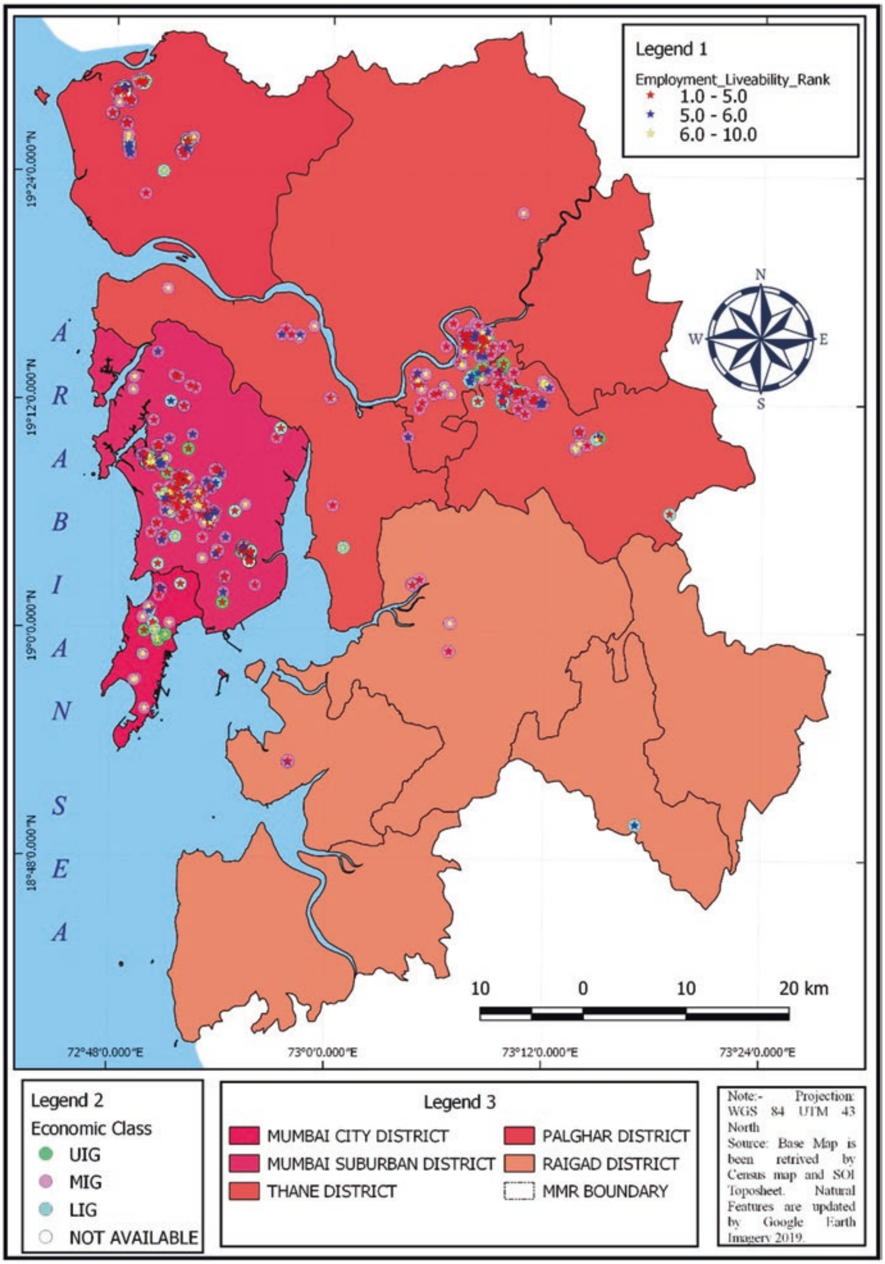


Fig. 3.3 Liveability: employment generation in select spaces of MMR. (Source: Primary data)

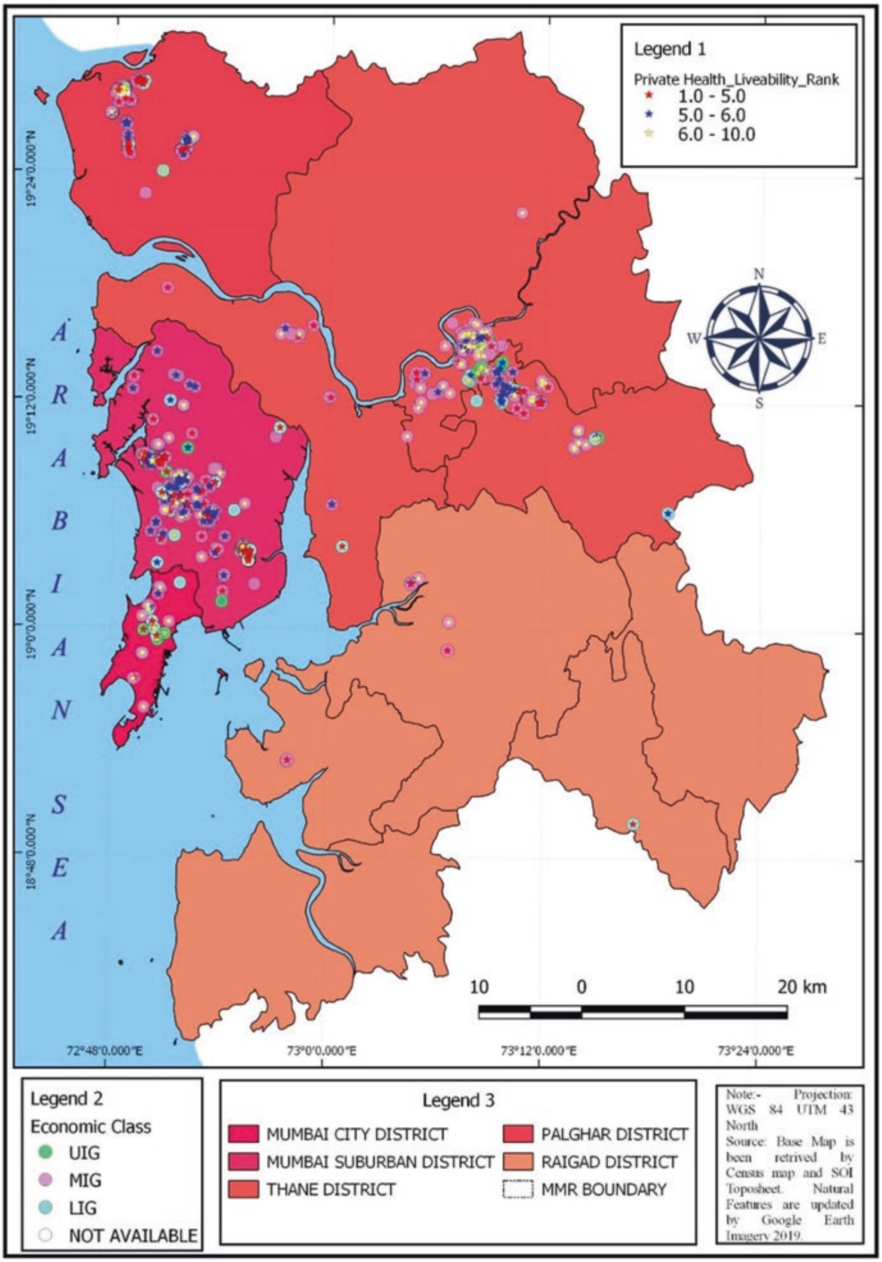


Fig. 3.4 Liveability – private health facilities in MMR. (Source: Primary data)

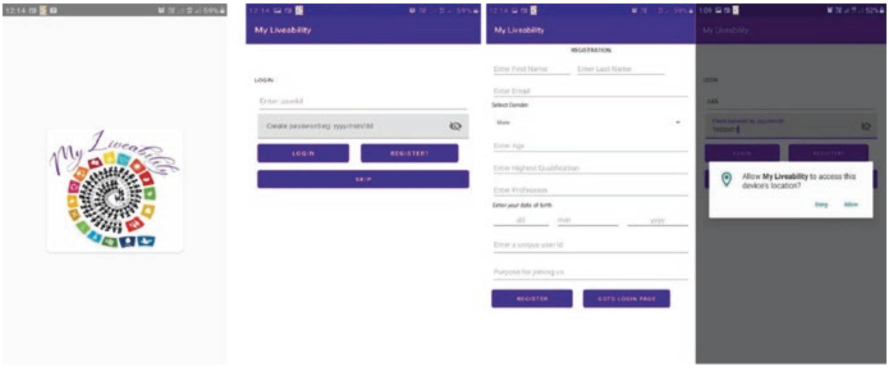


Fig. 3.5 The screenshots of My Liveability. (Source: Authors)

Fig. 3.6 Collection of expected and actual data. (Source: Authors)

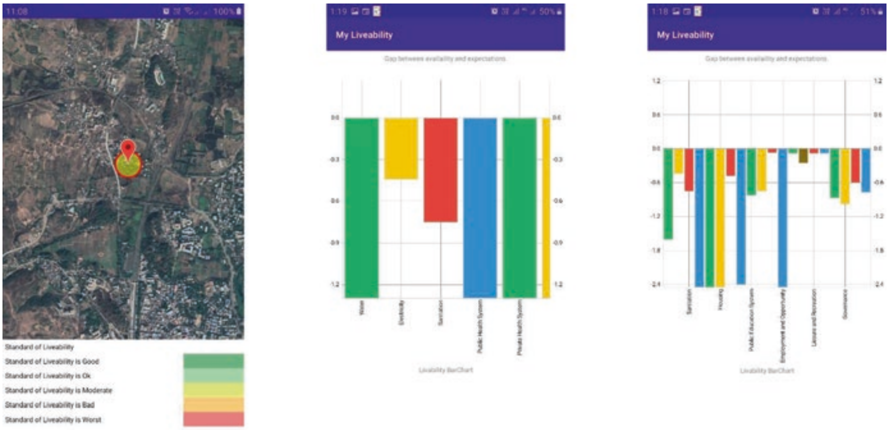


Fig. 3.7 Data visualisation in the app

(f) To remove this lacuna, communities can be trained in mapping their own liveability through various governmental and non-governmental organisations. The same will allow a huge compilation of datasets that are local in nature and help in setting the local benchmarks. The local benchmarks are of vital significance because they emerge from the geographical understandings. The expectations of people would convey the priority areas where planning is needed on an urgent basis. The same will also involve local communities in the process of local area planning process. To emerge with sustainable urban future, the urgent need of the hour is empowering the communities through community participation in the process of microlevel planning.

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Chapter 4
Operationalizing the Regional Sustainability Assessment by Indicators

Victor Tomaz de Oliveira, Denilson Teixeira, and André C. S. Batalhão

Abstract The regional scale has the potential to reduce the distance between the population, decision-makers, and stakeholders in general, which facilitates interaction between them and favors an evaluation process capable of indicating more sustainable and more effective paths. However, the regional sustainability assessment is not an easy task, and some challenges make this activity more challenging. Among the main challenges are the availability and accessibility of disaggregated data that describe the region, the effective participation of stakeholders in the development of indicators, the periodicity of the sustainability assessment, and, in particular, the integration of the spatial dimension in the assessment process. Evaluating sustainability spatially implies recognizing regional heterogeneity, bringing to decision-makers the perception of the need for sustainability strategies that are not homogeneous. In addition, communication based on a spatial representation (maps) contributes to society, achieving a better understanding and interpretation of the results. This chapter presents the challenges and practices concerning the regional sustainability assessment.

Keywords Regional sustainability · Sustainability assessment · Sustainable development

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1 Introduction

The discussions about the need for conceptual clarification around sustainability and sustainable development (SD) are still emerging and are proving to be a great challenge (Kuhlman & Farrington, 2010). However, the definition that sustainable development is characterized as “development that meets the needs of the present without compromising the ability of future generations to meet their own” is widely accepted (WCED, 1987). This is an interpretation that perceives sustainability from pillars representing the ecological (or environmental) system, the economic system, and the social system, although it is a difficult approach to identify its origin and questionable theoretical foundations (Purvis et al., 2019).

Although there are different currents of thought, this is a precept that favors sustainability assessments (SA) because it can meet the individual capacities of the participants in the assessment process, in addition to favoring the use of data that are often collected from this fractioned vision of the environmental, socioeconomic systems (Ginson, 2006) and sometimes with the insertion of a fourth dimension, for example, the institutional one (Purvis et al., 2019).

Although they diverge in the number of dimensions in which the human-nature relationship is expressed, there is a convergence in the understanding that, in order to achieve development on the path to sustainability, there is the need to carry out assessments that are able to “specify a limit between what contributes to sustainable development and what does not” (Sala et al., 2015), and from there, being able to support decision-making processes, whether at a strategic or operational level (Ramos, 2019).

There is a wide range of methods and tools capable of evaluating and reporting the SD; however, the use of sustainability indicators (SI) represents one of the most popular instruments used to translate the sustainability assessment (SA). Assessments that use SD-oriented SI seek to incorporate and integrate these different dimensions; therefore, these and other factors imply not only a series of opportunities but also challenges (Ramos, 2019).

Among some challenges that can be identified in applying SI at all scales are the methodological processes of developing indicators, weighing methods (weighting), and data availability and reliability (Verma & Raghubanshi, 2018). Other challenges can be encountered depending on the scale applied.

In a regional sustainability assessment (RSA), for example, Wallis et al. (2007) highlight obstacles such as the selection of indicators that are really in line with the sustainability vision of the assessed area, the need for inclusion and encouragement of stakeholder participation, the accessibility and condition of the data that feeds the assessment, and the unavailability of georeferenced data. While Graymore et al. (2008) mainly highlight the unavailability of data that are appropriate to the assessment scale, Coelho et al. (2010) state that an RSA should dialogue with the objectives of local and national developments, and that is why it needs to be an assessment that allows for the interaction between the different scales, but that this is still an underexplored issue.

Based on the above, we can infer that a regional sustainability assessment (RSA) requires even more specific observations. In an attempt to contribute to this debate, this chapter aims to discuss different operational particularities of the RSA, pointing out methodological paths to overcome challenges that we consider essential in the operationalization of the evaluation and that aim to fill some identified gaps, namely, the multilevel interaction, where the indicators dialogue in a cross-scale approach; the inclusion of stakeholders in the selection of indicators, from a broadly participatory perspective; and the geospatial approach in RSA.

Thus, this chapter is organized as follows: after the introduction, in which we present an overview of the concepts and gaps that remain in the RSA processes, we continue with a contextualization of different sustainability understanding (Sect. 2) that will support the multidimensional SD approach (Sect. 3). In Sect. 4, some challenges and particularities inherent to SI applications in RSA found in the literature are raised. Section 5 points out some methodological solutions proposed by different studies that aim to overcome three challenges which we point out as essential for an RSA. In Sect. 6, some final considerations are presented.

2 Sustainability: A Multidimensional Concept

After analyzing a vast body of literature on sustainability, Kuhlman and Farrington (2010) concluded that the concept that defines it remains to be clarified. Thus, the conceptual definition of sustainability, or sustainable development (SD), remains one of the main debates among thinkers on the subject, and this causes many and different concepts to be developed. Bolis et al. (2014) emphasize that the complexity surrounding sustainability is even more significant as its conception can mean many things to different people and that this plurality of meanings tends to increase over time.

However, there is a definition of sustainable development that is widely adopted worldwide, whether in academic or political literature (Purvis et al., 2019) and has been popularized by the United Nations as one that strikes a balance between the current generation's needs and those of the future generations (WCED, 1987). But Janouškov (2018) adds that this definition can serve as a springboard for a variety of interpretations, because it is accompanied by imprecision, ambiguity, and, at times, contradictions. Sala et al. (2015) corroborate this view and draw an analogy between the concept of SD and social justice, inferring that both are value-laden concepts and therefore capable of generating different perspectives and perceptions.

To illustrate the theoretical complexity surrounding the topic, we have identified here four different approaches in which sustainability can be interpreted according to Patterson et al. (2017), namely, ecological interpretation, economic interpretation, thermodynamic and ecological-economic interpretation, interpretation through the approach of public policies, and the theory of planning for sustainability. Although conceptually distinct, these interpretations have in common the focus on valuing natural resources as instruments for human well-being (Seghezzo, 2009).

This anthropocentric view of sustainability permeates the majority of conceptual debates and is premised solely on attention to human values and humanity's well-being, which means that policies involving the environment are directed toward this end (Seghezzo, 2009). Despite this, other currents of thought have also directed the sustainability discourse toward a more holistic worldview, also recognized as "eco-centric," in which nature would have an intrinsic value, that is, it is directly related to human interests (Ramos et al., 2020; Seghezzo, 2009).

At the same time, some less radical strands of thought discuss sustainability frameworks that involve spatial, temporal, and individual characteristics that may be disconnected from economic growth, a quality ecological environment, and even social justice (Seghezzo, 2009). This approach focuses mainly on the criticism and discussion of the overestimation of the economic dimension in the sustainable development pursuit.

However, such perspectives are far from the anthropocentric understanding of sustainable development pointed out by the United Nations from the report "our common future" (Brundland report), through Agenda 21 and more recently in Agenda 2030, in which economic growth can be seen as a solution to ecological and social adversities (Purvis et al., 2019). This description of sustainability in which economic, social, and environmental systems are seen separately but interconnected is prevalent (Purvis et al., 2019). We can find in the literature different nomenclatures for this triple relationship, such as "pillars of sustainability" (Ginson, 2006), dimensions (Stirling, 1999), or components (Stirling, 1999).

It appears, therefore, that the most widely accepted and disseminated conceptual and methodological path, whether in academic literature or in the political sphere, perceives sustainability from three bases that represent the ecological (or environmental) system, the economic system, and the social system. This conceptualization, sometimes called the triple bottom line (TBL), begins explicitly in 1987 with Barbier's (1987) description of three sustainability system objectives (biological, economic, and social) and gains strength after strong corroboration of the United Nations in its reports thereafter.

This understanding then becomes widely accepted for different scales. In line with this anthropocentric view, Smetana et al. (2015) define regional sustainability (SR) as the capacity that a system has, on a regional scale, to support current socio-economic and environmental conditions and which provides, or enables, future development, or, in the worst case, maintenance of the current state. Still in agreement with this perspective, Graymore et al. (2008) add that this concept implies that the population must live respecting the limits of social, economic, and environmental systems, in order to guarantee the equitable sharing of resources in an intergenerational way.

If we consider the different interpretations of sustainability listed by Patterson et al. (2017), we see that Smetana et al. (2015) define RS based on an alignment with the public policy approach and the theory of planning for sustainability, that is, it is a concept that, structurally, envisions a type of "balance" between the factors that are composed of multidimensional aspects. Therefore, it is a sustainability that, in order to be evaluated, criteria that involve human interaction and the environment in different dimensions must be considered.

3 Multidimensionality That Favors Assessment

This multidimensional approach, however, has an important advantage when it comes to assessing sustainability. In this sense, Ginson (2006) considers that this separation into different dimensions may come from the individual capacities of specialists who participate in the evaluation process, and it confluences with the way in which much of the data is collected separately, considering such categories, in addition to the institutional structure of governments, which generally takes place in a sectorial manner.

However, it should be noted that, although there is a broad TBL approach in several AS works, some studies consider the insertion of additional dimensions, such as institutional, cultural, and technical (Quadruple Bottom Line - QBL) (Purvis et al., 2019). Among the examples mentioned, the institutional dimension, or also called governance, has the potential to support decision-making that actually leads the evaluated areas to the path of sustainability. This is because the inclusion of governance among the sustainability dimensions can provide insight into sustainability areas that, in other TBL approaches, may be neglected, such as community involvement, transparency, accountability, and ethics (Aliba, 2017).

Whether using TBL or QBL approach, achieving sustainability requires obtaining assessment methods that can reliably measure sustainability, in order to enable well-informed planning and decision-making (Graymore et al., 2010), that is, it must translate the relationship of the systems that involve society in nature to decision-makers, in order to help them determine which actions should or should not be taken, related to a certain area (Kates, 2000), and this is not an easy task.

One of the most accepted understandings of sustainability assessment (SA) is the idea that it is possible to measure the sustainability state of an object of analysis, be it a nation, region, municipality, or company, in a multidimensional context involving the interaction between human activities and the environment. This concept can be expanded, as explained by Ramos (2019), because SA is widely used based on two distinct but complementary objectives, that is, if on the one hand, it can characterize the state of sustainability of a situation currently implemented, on the other hand, the evaluation can predict the possibilities of the implementation of some future activity.

Therefore, whether on a macro (strategic) or micro (operational) scale, this measurement must consider multidimensional data that vary according to the evaluation objectives. O'Connor (2010) adds that SA should also pay attention to the types of concepts that guide the assessment, the framework adopted, and the set of data that may be relevant to support the decision.

The concerns pointed out by O'Connor are part of a set of characteristics that differentiate an AS from a "purely" integrated assessment, that is, they must be conjectures that go beyond the simple integration of dimensions but that have sufficient scope and robustness to leverage effectively sustainability, going beyond the simple assessment of its progress. Sala et al. (2015) bring this important theoretical discussion about the fundamental differences between SA and other assessment methods and point out that, given the epistemological uncertainties of sustainability, it is a concept potentially influenced by personal views, it is deeply related to cultural perspectives, featuring a political nature, not being thus possible to separate the evaluation process of the effective involvement of stakeholders at all stages.

Although there are several methods for the SA, Sala et al. (2015) also point out that the most used tool is the use of sustainability indicators (SI), thus obtaining a prominent role in the evaluation that involves decision-making. It is essential to have an assessment that actually reflects the specifics of the area studied, inevitably passing by the process of selecting the indicators to be applied. However, this is still one of the greatest challenges for SA.

4 Regional Sustainability Assessment: Operational Challenges

Verma and Raghubanshi (2018) point out several challenges in using SI for SA. According to these authors, the challenges are divided into two categories, internal and external. In the context of internal challenges, problems such as the methodology used for the development of indicators, methods used in weighting, and the application of excessively complex or simplistic methods are listed. In the context of the external challenges are the lack of data, resistance on the part of government agents to implement the indicators, lack of consensus, and lack of comparative analysis. According to the aforementioned authors, these are some common problems in the implementation and incorporation of indicators in decision-making.

In this sense, Ramos (2019) brings a discussion that aims to identify new frontiers in the use of SI from an analysis that qualifies a set of challenges and opportunities identified in the literature, expanding those already pointed out by Verma and collaborators. In this study, Ramos identifies, for example, that the limitations related to data availability, the improvement in the criteria for selecting indicators, and the use of remote sensing technologies and data are highly relevant. These are examples of issues related to the operationalization of SI at all scales. In a regionalized context, these and other difficulties inherent to the assessment scale emerge. Below, we highlight three works that observed some obstacles at the regional scale.

Wallis et al. (2007) point out some challenges found in an RSA in Vitoria city – Australia southwest region and that can easily be faced in other regions of the world, such as the selection of indicators that really reflect the sustainability vision of the evaluated area; the availability, accessibility, and condition of the regionalized data that feed the assessment; the deterioration of confidence in the data due to incompatibility of time and collection techniques; the absence of qualitative data that could more appropriately reflect local values; and the absence of in-depth knowledge of the interdependencies of natural and human systems in the region.

Graymore et al. (2008) analyze the effectiveness of five sustainability assessment methods at the regional level and demonstrate that none were fully effective, mainly due to the absence, at a regional scale, of much of the data needed to carry out the assessment, in addition to the weakness in the aggregation process based on the integration of indicators. Based on this observation, Graymore et al. (2010) propose an assessment method that is applicable at a regional scale, based on the concept of human support capacity, and that is capable of producing well-informed decision-making, supporting the implementation of managing action strategies aimed at regional sustainability and that would facilitate awareness by the community about sustainability, enabling the inclusion of stakeholders in the transition. However, they also found limitations, mainly regarding the availability of data at a regional scale.

On data-related limitations, Wallis et al. (2007) point out the unavailability of economic, social, and even biophysical data that are georeferenced and that adequately meet the spatial and temporal scale. In their studies, Wallis and collaborators recognize the importance of using geographic information systems (GIS), which are a powerful tool in the collection, storage, and management of geospatialized data used in the development of indicators, and point to the possible visual impacts caused on the managers and decision-makers, who would facilitate the identification of potential intervention sites.

5 RSA Operational Gaps and Methodological Pathways

In this section, we will point out three different methodological pathways that aim to fill some gaps in RSA. First, we indicate a guideline for the regional sustainability indicators' interaction process with the local and supra-regional levels, in order to enable comparative analyses. Afterward, we will discuss the importance and a brief path for the operationalization of stakeholder involvement in the indicator selection process. And finally, we will discuss the geospatial approach in RSA, where the spatial dimension is presented as a key element, and the application of geospatial techniques, tools, and data can be essential.

5.1 Multilevel Interaction in the RSA

The classic concept of region describes it as a geographic area, which can be the result of grouping processes determined by the state, aiming to organize its territorial base with a view to public policies. This is what Cooke (2006) translates when he defines the region as an administrative division of a country, below the national level, but above the local or municipal level. However, regionality can also be established by natural limits, such as a set of hydrographic subbasins, not restricted to administrative limits. Therefore, it is a grouping of different geographic or administrative units, which may reflect different impacts generated from the relationship of human activities in the nature inserted there.

Therefore, if we think within an ecological context, we can add that this geographic area ends up connecting multiple biodiversity spatial and temporal scales (Brunckhorst, 2005). However, we understand that this multiscale connection, in time and space, is not exclusive to the environmental system but can also occur in socioeconomic systems. This makes the agents involved in regional governance have a particular SD task, as they are faced with different environmental, social, and economic conditions (Smetana et al., 2015).

And it is in this context of regional heterogeneity that we highlight the importance of RSA. This must be a process capable of going beyond an assessment between the places that are inserted in the region, but it must also allow a comparison of the sustainability performance between different regions, in order to promote the interaction between different spatial scales. However, to satisfactorily carry out this interaction of scales, it is necessary to have specific RSI, and which contain national and local relevance (Coelho et al., 2010). Therefore, here we have two distinct situations of multilevel interaction, one interregional, in which the evaluation process also looks at other regions, and the intraregional, in which the region is assessed as internal geographic units.

In the first (interregional), it is essential to use SI that provide enough information for a comparison of sustainability to be carried out and thus improve the analysis of asymmetries between different regions. In the second (intraregional), SI common to the localities and that can be adopted by all municipalities are necessary, which promotes competition between them. This approach increases the chances of involving local communities in the regional assessment process. To better clarify how RSIs act in the context of interregional and intraregional interactions, we describe below the main theoretical and methodological directions pointed out by Ramos (2009) and Munda and Saisana (2011).

5.1.1 Interregional Multilevel Interaction

To achieve the objective of producing information that enables a comparison of sustainability performance between regions, from a regional/national perspective, it is necessary to have a subset of common regional indicators (SCRI) inserted in the basic RSI set. This subset should be composed of indicators that have as an intrinsic characteristic their availability to all regions within the national governance scope. In this sense, in order to ensure greater consistency in its definition, this subset needs to be established at the national level. Thus, the SCRI will complement the specific regional indicators (Ramos, 2009; Munda and Saisana (2011).

Furthermore, there is also the possibility that each region has its own set of headline indicators that can compose, totally or partially, the national set. The selection of these indicators takes place according to the degree of relevance attributed by the interested parties (stakeholders) at a regional and local level and by the majority of specialists. This set of specialists can be formed by members of the academy, employees of regional agencies, in addition to other specialized professionals, including from other regions, and their participation takes place in the role of a steering or advisory group (Coelho et al., 2010) and will help to identify those indicators that are most relevant to the assessed region.

The headline indicators are very important in RSA because they have a high power to communicate sustainability to decision-makers, in addition to providing information that is particularly useful to nontechnical stakeholders (Ramos, 2009).

5.1.2 Intraregional Multilevel Interaction

If we analyze the composition of the SSI set, from the perspective of the regional/local relationship, we will see that it is necessary to define a subset of common local indicators (SCLI). This makes it possible to analyze the asymmetry between the places that make up the region. To select this subset of indicators, it is necessary to take into account the strategic instruments of the municipalities, based not only on common local resources and characteristics but also on shared objectives and goals. Thus, this set of RSI can also be used as a monitoring tool for these strategic instruments, such as a regional spatial project through land-use planning (Mascarenhas et al., 2010). However, Wallis et al. (2007) warn that, in order to access local knowledge, these main indicators must be also composed of qualitative data because they can truly represent local values. The obstacle, in this case, remains the availability of this type of information.

Having overcome this difficulty, it is clear that the existence of SCLI facilitates the formulation of appropriate public policies. And this happens as it becomes possible to identify the vulnerabilities and risks to ecosystems, social communities, and economic categories for each location. Thus, the relevant characteristics and actions taken in one municipality can be compared with their counterparts in other municipalities. This will allow local decision-makers to point the strengths, weaknesses, opportunities, and existing threats, as well as discuss and share new ideas, which provides a rich process of mutual learning (Mascarenhas et al., 2010).

This approach of common local indicators in an RSA has two very important skills. On the one hand, it promotes the qualitative and quantitative enrichment of data at a local scale that is also relevant regionally, and on the other, it has the potential to involve local stakeholders in the assessment process. This creates an interactive process with communities (Coelho et al., 2010).

The organization of the core set of indicators and the intra- and interregional ISR subgroups are illustrated in Fig. 4.1.

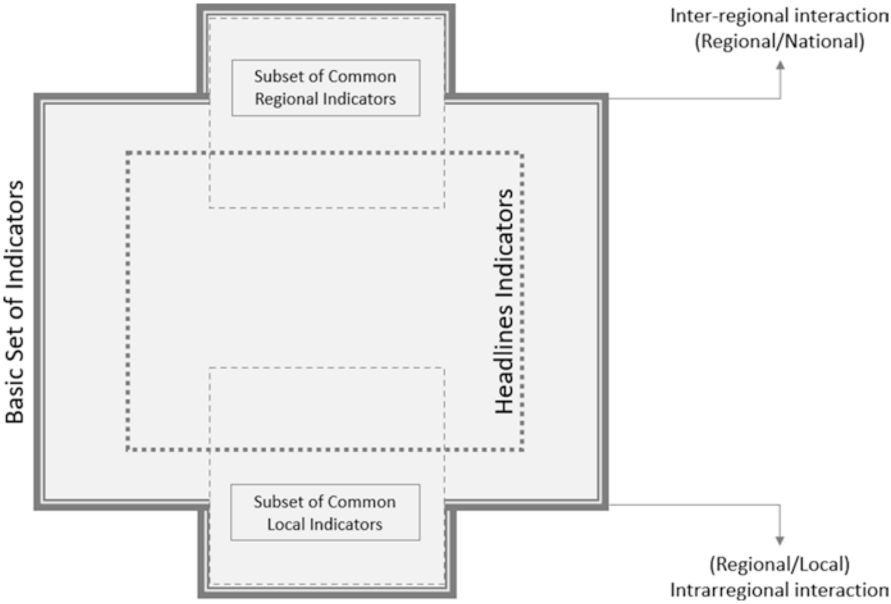

Fig. 4.1 Schematic composition of the core set of indicators

5.2 Stakeholder Participation in RSA

Public participation in RSA processes using indicators plays a key role. Ramos (2009) highlights the relevance of this participatory approach not only by experts but also by stakeholders in general. And he adds that this participation is especially important at regional and local scales because it is precisely at these scales that there is greater proximity between the community, experts, and decision-makers, which can represent a simpler and more effective interaction. To better explain how this interaction of stakeholders in RSA can take place, we will address some aspects pointed out by Coelho et al. (2010), among them, the identification of who these stakeholders are and how they are organized, where public participation can effectively occur, the tools and instruments to operationalize this participation, in addition to the advantages of adopting this practice.

Coelho et al. (2010) identify three main stakeholder groups that in some way may be included in the participation process: (i) national, regional, or local public administration agents, (ii) private groups representing companies or industries, (iii) and the general public with representatives of the community as well as of nongovernmental organizations (NGOs). It is noteworthy that, sometimes, a fourth group can act with a consultative character, formed by specialists.

Undeniably, stakeholders can be a viable source in identifying the most relevant and priority regional and local sustainability issues, which is why public participation in the selection of general indicators as well as the *headlines indicators* is so important. Furthermore, integrating the community also allows for a voluntary data collection movement (Coelho et al., 2010). Obviously, this process needs to be coordinated in order to achieve good reliability of the collected data.

Therefore, it is necessary to provide means, or techniques, that enable this participatory process of selecting indicators where regional and local actors can interact in order to collaborate. Among some instruments, we mention workshops and seminars, which can be open to the participation of all stakeholders. In addition, some thematic meetings can take place where more specific stakeholders participate, such as NGOs and public and private institutions. In this case, they are carried out through sectorial meetings, working groups, and round tables (Ramos, 2009).

In general, the participatory approach is of paramount importance to create an interactive movement with communities, inserting them into the RSA process from the beginning. Thus, it is possible to obtain a set of indicators that are in fact relevant and that measure more precisely what is regionally significant.

5.3 Geospatial Approach in the RSA

We highlight here some important aspects that must be considered in an RSA from the perspective of geospatial characteristics inherent to the regional scale, where the heterogeneity of resources, in all dimensions, is intrinsic. We want to demonstrate that, if on the one hand, the spatial characteristics of the regions can pose new challenges, on the other hand, the application of geospatial techniques, tools, and data can represent new opportunities.

As already mentioned, the determination of indicators that are common at different scales can favor the comparative analysis of sustainability performance within and across regions. However, Smetana et al. (2015) warn that the differences between the state of regional sustainability will depend on the quantity and quality of available resources and that the region's spatial characteristics, namely, shape, size, and physical quality of the environment, can be determining factors in the result.

Here, an important challenge is highlighted, which is the definition of the limits of the region in which it intends to assess. An RSA that considers a region characterized by administrative boundaries (Cooke, 2006) may encounter difficulties for comparative analyses. This is because the regions will have different sizes, and it is to be expected that the larger the size, the greater the number of resources, for example. Furthermore, the spatial distribution of these resources must be considered because they are likely to be unevenly distributed. The georeferencing of the resources evaluated can favor a localized understanding of the problems that lead the region away from the path of sustainability.

We can exemplify from the mapping of land use and occupation patterns that can be seen as a key element for RSA. The work of geospatial identification of land use in a region is of great importance, for example, to verify the existing relationship with areas of degraded soil, or with the imbalance in the availability of water resources, or even with the loss of biodiversity (Smetana et al., 2015), that is, they are extremely important information for RSA. Thus, what can be seen is that, whether due to the heterogeneity in the spatialization of resources, or concerning the size of the region, or how the limits are arranged, the use of geospatial data is an essential way to obtain more effective results.

5.3.1 Spatialization of Data for RSA

As mentioned above, we understand that for a SA focused on SD, different dimensions involving human actions and the environment must be addressed in an integrated manner. These different dimensions are represented by SI which in turn are reached from environmental and socioeconomic data. However, due to the nature of the information, these data may have different collection methodologies, causing them to be represented in different spatial contexts.

To illustrate the abovementioned situation, we can mention the measurement of the gross domestic product (GDP) inserted in the socioeconomic dimension (although widely criticized), and which is, for the most part, scaled to municipal scales or larger. The same is true for demographic data, income and education, unemployment, housing, among others, while environmentally important data, such as measuring environmental noise, for example, inevitably occurs at a local level. Therefore, it is evident that the assessment scale has a fundamental role in choosing the indicators to be used.

However, the characteristics and particularities of data spatialization and its use in RSA go beyond that. The European report *Planning System for Sustainable Development*, by the *Ministry of Environment and Energy of Denmark – PSSD* (Hansen, 2001), makes some observations that are technically important for discussing the operational challenges that exist when developing SI for RSA concerning the geometric shape of representation. It is well known that some socioeconomic and environmental data are collected from a relationship with polygonal entities; however, there may be intrinsic structural differences between them. In other words, if, on the one hand, social and economic data are almost always collected considering spatial units that have been administratively defined, on the other, environmental data come from a specific spatial variation.

Therefore, there may be a conflict in the way in which these data are geometrically represented, featuring another methodological challenge which is the crossing of data to determine the performance of regional sustainability. To represent this situation, we return to the example of GDP, which is represented polygonally (city, region, country, continent, etc.), while environmental noise is represented punctually. We observe the same situation between data on land use and occupation (polygonal) and air quality or traffic count (punctual), for example. Despite this, SI are commonly based on statistical aggregations that disregard the spatial distribution of data, restricting themselves to administrative limits (Hansen, 2001). These limits may change over time.

These notes highlight some challenges inherent to the spatial problem in RSA, which can create difficulties for decision-making processes that actually lead to DS. However, some initiatives have been developed in order to provide methodological solutions for a spatialized sustainability assessment, based on the use of geospatial techniques, tools, and products, such as the geographical information system (GIS) and data from remote observations of the earth (Remote sensing).

5.3.2 Geospatialized RSA

GIS is a powerful tool that acts from the collection, storage, processing, and evaluation of spatialized data, in addition to providing an efficient visualization of results in a geographic context. Remote sensing, on the other hand, can be understood as a science that, in general, acts in the observation of the earth through orbital sensors that record electromagnetic energies from different fractions of the electromagnetic spectrum, generating digital images in different spatial, spectral, radiometric, and temporal resolutions.

These two areas of knowledge are fundamental for obtaining and processing spatialized data that are potentially needed in RSA. Next, four geospatial approaches in SA will be cited that provide, from previous experiences, methodological proposals that aim to fill some gaps, already pointed out in the literature, related to the spatial problem in RSA.

Graymore et al. (2009) generated a regional sustainability index from a decision support model based on GIS, which can also be identified as a spatial decision support system (SDSS). This work consists of a SA on a regional scale, in which the grouping of a set of subbasins was considered, that is, these are limits that were defined naturally and not by administrative standards. The method proposed in this work performs a weighting and aggregation of indicators with the support of a decision support system, which, according to the authors, imposes an objective character on the process.

The application of an SDSS in an RSA proved to be potentially useful in supporting decision-makers, especially in the step referring to the communication of the results obtained. The combination of geospatialized data with multicriteria decision models allowed illustrating the results through maps that make it possible to spatially illustrate the variation in sustainability between the subbasins that make up the region. This can provide decision-makers with the opportunity to prioritize, in a localized way, the subbasins that need initiatives that aim at sustainability, in addition to other management actions involved in decision-making. In addition, this geospatialized method allows you to visualize any changes in the performance of the sites that make up the region, as assessments are repeated over time, and this will support the assessment of the effectiveness of sustainability strategies and plans.

As in the previous example, the work developed by Boggia et al. (2018) proposes the application of an SA model based on spatial multicriteria analysis. However, they differ in that they propose a Multicriteria Spatial Decision Support System (MCSDSS), with complete integration between geospatial data and multicriteria analysis through a GIS interface. This means that, for its use, only one tool must be manipulated, which simplifies the process and enables a greater range of use among evaluators and researchers.

The model proposed in this work allows analyses at any level (local, regional, national) regardless of the definition of limits (natural or administrative) and allows the use of multidimensional indicators. These sustainability indicators are displayed in a table (attributes table) that is associated with each of the geographic features corresponding to the various locations that, interconnected, form the geographic space of the region. Thus, sustainability indexes are generated for each dimension considered, as well as an overall sustainability index. Regarding the communication of results, this method proposed by Boggia et al. (2018) generates, in addition to the graphics, different maps where each dimension can be evaluated separately, or in a single map, where the spatial differences that will translate the region's heterogeneity can be identified, allowing a comparison between the places that make it up, in addition to allowing the identification of areas where measures are most needed.

This approach proposed by Boggia et al. is promising for regional assessments as it is able to identify the spatial differences in the region, pointing out the need for sustainability strategies that are not homogeneous across the national scale, that is, it is capable of identifying demands specific in different areas.

The next example differs from the others in terms of the methods and data used. Vitor et al. (2020) develop a sustainability index on a regional scale, defined by a set of subbasins. For the composition of the index, indicators that contemplate the environmental, social, and economic dimensions of sustainability were aggregated; however, the results obtained are not limited to administrative limits, nor the natural limits of the subbasins, but represent a spatial interaction that goes beyond of discrete objects and starts to adopt a characteristic of continuous fields. This was made possible by using geoprocessing tools to combine census data and information resulting from remote sensing image analysis.

The map resulting from the analysis made by Vitor et al. (2020) provides information on the spatial sustainability of the region in order to identify priority areas for initiatives to be taken on the path to sustainability in an even more specific way, due to its geographically specific character. Thus, the approach proposed by these authors advances in the discussion of the spatialized representation of regional sustainability performances because it allows the obtaining of spatialized indexes that go beyond administratively or naturally defined geographic borders; however, it presents an important limitation insofar as the number and the types of indicators are predefined, not allowing for more efficient processes of varied selection of IS.

The last example to be cited is a methodological proposal of aggregation and disaggregation of the collected data's spatial patterns that will compose the SI. The document *PSSD* (Hansen, 2001) guides a spatial approach to data that is different from the other examples cited. Regarding the use of GIS in SA, they emphasize that it is assumed that indicators have spatial characteristics associated with a specific scale, that is, a geospatialized indicator requires its own reference area. Sustainability indicators that make up the socioeconomic dimensions are commonly related to administrative boundaries (e.g., municipalities, counties, states) or, rarely, to physical boundaries (e.g., watersheds). Despite the possibility of processing that allows interchangeable changes between these two types of borders, data collection takes place respecting the original reference areas.

Additionally, we can consider some indicators that may have arbitrary spatial units, inherent to the scale adopted at the time of data collection, as in the case of biodiversity, for example. Hansen (2001) guides such cases the use of the GRID method.

This means that the authors propose a change concerning the adoption of geographic features, that is, no longer representing space by polygonal objects, and adopting a subdivision of space into discrete squares called cells, for which values are stored. A cell can be understood as a uniformed unit that will represent a defined area on the earth's surface (such as a square meter), but which will change in size depending on the purpose of the assessment.

The GRID method approach allows that data that was originally collected punctually can be represented by one or a few contiguous cells, while data collected polygonally can be represented by a range of cells. Among the advantages of this method are the fact that these cells do not change in size over time, unlike what can happen with administrative boundaries, and this makes the use of GRID a more appropriate system in change analysis. Another advantage is related to the spatial adequacy of the RSI between socioeconomic and environmental data, which, despite adopting discrete limits, can generate results on a continuous basis. Among the disadvantages are the computational limitations for processing at very large scales, in addition to the challenge of choosing the appropriate cell size.

6 Final Considerations

It is widely known that SA are essential to support managers and public agents in decision-making that direct the areas evaluated, at different levels, to the SD. In this sense, the use of SI is the most popular tool in assessment processes. However, the regional scale presents several peculiarities, ranging from the necessary cross-dialogue between the scales at the level above and below to the conflict between the spatial patterns of the disaggregated data that are collected.

Thus, in this chapter, we address three factors that we consider to be main in RSA and that deserve to be highlighted: (i) The multilevel interaction, which takes place on a national-regional-local scale, is addressed using regional indicators applied to all regions, allowing for comparability, in addition to a common set of indicators applicable to all municipalities and assumed for the entire region. (ii) RSA's participatory stakeholder approach, which creates an iterative process with communities and makes the selection of indicators align with recognition of the most important regional issues. This participation of people from the public administration, private groups, and the community, in general, can take place through workshops, seminars, round tables, among others. Finally, (iii) the geospatial approach in RSA. Issues such as defining the boundaries of the regions to be assessed and the spatial distribution of resources must be taken into account in the assessment process. Thus, the use of geospatial data, geoprocessing techniques and tools, and remote sensing products may be unavoidable. More than that, they can be fundamental for having results that actually help in decision-making that effectively lead the regions to the path of sustainability.

6.1 Research Limitations

This chapter aims to broaden the debate on RSA constructively by presenting some methods potentially capable of filling some gaps that persist in the literature, especially those related to the availability, adequacy, and feasibility of data that will feed the process of evaluation. However, there is a limitation that the text reflects the authors' point of view by pointing out the methodological approaches they consider essential for the discussion of the topic.

6.2 Gaps That Persevere

Despite pointing out some paths found in the literature to provide greater potential for RSA in influencing decision-makers in taking sustainable initiatives, other gaps related to the topic still persist. As already clarified, the participatory approach is fundamental so that the evaluations can portray what is really important for the community inserted in the evaluated territory; however, the persuasion of this need by the stakeholders themselves is still a challenge. The majority participation of some groups in the selection and/or collection of indicators may mean that the assessment does not necessarily reflect the common interests of society.

The use of geospatialized data and products derived from earth observations is still quite incipient compared to the entire period of debate involving SA. Furthermore, georeferenced socioeconomic data is still very scarce. Another very important gap is the lack of studies that assess the perception of stakeholders and specialists regarding spatialized sustainability assessments. In this sense, some questions can be raised: do spatialized organizations actually contribute to truly sustainable decision-making? Does the communication step of an SA through continuous spatial feature maps favor punctual decision-making? These questions still need to be answered.

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Chapter 5
Voluntary Sustainability Standards for Corporate Social Responsibility

Kairo Fernandes Martins, Denilson Teixeira, and André C. S. Batalhão

Abstract Companies are increasingly being asked to take responsibility for the social and environmental impacts of their operations. These pressures from the market and consumers have led to an increase in demand for sustainable certification of processes and products, making the Voluntary Sustainability Standards (VSS) an issue present in businesses and global value chains (GVC). The adoption of voluntary standards provides mechanisms to face the threats and opportunities faced by companies in increasingly global environments that demand greater corporate social responsibility (CSR) mainly due to the interest of society and consumers for safe goods and services that do not harm the environment. In addition, consumers and companies are more likely to make purchase decisions based on ethical criteria, posing new governance challenges to improve transparency, accountability, and sustainability across chains. Participation in multi-sector sustainability alliances with diverse actors with a reputation for social and environmental responsibility helps to reduce accusations of "greenwashing" and a clear allocation of rights and responsibilities among market actors. Studies addressing VSS have been substantial and multidisciplinary and appear in many disciplines. Companies are increasingly being asked to take responsibility for the social and environmental impacts of their operations. These pressures from the market and consumers have led to an increase in demand for sustainable certification of processes and products, making VSS an issue present in business and GVC. The adoption of voluntary standards provides mechanisms to face the threats and opportunities faced by companies in increasingly global environments that require greater CSR, mainly due to the interest of society and consumers for safe goods and services that do not harm the environment. In addition, consumers and companies are more likely to make purchase decisions based on ethical criteria, posing new governance challenges to improve

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transparency, accountability, and sustainability across chains. Participation of the GVCs in multi-sector sustainability alliances with diverse actors with a reputation for social and environmental responsibility helps to alleviate charges of “greenwashing,” legalization, and a clear allocation of rights and responsibilities among market actors. Studies addressing VSS have been substantial and multidisciplinary and appear in many disciplines, including value chain management and operations, strategy, accounting, economics, and political science. This chapter links VSS to CSR and their contributions, including value chain management and operations, strategy, accounting, economics, and political science. This chapter links VSS to CSR and its contributions.

Keywords Sustainable certifications · Voluntary Sustainability Standards · Global value chains · Corporate social responsibility, Governance, Greenwashing

1 Introduction

Increasingly, social and environmental issues and the demands of consumers and large global businesses for products that present a better environmental performance throughout their life cycle have demanded from companies more commitment and responsibility to minimize the impacts of their activities. These pressures coming from the market and consumers have led to an increase in the demand for sustainable certification of processes and products, making the Voluntary Sustainability Standards (VSS) a present issue in business and global value chains (GVC).[1] The VSS aim to make the GVCs, from the producer to the consumer, more sustainable chains, taking into account the social and environmental requirements in the production processes (UNCTAD, 2021).

The *United Nations Forum on Sustainability Standards* (UNFSS) conceptualizes the VSS as special rules that ensure that the products we buy do not harm the environment and the people who make them (UNFSS, 2018). Corrêa (2019) states that the VSS are requirements developed by private entities using the same principles of technical standards and concepts related to sustainability as, for example, the Sustainable Development Goals (SDGs), which are “verified” in the form of programs for certification.

Eberlein et al. (2014) argue that as these norms proliferate, they increasingly interact with each other and with state-based regimes. An important factor that may explain the general increase in the multiplication and adoption of VSS is the existence of a consumer market for certified products. Another factor that can drive VSS

[1] They comprise several companies that contribute intermediate inputs for the final good or service (Partiti, 2019).

adoption is business demand. In public procurement, for example, VSS are increasingly used as a shortcut to facilitate sustainable procurement (D'Hollander & Marx, 2014; Marx, 2019).

The adoption of voluntary standards also provides mechanisms to face the external forces experienced by companies in increasingly global environments and that comply with the principles of corporate social responsibility (CSR), mainly in the interest of society and consumers in safe and secure goods and services that do not harm the environment. Such mechanisms correspond to (i) meeting the growing consumer demand for sustainable products; (ii) the business world is increasingly using VSS as a signaling mechanism to inform consumers about the sustainability of their products; (iii) as differentiation to gain market share; (iv) as a means to mitigate reputational risks; and (v) as a way to govern their value chains at a time of increasing *due diligence*[2] requirements (Galati et al., 2017).

The so-called corporate social responsibility is understood as the improvements and voluntary reports that corporations started to carry out in their processes (Mena et al., 2012). Fiaschi et al. (2020) highlight that despite its importance, little academic attention has been given to measuring corporate irregularities, including corporate misconduct, irregular organizational practices, or corporate social irresponsibility. However, companies are guiding their sustainability efforts in collaboration with other efforts that bring complementary resources, including knowledge and legitimacy (Rasche et al., 2013). An important means of conducting these efforts is for companies to engage with VSS and audits, which monitor organizations, processes, or products concerning the predefined and codified sustainability criteria and reward implementers with a label or certificate to demonstrate compliance (Tuczek et al., 2018).

The development and improvement of organizations' management systems are one of the key points ofsustainability standards. Furthermore, engaging in multi-sustainability agreements with diverse *stakeholders* and with social and environmental responsibility reputation makes it possible to avoid *greenwashing* practices (Dentoni & Peterson, 2011). That is, claims that the products are sustainable, but actually contribute little or nothing to it.

In many sectors, VSS can play an important role in filling gaps at the transnational stage, as they bring greater legalization and a clear allocation of rights and responsibilities among market actors. Studies addressing VSS have been substantial and multidisciplinary and appear across many disciplines, including bioeconomics, value chain management and operations, political science, environmental science, foreign trade, and CSR.

However, the literature shows the strengths and limitations of the standards, as well as opportunities for developing countries and their contribution to sustainable development. Potentials include making trade more sustainable, mainstreaming

[2] It refers to when a company is proactive in considering its external impacts before making decisions that have long-term impacts for any sustainability pillar. This is carried out by the company following appropriate procedures, such as risk assessments and others that ensure that stakeholders are informed, engaged, and respected (Liu, 2009; ITC, 2011; UNFSS, 2020).

VSS into public policy, more transparency to consumers, stronger incentives for producers, and other actors to adopt and use VSS (UNCTAD, 2021).

But there are also several barriers to acceptance of VSS, specifically in the context of developing countries, which do not always have the resources and capacity to meet sustainability standards. These barriers are related to the costs involved in obtaining sustainable certifications, the lack of incentives, the governance gap[3], and distrust of such labels or certificates.

As opportunities, the VSS usually connect, commercially, developing countries, in which many producers are located, with developed countries. In addition, trade policy is being used to pursue non-trade goals, including those increasingly related to sustainability to achieve the goals of the 2030 Agenda, and hence sustainable development (UNFSS, 2020).

Thus, this chapter aims to link the Voluntary Sustainability Standards to corporate social responsibility, making an overview, through a literature review, of standards, global trade, and CSR. The chapter brings contributions and challenges concerning these very current issues in the global market.

Section 2 provides an overview of VSS with the appearance and purposes in sect. 2.1. In Sect. 2.2, the voluntary nature of the VSS is discussed and whether they will tend to be mandatory in the future. Section 3 shows the emergence and concepts related to the term CSR. Section 4 shows the relationships of the VSS, global trade, and CSR to form sustainability networks. The contributions of the VSS in the CSR are in Sect. 5, and the challenges of the themes are in Sect. 6. In Sect. 7, the conclusions are presented.

2 Voluntary Sustainability Standards (VSS)

2.1 Emergence and Purpose of the VSS

The Voluntary Sustainability Standards (VSS) have emerged as global regulatory mechanisms to address sustainability, quality, health, and safety in organizations and their value chains (Büthe & Mattli, 2011). Scholars understand that the VSS arise for risk management or even that they result especially from pressure from distributors. Broadly, they are privatizing functions that were previously the responsibility of States (Henson & Humphrey, 2010), being a new form of regulation.

The outbreak of VSS is often attributed to the inability of national regulations to address transnational problems (Büthe & Mattli, 2011). Consequently, private actors such as nongovernmental organizations (NGOs), industry associations, and transnational bodies have emerged and developed rules to govern various

[3] In VSS, it is related to who defines the requirements and their applications (Castka & Corbett, 2016), and the aspects of ownership and management. In GVCs, it is related to the exercise of control along the chain, the relationship of authority and power, generating prescriptions and rules that will be applied across national borders.

management practices (Castka & Corbett, 2015). One of the initial voluntary standards is the ISO 9000 and ISO 14000 series for quality management systems and environmental management, respectively. Developed by the *International Standardization Organization* (ISO) in the 1980s and 1990s, these standards have spread widely around the world and paved the way for the development of other voluntary standards in sustainability, social responsibility, health, safety, and several other areas (Castka & Corbett, 2015) and more recently were called the voluntary sustainability norms.

The development of these private standards, described above, provides a means for companies, organizations, cooperatives, and governments to address the threats and opportunities related to the globalization of value chains, sustainable consumption, and corporate social responsibility (CSR). Threats are predominantly related to the lack of risk control, which expands with the increasingly strict regulatory environment, the complexity introduced in global value chains (GVC), and the new responsibilities placed on sustainable production and consumption. Opportunities in the adoption of VSS are associated with product differentiation and value addition, mainly through the development of credible products (Henson & Humphrey, 2010), as well as *premium price*[4] and access by developing countries to the most demanding markets of developed countries (Thorlakson et al., 2018; UNFSS, 2020).

VSS has also become more important in tackling quality and safety concerns in food markets as the introduction of performance- and process-based controls has shifted responsibility from public entities to private food companies and retailers (ITC, 2011). According to Henson and Humphrey (2010), concerns with food safety led to the development of tools for comprehensive care in the chain, such as responsibility, Good Agricultural Practices (GAP), total quality management, and analysis of hazards and critical control points (Hazard Analysis and Critical Control Point – HACCP). Implementing such tools along a value chain allows chain partners to ensure the quality and safety of their products. As a result, producers "voluntarily" adhere to such standards and have their products certified, under pressure to improve the so-called responsible consumerism and a growing institutionalization of CSR (Partiti, 2019). Table 5.1 shows some VSS and the sector, subject, or product to which it applies.

2.2 VSS: Voluntary Use or Mandatory Trend?

Voluntary Sustainability Standards are commonly used and repeated rules, guidelines, or characteristics for activities with results established by consensus and approved by a recognized body (Bruckner et al., 2014). Compared to mandatory standards, VSS is not required by law. Organizations adopt these standards voluntarily. However, the most demanding global markets started to value and require, in

[4] Value paid more for a sustainable product due to differentiation and higher quality (DIE, 2017)

Table 5.1 Main Voluntary Sustainability Standards and applications

VSS	Sector/product
4C	Coffee
Better Cotton Initiative	Cotton
BONSUCRO	Sugarcane
Cotton Made in Africa	Cotton
Fair Trade Certified	Agricultural production
Forest Stewardship Council	Forest
Ethical Trading Initiative – ETI	Labor practices
GLOBAL GAP	Agricultural production
Organics International Standard – IFOAM	Organic crop production
Program for the Endorsement of Forest Certification – PEFC	Forest
ProTerra *Foundation*	Agricultural production and feed
Rainforest Alliance *	Forest
Roundtable on Sustainable Palm Oil – RSPO	Palm oil
Round Table on Responsible Soy – RTRS	Soy
Travelife Award of Excellence	Tourism
USDA *National Organic Program* – NOP	Organic products
Union for Ethical BioCommerce – UEBT	Agriculture, floriculture, horticulture

Source: ITC/Standards Map (2021)

an almost mandatory way, certifications that certify that the products complied with sustainable requirements. VSS brings together organizational practices and provides a set of requirements that an organization must meet to obtain third-party certification. Generally speaking, the standards "require" that organizations develop, maintain, and improve their management systems. Tuczek et al. (2018) state that these characteristics and forms of requirements are already real and common to the VSS and mean that standardization is possible for intangible aspects such as quality management, environmental management, and social responsibility.

A large number of developing country governments feel that the rise of VSS threatens their market access and will reduce their export opportunities. In particular, GAP and food safety standards have come under scrutiny because they tend to be imposed by large corporate buyers on their suppliers as a prerequisite to doing business. Although in theory, they are voluntary in nature, they are increasingly seen as actually mandatory. According to Liu (2009), the Global GAP standard generated a particular concern due to the growing number of large supermarket chains that require it.

On the other hand, voluntary norms contribute to the global order, imposing rules whose normative value is limited and which are not legally binding (*soft law*). They also serve as instruments that allow transactions between organizations and contribute to reducing the asymmetry of information about products and their characteristics (Castka & Corbett, 2016). One of the drivers of standards development has been a more demanding regulatory environment, such as increasing levels of food companies' responsibility concerning food safety aspects (Liu, 2009).

This adoption and use of VSS has seen strong growth over the past few decades. While in some countries there have been modest contributions to this growth from government agencies, for the most part, the growth has been driven by cooperation and strategic alliances between civil society organizations and businesses. As such, the movement has expanded widely outside the so-called *Agreement on Technical Barriers to Trade* (TBT[5]) and the World Trade Organization (WTO). The movement has gained a boost in the level of private financing and a breadth of political support, which means that it can no longer be restricted, even if a portion still wants to (Salmon, 2002; Thorstensen et al., 2019).

In the sphere of public standards, regulations are probably the best-known standards. According to the Deutsches Institut für Entwicklungspolitik – DIE (2017), government entities seek, through the use of standards, to protect the safety and health of their citizens, as well as ecosystems, limiting the scope of action for companies and private actors within national boundaries and scope. This national legislature is usually based on international declarations and intergovernmental agreements that address global issues, with an emphasis on climate change, decent work, and fair trade. As supranational bodies generally do not have the power to enact binding laws, intergovernmental declarations and agreements establish universal principles that provide voluntary international guidelines and standards (DIE, 2017). The results for sustainable business practices of such intergovernmental efforts are, for example, the guidelines of the Tripartite Declaration of the International Labor Organization (ILO) on Multinational Enterprises and Social Policy and the guidelines for multinational companies of the Organization for Economic Cooperation and Development (OECD), which should be incorporated into companies' corporate social responsibility strategy.

It is important to highlight that the consumer countries' governments also interact with privacy regulations. The governments of Europe, for example, increasingly regulate corporate social responsibility, relying upon facilitating and mandate to encourage the adoption of companies' CSR practices (Knudsen et al., 2015). Several consumer country governments require companies to disclose environmental and social information about their supply chains (Lambin & Thorlakson, 2018). Therefore, amidst a large number of rules, agreements, and market requirements, the questioning about the voluntary nature of sustainability standards remains open when it comes to market expansion, especially for products manufactured in emerging countries.

[5] Agreements that avoid the use of nontransparent or non-grounded technical standards or regulations based on internationally accepted standards or arising from the adoption of nontransparent and/or excessively costly conformity assessment procedures (Thorstensen et al., 2019).

3 Corporate Social Responsibility (CSR)

Studies on the topic of corporate social responsibility (CSR) gained importance and greater popularity internationally during the 1970s and 1980s, but their origin dates back to the late nineteenth century due to pressure from society toward the industries with the Industrial Revolution. The pressures were mainly related to the environmental issues and risks created by pollution, the lack of criteria for correctly disposing of waste, and concerns for the well-being of workers and labor movements. All these concerns made the discussion on the CSR theme expand around the world in the 1980s to resolve issues of how companies could cooperate in achieving a sustainable society (Mena et al., 2012; Witkowska, 2016; UNCTAD, 2021).

Dahlsrud (2008) states that there is no universal understanding of the meaning of CSR. However, for the World Business Council for Sustainable Development (WBCSD), CSR can be defined as "the ongoing commitment of companies to contribute to economic development and, at the same time, improve the quality of life of the workforce and their families, as well as the community and society at large (WBCSD, 2011). Benabou and Tirole (2010) say that CSR definitions emphasize that companies sacrifice profits for the social interest. Belu and Manescu (2013) interpret CSR as the companies' responsibility to successfully integrate economic, environmental, and social issues in organizational practices.

Therefore, it is observed that CSR is constantly provoking discussions regarding the understanding of this concept, the dominant models in business practice, and the consequences of companies' involvement in socially responsible activities. However, business practice shows that companies voluntarily consider social and environmental issues in their activities and relationships with stakeholders, although it is difficult to define the intentions behind their involvement (Witkowska, 2016).

According to Carroll and Shabana (2010), CSR encompasses the economic, legal, ethical, and discretionary expectations (later called philanthropic) that society has of organizations at any given time. Lambin and Thorlakson (2018) state that CSR occurs when companies take responsibility for their impact on society. In her conclusions, Witkowska (2016) highlights that CSR is understood as the voluntary integration of social and environmental aspects in businesses.

Thorlakson et al. (2018) see that companies are increasingly being asked to take responsibility for all social and environmental impacts of their operations, as demonstrated by the inclusion of the private sector as a key partner in achieving the Sustainable Development Goals (SDGs) of the 2030 United Nations' Agenda. This interest of companies in aligning themselves with corporate social responsibility and sustainable development has been a hallmark of recent decades and is leading to an increased demand for environmental and social certification of business processes and products (Salmon, 2002). In addition, there is also a growing demand from society and consumers for goods and information produced with greater responsibility on the conditions of production and processing of products. The result is an increasing number of consumers and companies who base their purchasing decisions on ethical criteria and who have a greater sense of corporate social responsibility (ITC, 2011).

Some studies are interested in organizations managing their social agendas and getting involved in corporate social responsibility. There are also some studies that analyze these organizations in light of their ability to make companies collaborate on development agendas and form partnerships among themselves, with governments, and with Civil Society Organizations – CSOs (Fransen, 2018).

For some authors, corporate environmental management is unlikely to improve unless models and measurements are grounded in a scientific understanding of ecological systems. The knowledge of the scientific community must expand its focus on the use of environmental data and monitoring and embrace the potential of applying new data and information to private sector decision-making to meet these needs (Kareiva et al., 2015).

As an example of this focus expansion, Salmon (2002) saw a relationship between CSR and VSS when he said that the corporate social responsibility movement growth and the associated trends of tripling performance appraisal and accountability in business have created a major new factor in the preparation and use of Voluntary Sustainability Standards and labels.

4 The VSS, Global Trade, and CSR for a Sustainability Network

The Voluntary Sustainability Standards have become a significant element of international trade governance and production. VSS are responsible for a rapidly growing proportion of global production and trade, covering a variety of products (FiorinI et al., 2019). Some of the top VSS for agricultural commodities, for example, illustrate this trend. Between 2008 and 2015, the *Rainforest Alliance* had a covered land area certified by this VSS that increased almost fivefold, from 0.4 million hectares to more than 1.8 million certified hectares. In the same period, the area of land certified by the *Roundtable on Sustainable Palm Oil* (RSPO) has increased nearly 30-fold, from 0.1 million hectares to nearly three million hectares. Another example was UTZ certification,[6] which grew by 1.9 million hectares between 2009 and 2015 (Lernoud et al., 2017).

In addition to focusing on environmental sustainability issues, the VSS has also become a more important instrument of corporate responsibility in the labor rights and basic human rights protection areas. According to Fiorini et al. (2019), the *Business Social Compliance Initiative* (BSCI) code of conduct, Social Responsibility Standard 8000 (SA 8000), and the *Ethical Trading Initiative* (ETI) base code are

[6] In 2018, UTZ merged with the Rainforest Alliance. Since then, a new, more complete, and unified program has emerged called the Rainforest Alliance 2020 Program.

among the main social responsibility certification schemes currently applied all around the world.

The 2010 introduction of the ISO 26000 standard on social responsibility reflected the general evolution of voluntary standards that had already started in the late 1990s, the local community, the environment, and workers (DIE, 2017).

NGO-led certifications are also being adopted by corporate actors to implement their promises and wishes. Companies also rely on NGOs to help implement their corporate social responsibility programs (Elder & Dauvergne, 2015). All these demands come from consumers and civil society organizations, which are demanding greater corporate social responsibility from agrifood companies, for example, posing new governance challenges to improve transparency, accountability, and sustainability in the links of value chains (Furumo et al., 2020).

An increasingly sought-after solution also for more sustainable production, in the case of commodities, is the adoption of these voluntary certification schemes. These programs are incentives that aim to standardize sustainable production practices and create shared value along the supply chain, bringing together various stakeholders (Henson & Humphrey, 2010; Furumo et al., 2020). For example, the VSS or Global GAP (Good Agricultural Practices) scheme is a farm management certification scheme. ISO 26000 provides guidance for companies and other organizations on social responsibility to improve their impact on workers, natural environments, and communities (UNFSS, 2018).

Developing countries complain that developed country governments have transferred food safety monitoring to their private sector, in particular to retailers. Those, in turn, transfer this responsibility to their suppliers through certification requirements. In the case of imported food, this means that the burden and cost of monitoring food safety have shifted from importing countries to exporting countries (Liu, 2009).

Salmon (2002) highlights that this global trade is a key factor behind many of the changes described above. The widespread loss of confidence in conventional agricultural production, especially in Europe, is another factor. Green or sustainable consumerism continues to grow, but its significance as a driver of trends over the past few decades goes beyond a larger and deeper trend. The growing social demands for companies to behave in a socially responsible manner and the paradigm shift that is taking place respond to this.

What is perceived is a transition when removing the eco-label from the product itself for a business organization or group of producers. Large supermarket chains show this, as they responded to consumer concerns as a matter of competitive strategy. Many of these networks have developed their own environmental and social standards and have translated them into supplier requirements that are progressively being expanded across the entire product range. The effect is the certification or this attestation through an "ecological label" of the supermarket chain itself, as environmental and social responsibility. Another effect is the "greening" of global supply chains, a process that can spur considerable innovation in sustainable production techniques (Salmon, 2002).

In the context of the significant trends listed above, and especially for the purpose of considering trade implications, it would be artificial to speak of eco-labels in isolation from other Voluntary Sustainability Standards and certification schemes that share purpose and raise similar issues. With so many nomenclatures related to sustainable standards (VSS, certification schemes, sustainable certification, eco-labels or seals, among others), Salmon (2002) uses the term "Voluntary Sustainability Standards and Labels" (VSSLs) to adopt (i) agreed rules for business-to-business transactions, as well as those used for transactions with consumers; (ii) management system standards as well as product standards; (iii) environmental product declarations, as well as independently certified labels; (iv) labels developed by producers or retailers, as well as those with independent governance; and (v) standards owned by the government, NGOs, or commercial interests, provided they are voluntary in nature.

The certification in accordance with VSS provides reliable information to consumers about the attributes of the product and its producers. As a result, certification helps companies operationalize their commitments to corporate social responsibility (Ssebunya et al., 2019). Kareiva et al. (2015) explain that improving the consistency and scientific credibility of annual corporate environmental disclosures can have a ripple effect and also improve the certification of consumer products. In particular, the same environmental indicators that inform corporate reports can ideally inform sustainable product certification and, in turn, influence consumers.

The absence of standards and consistency in sustainable valuations still haunts many corporate sustainability reports. This lack of rigor undermines the power of consumer certification. Consumers often report that they are skeptical and confused by the company's disclosures on sustainable product labels. In fact, in 2010, 95% of "greener" products were found to have some form of greenwashing, that is, the "act of deceiving consumers regarding a company's environmental practices, the environmental benefits of a product/service or misinformation that that product presents a sustainable image" (Kareiva et al., 2015; Thorstensen et al., 2019).

Therefore, it is essential to provide reliable information to motivate consumer action to purchase more sustainable products, as several studies suggest that there is a growing segment of consumers who value environmentally friendly products if they receive specific information about their impacts. A survey exemplified in the work by Bemporad et al. (2012) pointed out that 63% of consumers would agree to make more sustainable purchases if they had a clearer understanding of what makes a product environmentally or socially responsible. Therefore, advancing in sustainable certifications with more scientific information can be important to validate the company's performance and improve consumer response (Kareiva et al., 2015).

There is also the so-called sustainability network, which involves a set of actors, objects, procedures, and relationships that coalesce around addressing or managing social and/or environmental aspects of the production, processing, exchange, and consumption of commodities. According to Ponte and Cheyns (2013), the sustainability networks can take an institutional form, as an initiative of multiple stakeholders, an industry association, or formal alliance standards-setting bodies, or may be more informal, such as a network temporary built around a specific campaign, a coalition of stakeholders, or a network built around sustainability conference circuits.

These sustainability networks can revolve around one or more products, a variety of verification systems, such as self-monitoring or industry monitoring codes of conduct, and third-party certification systems, and can result in different communication devices such as an affixed tag in the final product, or corporate social responsibility reports (Ponte & Cheyns, 2013).

5 VSS Contributions to CSR

VSS can contribute to boosting workers' earnings by demanding equivalent wages or wage premiums and demanding that employers actively train and encourage workers to bargain collectively (Bennett, 2018). In a paper that examined the 16 most important active norms in agriculture, forestry, and biofuels, Potts et al. (2014) found that 63% of VSS impose the national minimum wage and 29% demand payment above the minimum wage. The authors also suggest that labor standards appear to be less robust than environmental or social provisions. These data are in line with several studies that show how VSS focuses more on safety and efficiency than on issues of social and economic inequality, such as access to and distribution of resources. Other studies make suggestions about international economic policy and institutional factors that can put pressure on norms (Bennett, 2018).

The VSS are not alone in these trends noted above. In the case of CSR strategies, they may be stronger in quality control, health, safety, and environmental management than in employee compensation and benefits (Kortelainen, 2008), and ILO standards may be more focused on horizontal wage equity, for example, equal pay for equal work (Bennett, 2018).

Since the 1950s, VSS have been recognized as a positive force for improving rural livelihoods while meeting terrestrial and marine biodiversity conservation goals (Ting et al., 2016). In their work, Tuczek et al. (2018) concluded that voluntary standards that address quality, social environmental responsibility play an important role in the industry as well, as they aim at conserving biodiversity.

Furthermore, if the degradation of natural capital is treated as a real cost by organizations, we can imagine an economic system that rewards resource efficiency and more effectively generates shared value for business and society. Such a system will likely require mandatory corporate disclosure of various dimensions of the ecosystem (Kareiva et al., 2015). The same authors also say that it will take industry-specific consensus on environmental indicators, standardization of impact metrics, and strong incentives for multinational companies to meet sustainable reporting requirements. Nongovernmental organizations, government entities, and scientists can contribute to creating these enabling conditions for companies to improve their practices. Researchers are suggesting greater coordination between these groups to advance big sustainable brands and global environmental governance.

Many authors emphasize that the time is now to standardize corporate disclosures of environmental sustainability with a solid ecosystem service awareness. Giuliani et al. (2017) concluded that farms that received certification demonstrated better environmental behavior but did not improve social conduct concerning non-certified farms. The same authors also found that the positive relationship between certification and environmental conduct is stronger if the farm sells to a cooperative and if it is located in an institutionally weak country.

6 Challenges VSS and CSR

Voluntary Sustainability Standards can be problematic when addressing areas that are already covered by technical regulations. Two problems can arise, as addressed by Liu (2009): they can be more restrictive than technical regulations, or they can be more prescriptive, or both without objective reasons. The benefits of VSS to society depend on the extent to which the prescribing organization's purpose serves the collective public interest. The problem with standards set by companies is that they can be used as a tool to differentiate the company from its competitors. When the company sets a standard to achieve only limited corporate goals, such as improving its image, no benefit can be expected.

In Brazil, the Brazilian Platform for Voluntary Sustainability Standards, managed by the National Institute of Metrology, Quality and Technology (INMETRO), and the United Nations Forum on Sustainability Standards (UNFSS) present the following challenges related to VSS:

(a) The real effect of these norms on international trade and, especially, on exports from developing countries (INMETRO, 2019).
(b) The rules or international agreements that can be applied to the frame or provide incentives and disincentives for these standards, if any (INMETRO, 2019).
(c) The level of responsibility that governments have over the VSS developed within their territories and their effects on international trade (INMETRO, 2019).
(d) The growing number of VSS available on the market is a challenge in terms of guidance for consumers, producers, traders, and public authorities (UNFSS, 2018).
(e) Need to have adequate information about VSS and its effects on the national market through National Platforms, which will help policy-makers to determine the most appropriate policies for the country (UNFSS, 2018).

For large farms and large companies, case studies show that private standards are an extra cost but generally remain affordable. For Liu (2009), obtaining certification does not generate a price premium but can give rise to other types of direct and indirect benefits, such as production rationalization, input savings, more efficient management, and corporate image improvement. Another challenge is the huge inconsistency in corporate environmental performance indicators. Many companies are accused of misrepresenting their environmental performance.

Despite technological advances in the management of the value chain, methodological deficiencies in measuring sustainability and complex decision support tools make it difficult to carry out corporate analysis of environmental impacts and risks. According to a survey of corporate professionals, integrating sustainability into core business functions remains a considerable challenge (Kareiva et al., 2015).

Failing to respond to environmental feedback between business activities and ecosystem services is a missed opportunity. Liu (2009) argues that one of the ways for ecosystem science to engage with corporate environmental disclosure would be that instead of rigid reporting models, standards take the form of a targeted series of questions or investigations into business practices and their links to the environment and then presentations streamlined and consistent of information to investors and consumers.

Liu (2009) also highlights that most environmentalists and sustainability scientists agree that a sustainable planet depends on improved corporate practices. However, methods for modifying corporate behavior vary widely. The suggestion to deepen collaboration between scientists and ecosystem companies is a departure from a widespread approach to defaming their environmental crimes. While public publication campaigns and boycotts of multinational companies have been successful in altering the supply of some products, these one-off victories can require several years of continual pressure, and their lasting impacts are unpredictable.

For Kareiva et al. (2015), any approach to systemic change must address corporate environmental decision-making protocols. Mechanisms for achieving this shift will include market-driven consumer pressure as well as advances in ecosystem science that describe companies' material dependence on the environment. However, the authors emphasize that mandatory disclosure is necessary. When reporting is voluntary, there are many opportunities for selective disclosure.

In their study, Ting et al. (2016) concluded that information on the application and certification processes was readily available to interested parties in terms of Payment for Ecosystem Services (PES), eco-labeling, and CSR schemes. On the other hand, there are limitations in the existence of problems arising from a mismatch in the demand of interested parties, especially in relation to meeting the profits driven by the producer. This has resulted in the failure to establish concrete biodiversity conservation guidelines and the erosion of robust monitoring standards. The certification schemes that were considered successful, however, addressed these problems with the inclusion of an attractive conservation premium mechanism, complemented with good governance measures and a focus on locally relevant species.

As already seen, although sustainability standards are almost exclusively voluntary in nature, in specific markets, Henson and Humphrey (2009) argue that market forces can make voluntary standards in fact mandatory, even if there is no legal penalty for noncompliance. In some co-regulation cases, the legislator also enacts legislation related to private standards or refers to voluntary standards in order for the VSS to become legally binding. These two situations already explain why the classification of norms is not straightforward, but in fact, obscured.

VSS can become de facto mandatory or even legally binding and therefore part of public regulations (DIE, 2017). The public and private standards spheres are truly interconnected as, on the one hand, companies can incorporate public standards and regulations into their CSR strategies, while, on the other hand, the local VSS can adopt national regulations. Finally, many authors emphasize that companies can also adopt VSS in their CSR strategies. However, it is necessary to remember that the rules are subject to constant changes and that the limits are still lacking in transparency. Also due to the more qualitative characteristic of the VSS and CSR themes, greater integration of both in the companies' strategy and the use of indicators to measure their performance would be necessary.

7 Conclusion

The new paradigm of corporate social responsibility and accountability needs to be actively supported by changes in the governance structure to provide fair competition in the global economy. In this context, sustainable certifications will be in a position to provide working models of development and governance through sustainability standards, solving a range of foreseeable practical difficulties of the emerging global landscape and providing public understanding and political support for measures to promote sustainability in the production and consumption.

Many studies conclude that in some sectors, VSS and CSR were able to play, although not necessarily used together, an important role in filling gaps in the transnational stage, as they brought greater legalization and a transparent allocation of rights and responsibilities among stakeholders.

In the food safety area, for example, it is observed that the VSS and the CSR reassure consumers about the food they buy, provide competition for quality and safety, and protect the main food agents from liability in the event of public health or health crisis. Increasingly, the quality competition provides another incentive for the adoption of VSS and CSR. Adopting sustainable certification, producing sustainably, and communicating all of this to customers are strategies to improve the corporate image, differentiate products, add value, and position or reposition itself in the market.

There are many similarities in the characteristics of the VSS and CSR themes: multidimensional and multidisciplinary nature; qualitative nature of most structures, which does not allow for a robust assessment of the company's overall performance; voluntary nature; and the presence of themes related to the dimensions of sustainability and concepts related to sustainable development. Furthermore, both themes are constantly changing both in nomenclature and in their concept.

We also note that there are still many paths to be taken concerning the assessment and wide adoption of these themes by companies. The diversity of indicators recommended for evaluating them can represent an obstacle to the acceptance and construction of a strong conceptual and methodological framework. Several authors state that reference values for a minimum acceptable performance level have not been established nor have ideal performance criteria been defined for companies' operations.

It is concluded that the objectives related to achieving accountability, standardization, transparency, and process improvement in a more sustainable way are essential mechanisms in the global search for sustainability. Furthermore, certifications based on internationally recognized standards and CSR concepts are tools that can chart paths to achieve them efficiently, effectively, and productively.

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Chapter 6
Universities to Educate in Sustainability: From Pedagogy to Management

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Abstract The crises and challenges of sustainability are built not only by the elements of the productive and technological system but by a culture, a way for society to understand, see itself and nature, and in the construction of this relationship. Therefore, the transition to sustainability requires a profound change in the way society thinks and acts. It takes a set of knowledge, values, skills, and competencies that foster attitudes toward sustainability. In this context, it is essential to structure all levels of the educational system to educate for sustainability. Higher education institutions (HEIs) are fundamental, due to their responsibility in generating new knowledge, independent critical analysis, conducting research, and institutional partnerships, in the education of professionals and, above all, of new educators. There are several challenges in restructuring HEIs to educate in sustainability, structural barriers such as the disciplinary approach, institutional fragmentation, the punctual and superficial thinking habits, and the view of higher education only as a market opportunity. To face these barriers, several studies point to pedagogical strategies, such as better teaching-learning methods and studies of scenarios for greater social engagement, and management strategies, such as the use of instruments that corroborate the evaluation of the environmental performance of HEIs. This chapter seeks to present the concepts of sustainability education, sustainable universities, and management and pedagogical strategies and instruments for a systemic approach to education for sustainability.

Keywords Higher education institutions · Sustainable development · Education for sustainability

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1 Introduction

The global socioeconomic and environmental crisis is multidimensional and presents a critical scenario, in which the sixth great extinction of life on the planet may also encompass the human species (Ceballos et al., 2015). All ecosystem services that maintain and sustain life are threatened by different types of pollution, climate change, the growth of cities and urban areas, agroindustry production systems, deforestation, among others.

Overcoming these challenges will not only come about through punctual isolated improvements in existing production technologies or through the increase in multilateral treaties on sustainable development. Changes that are effective; transformations in the way of thinking, producing, and relating to the environment; new sets of processes; and systems that make our practices compatible with the laws and limits of the biosphere are necessary. The study of these challenges belongs to the research area conceptualized as transition to sustainability (Köhler et al., 2019; Markard et al., 2020).

Work in this area has focused primarily on the themes of urban mobility, energy generation, agriculture, and food production, basically considering technological innovations in production chains and business models. These researches indicate that the transition process to sustainability has been limited by factors such as the lack of structural and political integration, the resistance of traditional companies and corporations affected by the transformations, the need to change social practices, and habits and lifestyles of society (Markard et al., 2020; Turnheim & Sovacool, 2020).

The transition to sustainability therefore requires a profound change in the way society thinks and acts, as crises and challenges are not built only by the elements of the production and technological systems but for a culture, a way for society to understand and see its relationship with the environment (Morin, 2015; Morin & Díaz, 2016). It takes a set of knowledge, values, skills, and competencies that promote practices toward sustainability.

And so, we arrive at a disturbing question: What is the role and responsibility of education systems, in particular, universities in the transitions to sustainability in a broader spectrum, beyond technological innovation?

This chapter seeks to present the concepts of sustainable universities, addresses pedagogical and management transitions, and presents some tools that can help HEI transition to education in sustainability.

2 Sustainable Universities

Sustainable development has become a fundamental issue in many official plans, especially at the United Nations, and from the beginning, the need to involve universities in this process was realized. In 1972, the Report of the United Nations

Conference on the Human Environment made the first reference on sustainability in higher education (UN, 1972). Since then, more than 24 international initiatives aimed at education for sustainability have been officially established (Lozano et al., 2013).

The United Nations (UN) launched the United Nations Decade (UND-2005/2014) of Education for Sustainable Development (ESD), which provides a set of principles and tools for teaching and learning. According to the United Nations Educational, Scientific and Cultural Organization (UNESCO, 2004, 2009), ESD is:

- Education that allows students to acquire the skills, capacities, values, and knowledge necessary to ensure sustainable development
- Education at all levels and in all social contexts (family, school, workplace, community)
- Education that fosters responsible citizens and promotes democracy, enabling individuals and communities to have their rights granted and fulfill their responsibilities
- Education for lifelong learning
- Education that promotes the balanced development of the individual

According to Kraemer (2004), these definitions gave the first signs to universities regarding their role in the global path toward sustainable development. The documents associated with the Conferences on Human Development in 1972 and on Environment and Development – UNCED in 1999 explain objectives and measures aimed at higher education institutions (Table 6.1).

At the end of the twentieth century, there was a change in university campuses related to the implementation of environmental policies and environmental management processes in the daily activities of their activities and infrastructure in search of awareness and commitment of the academic community (Rodrigues, 2018).

In order to introduce sustainable improvements within universities and train leaders concerned and engaged in environmental issues, the institutions promoted international meetings with the presence of universities from various countries with the aim of educating for sustainability. Therefore, Kraemer (2004) and Rodrigues (2018) prepared a summary of the main documents and principles proposed by these institutions during the meetings, as shown in Table 6.2.

In 2012, at the Rio + 20 Conference, the Declaration for Higher Education Institutions was approved, a commitment assumed by 260 universities and schools of administration around the world that brought the incorporation of sustainability issues in teaching, research, and in the management and organization of institutions, whose objectives are summarized in Table 6.3.

In 2015, at the UN Sustainable Development Summit, a global pact was signed – the 2030 Agenda. Composed of 17 Sustainable Development Goals (SDGs) that unfold into 169 goals, the 2030 Agenda represents a new universal set of goals that aim to “eradicate poverty in all its forms” by 2030 “and balance the three dimensions of sustainable development: economic, social and environmental. We would highlight SDG 4 whose main objective is to “ensure inclusive, equitable and quality

Table 6.1 The UN and universities in the context of sustainable development (1972–1992)

Document	Objectives	Recommended actions
UNCED (1972) Stockholm Declaration (Principles 9 and 24)	Predict and/or mitigate aspects contrary to sustainable development	Formulation of multi- or bilateral agreements or other forms of cooperation (namely in technology transfer)
UNCED (1991) Preparatory Committee Report	Engaging everyone in education for sustainable development	Involvement of decision-makers in government, of experts who advise them in universities, research institutes, etc.
UNCED (1992) Rio Declaration (Principle 9)	Strengthen capacity development for sustainable development	Exchange of scientific and technological knowledge. Development, adaptation, diffusion, and transfer of technologies, new and innovative
UNCED (1992) Agenda 21 (Chapters 31, 34, 35, and 36)	Clarify the role of science and technology in sustainable development	(Re)designing national programs in Science and Technology in order to clarify sector contributions to sustainable development and identify sector roles/responsibilities in human development
	Generate and disseminate knowledge and information on sustainable development	Produce long-term scientific assessments of resource depletion, energy use, health impacts, and demographic trends, and make public in widely understood ways
	Educate everyone for sustainable development	Development of environmental education and development programs (accessible to people of all ages). Incentives from countries to universities and networks in this area

Source: Kraemer (2004)

education, and promoting lifelong learning opportunities for all." And its target 4.7 states that:

> the country must ensure that all students acquire the knowledge and skills necessary to promote sustainable development, including, among others, through education for sustainable development and sustainable lifestyles, human rights, gender equality, promoting a culture of peace and non-violence, global citizenship, and valuing cultural diversity and the contribution of culture to sustainable development

How could universities be agents of change and behavior in the academic population, putting the SDGs into practice? These are crucial issues and deserve the attention of professionals and academics (Leal Filho et al., 2015).

The university system, in general, is divided into five interdependent dimensions: education (courses and curricula), research (basic and applied), campus management, community outreach, and assessment and communication. In an ideal scenario, the precepts of sustainable development would reach the entire academic community in a systemic way; however, in practice what happens is fragmented incorporation (García et al., 2006).

One of the challenges in the transition from a traditional university to a sustainable university lies precisely in issues related to the educational system.

Table 6.2 Summary of global university actions

Document	Contents
Declaration of Talloires, France, 1990	Twenty university leaders from all regions of the world expressed their concerns about the increasing pollution, environmental degradation, and depletion of natural resources. The signed document reaffirms the crucial role of universities in this context and presents the actions to be implemented
Declaration of Halifax, Canada, 1991	Senior representatives of the International Association of Universities (IAU) of the United Nations University and the Association of Universities and Colleges of Canada met with university leaders from around the world to discuss their actions that resulted in the Declaration
Swansea Declaration, 1993	At the end of the 5-year conference of community universities, participants understood that solutions to environmental problems would be effective if they had popular participation. And that discussion triggered the actions that make up the Declaration, which was released at the conclusion of the Association of Universities Conference, University of Wales, Swansea
Kyoto Declaration, 1993	Promoted by the IAU, it highlights the ethics of education for the SD, which, in addition to teaching principles, should promote sustainable practices. It was based on the discussion promoted at the meeting of about 90 university leaders who gathered to discuss and adopt a declaration of principles from the Talloires, Halifax, and Swansea Conferences
Carta COPERNICUS, 1994	Also called the University's Charter for SD, it defines principles of action to be adopted by Universities in favor of SD. Inspired by the Copernicus Program Strategies – Cooperation Program for Environmental Research in Nature and Industry through Coordinated University Studies launched in 1988, by the Conference of Rectors of Europe (CRE)
Students' Declaration for a Sustainable Future, 1995	Organized by the Environmental Community for Educational Development (ECED), this Declaration gained support in the United Kingdom, at the University of Sunderland, where 80 people from 34 British Universities and faculties discussed the environmental responsibility of students to frame a statement encompassing additional actions
Global Partnership for Higher Education for Sustainable Development – GHESP, 2000	Partnership formed by University Leaders for a Sustainable Future (ULSE), Copernicus-campus, IAU – International Association of Universities and the United Nations Educational, Scientific and Cultural Organization (UNESCO), the result of the work program of the Commission for the Sustainable Development of the United Nations, which anticipated the World Conference on SD
Luneburg Declaration, 2001	Directs an appeal to the UN for the designation of educators as the tenth key stakeholder group in the Johannesburg World Conference on Sustainable Development –WSSD process. It reinforces the universities' commitment to creating a global learning space in education and sustainability, to be developed based on international networks and through regional centers of excellence that bring together all formal teaching institutions, from elementary to higher education

(continued)

Table 6.2 (continued)

Document	Contents
International Conferences on Environmental Management for Sustainable Universities, 2002	It brought together 150 delegates to debate the question: "What is the role of Higher Education in Sustainable Development"?

Source: Rodrigues (2018) adapted from Kraemer (2004)

Table 6.3 Objectives of the Declaration for Higher Education Institutions

Proposal	Objective
Incorporate sustainability into the curriculum	Develop skills to understand how to achieve a society that values people and the planet with respect for the finite limits of the Earth's resources
Encourage research on sustainable development	Improve scientific understanding with scientific and technological exchange and inclusion of innovative technologies
Green campuses	a) Reduce the ecological footprint with energy, water, and the use of materials in buildings and facilities; b) sustainable purchases of materials and services; c) sustainable mobility options; d) minimize waste, recycle and reuse; e) encourage more sustainable lifestyles
Support sustainability actions in communities where local authorities and civil society live together	Promote more livable communities that are resource-efficient and socially inclusive with small ecological footprints
Sharing results across international structures (United Nations Decade of Education for Sustainable Development, United Nations University, United Nations Global Compact, United Nations Principle)	Exchange knowledge and experiences and regularly report on progress and challenges

Urce: Gaion (2013) cited Rodrigues (2018)

3 Pedagogical Transition

The traditional education system is predominantly based on competition and individualism, supported by the acquisition of punctual information, fragmented by disciplines, and curricula plastered in contexts disconnected from the environmental, economic, and sociocultural reality. Its mission is to train citizens who meet the demands of an urban and industrial society, which promotes unsustainable consumption and living standards (Da Silva, 2019; Morin & Díaz, 2016).

In this system, environmental education, despite being characterized as transversal and transdisciplinary, was inserted as an isolated disciplinary content, with decontextualized approaches. From early childhood education to university, projects with themes such as the reduction of water consumption, the selective collection of waste, and the saving of electricity predominate, without integration with the context of political, social, and economic issues, transferring completely to the individual responsibilities that they do not match its impact and power within the production system (Loureiro, 2014).

Therefore, for sustainable thinking and acting, it is logical to assume that educational systems need their own transition to sustainability. Rethinking the function, form, methods, and contents, but above all, the mission to educate in sustainability and the values associated with it.

The transition must involve all levels of the educational system; however, universities are essential for their responsibility in generating new knowledge, in independent critical analysis, in conducting research, institutional partnerships, and in the education of professionals, especially new educators (Amaral et al., 2015; Beynaghi et al., 2016; Da Silva, 2019; Gale et al., 2015; Larsson & Holmberg, 2018; Serodio & Prado, 2017).

The definition of sustainable university present in the literature always refers to environmental, economic, and social concerns that HEIs must have in their activities, and the obligation to lead by example is emphasized. A university must "minimize the negative environmental, economic, social, and health impacts generated in the use of its resources" (Velazquez et al., 2006). This attitude is justified by the fact that universities educate current and future decision-makers and act as "shapers of society's values" (Godemann et al., 2014, p. 218).

The importance of sustainability on the agenda of universities is also confirmed by the high number of national and international declarations developed regarding the treatment of this issue in higher education institutions (Lozano et al., 2013). The insertion of environmental themes in universities has been gaining more and more strength in some countries, especially when considering the articulation of the multiple dimensions of this process such as teaching, research, extension, campus administration, and institutional management (Wachholz, 2017).

Transitions toward sustainability, however, require profound changes in the behaviors that mediate the relationship between human beings and their environments. They imply not only in multilevel management and governance regimes but in people's beliefs, values, and behavior patterns (Westley et al., 2011).

It is expected, therefore the level of knowledge about sustainability, that the higher education institution, as a whole or in part, promotes, at a regional or global level, the minimization of negative impacts on society, both environmental, social, economic, and in relation to health, generated by the use of resources in fulfilling its teaching, research, extension, and maintenance functions; and leverage its positive impacts. And that, in this way, it helps society in the transition to sustainability (Bizerril et al., 2018).

There must be a transformation in people's knowledge of ecosystems and their relationship to them; in their attitudes, values, and beliefs regarding environmental issues; in their practices, as materialized intentions that simultaneously determine how such transitions toward sustainability begin and occur; and how the knowledge, attitudes, and practices (KAP) inherent to the theme change (Salas-Zapata & Cardona-Arias, 2020).

It is noteworthy that knowledge, attitudes, and practices are three of the fundamental components of human behavior. Knowledge refers to the set of ideas, concepts, and information that people have and use about something; attitudes comprise postures, ways of acting in response to something, the inclination or tendency to act in a certain way, and people's beliefs about a specific issue; and practices are the set of explicit or observable actions of an individual in response to something (Gumucio, S., et al., 2011).

The main structural barriers to sustainability education in universities are four: disciplinary approach, institutional fragmentation, punctual, and superficial reasoning habits. These barriers prevent, respectively, the understanding of what sustainability is: multi-interdisciplinary dialogue and complex reasoning. The fourth barrier is economic globalization, which sees higher education only as a market opportunity (Gale et al., 2015). To overcome them, structural changes, a general reform regarding the education model, management structure, and responsibilities toward society and the environment are suggested. A future-oriented, challenging education that goes beyond the limits set by the State and the market much more focused on social transformation than on cultural transmission (Gadotti, 2000).

There are, however, factors that favor the implementation of sustainability in universities and the formalization of the institution's commitment to sustainability (Lozano et al., 2015); the commitment of managers and leaders to the topic (Burford et al., 2013); and the integration of sustainability in curricula in a critical and complex perspective (Segalàs et al., 2012). (Bizerril et al., 2018), the participatory approach in the implementation of sustainability (Disterheft et al., 2012) and the establishment of a consistent way to assess and report institutional performance in terms of sustainability (Lozano, 2011; Ceulemans et al., 2015; Amaral et al., 2015).

There are four major dimensions of pedagogical actions for an HEI to be able to act in the transition to sustainability: to model sustainable practices for society, through local actions; educate students to promote skills of integration, synthesis, and systems thinking and guide them to deal with complex problems that are required by sustainability; encourage the study, research, and analysis of real problems for sustainability; and promote integration between individuals and institutions, so that the HEI acts as a multidisciplinary and integrative agent with other civil society organizations (Cortese, 2003).

These four dimensions of pedagogical actions must obviously be related to the context in which each institution is included, considering its sustainability challenges and potential. According to Cortese (2003), it is necessary to pay attention to some external and internal factors to the institution in order to guarantee a systematic and systemic approach in each context:

- The dominant sustainability challenges of each region as social, technological, and environmental factors
- The financial structure and where the institutions' money comes from, whether from private or public sources
- The organization and structure of the higher education system, how curricula are constructed, and the role that the HEI should play

- The democratic process – the rights and means of access to higher education and the transparency of higher education
- Communication and interaction with society in the management and dissemination of information with the academic community and other nonacademic actors in society

The pedagogical transition so that universities can educate in sustainability suggests, therefore, that teaching/learning approaches and strategies should be structured in such a way that they provide a complex understanding of sustainability, without being limited to the exclusive academic and contemplative debate of the theme. Such approaches should provide the entire university community with experience, research, and integration with other sectors of society in the sustainability paradigm, which implies a restructuring and new alignment of the universities' mission. Some of the changes proposed in the pedagogical transition to sustainability education can be seen in Table 6.4.

Universities have been encouraged to review their role as important educational actors in building a more sustainable society. It is an urgent transformation given the new emerging paradigms: as an incessant source of knowledge production, it increasingly needs to incorporate sustainability guidelines so that its production establishes concrete relationships with society and allows the knowledge built in its rooms to be able to go beyond its campuses and contribute to the community in which it operates (Wachholz, 2017).

Table 6.4 Pedagogical transitions for education in sustainability

Change from	Toward
Specific insertions of the theme in existing curricula	Innovation within existing curricula or even new curricula
Passing on knowledge and raising awareness about problems	Questions and investigation of root causes
Teaching about attitudes and values	Encouragement to clarify existing values
View of individuals as problem generators	View of individuals as social and historical beings and agents of change. View of the political construction, social, and power structures in societies
Sending messages about sustainable development	Creating opportunities for reflection, negotiation, and participation
Create awareness and attempt to change behavior	Understanding the structuring of economic models and their social and political mechanisms for conditioning societies Discussion of the meaning of development Challenge to mental models that influence decisions and actions in the individual and collective field
Negative problem-solving approaches	Construction of future alternatives beyond technological innovation
Changes and isolated actions	Teaching for and in change

Sources: Loureiro (2014); Tilbury (2011).

Several studies analyze the transition processes of higher education institutions in sustainable universities and indicate aspects that hinder this process, which necessarily proposes profound changes in the way the university works; among them (Bizerril et al., 2018):

- Personal resistance to change and innovation (Lozano, 2006; Cullum, 2014)
- Institutional and systemic barriers to change (Harris & Crane, 2002 and Pereira et al., 2013)
- The limited perception of the concept of sustainability by managers (Wright & Horst, 2013)
- The problems in conducting the participatory process in the institutionalization of sustainability (Disterheft et al., 2012)

There are, therefore, two fundamental aspects of sustainability in universities: one concerns the pedagogical issues addressed so far, and the other refers to the universities' commitment to managing the campus, making it sustainable (Drahein, 2016).

4 Management Transitions

Sustainability has been a challenge in higher education institutions (HEIs), both for managers and public policy-makers, as well as for students, teachers, and administrative technicians, that is, the entire academic community. This is mainly due to the fact that many of the universities currently have a significant impact on the economy, society, and the environment, as they resemble "small cities" in size and population (Ávila et al., 2017).

Bizerril, Rosa, and Carvalho (2018) corroborate Gonzáles-Gaudiano (1998, 2005) by stating that, on the one hand, there is a more technological and behavioral perspective for the solution of environmental problems, recognized by many authors as related to the idea of education for the sustainable development of another, socio-environmental sustainability is an alternative model of society in which participation, involvement, dialogue, and a sense of community belonging, justice, and global responsibility are preponderant in decisions about a common future for all, thinking also adopted by Loureiro and Layrargues (2013).

According to Caeiro and Azeiteiro (2020), higher education institutions (HEIs), within their mission and activities, have an important responsibility in the transformation of societies: they can implement sustainable development in different dimensions, according to a holistic approach, from education and curricula, campus operation, organizational management, external community, and research, for assessment and communication. A more sustainable society will result from this effort.

Ideally, these implementations are based on a holistic integrated approach that the United Nations Educational, Scientific, and Cultural Organization (UNESCO, Paris, France) calls the "Whole-School Approach" (Caeiro & Azeiteiro, 2020).

Assessing the effectiveness and impact of these different dimensions of implementation allows you to measure and assess how sustainability is being applied in practice, highlight strengths and weaknesses, and define necessary improvements.

HEIs play a crucial role, mainly because of their inherent characteristics and mission:

- As educational institutions, HEIs have the responsibility to prepare future leaders and citizens to be more aware and active in the dissemination of sustainable principles.
- As owners of physical structures configured in extensive systems that consume large amounts of energy and other resources and, as a result, generate waste, HEIs have the opportunity to implement actions to reduce costs and impacts associated with the operation of the campus.
- As administrative structures, HEIs have to manage people from different sociocultural and financial backgrounds and also seek engagement among employees, academia, and the community.
- Therefore, HEIs have a social responsibility to incorporate all these issues and act by example.

In addition to paying attention to the information provided on websites, reports, or statements, it is important to identify the actions and initiatives presented in the sustainable campus plans; determine whether these are implemented; and understand the type and magnitude of its environmental, social, and economic impacts (Amaral et al., 2015).

Thus, the sustainable university must go far beyond generating savings through the conservation of natural resources, reducing waste, and promoting efficient environmental management; it must foster equity and social justice, transcending these values to the community in which it operates.

It is worth noting that in the transition process to sustainability in universities, there are two fundamental concerns: first with the environmentalization of individuals who are inserted in that context and second with the management tools available at the institution, as we will see below.

4.1 Environmentalization

The phenomenon of environmentalization at the university needs to be understood from an epistemological and, above all, anthropological perspective, as it is under constant construction in different social spaces (Borges, 2013). The search for understanding the phenomena and the investigative capacity that accompanies each individual are essential to reflect on the existing educational processes (Wachholz, 2017).

The environmentalization process is continuous and dynamic, and through transversality, it is capable of covering four dimensions: curriculum, search, extension, and campus management, which integrate the various sectors and actors of the academic community in the construction of an environmental policy consistent with current discussions (Guerra & Figueiredo, 2014).

Environmentalization requires conceptual, methodological, and attitudinal innovations, as well as structural and organizational innovations, as well as another look at the insertion of the dimensions of sustainability (Orsi et al., 2015). With the environmentalization process, the university confirms its commitment to continuous improvement, the construction of ecological awareness and sustainability by suggesting changes in the cultural habits of the university community, through projects, plans, and policies that will spread knowledge and environmental information (Bratkowski et al., 2017).

Inserting sustainability into the university implies a profound reformulation in the institution's functions and structure. An integral environmentalization only happens when one understands and is aware of the environmental crisis and assumes political responsibility with these changes; unlike isolated and punctual behaviors, this results in a process of maturation of continuous and permanent values and visions (Wachholz, 2017).

Sustainability will only be recognized when looking at it is one of recognition of its inherent potential to the whole; ethical, economic, social, political, ecological issues, among others, justify the inclusion of the environmental theme, especially education for sustainability in all sectors and for all university actors (Wachholz, 2017).

4.2 Tools for Assessing Sustainability Management at HEIs

The sustainability movement in higher education has grown significantly over the past few years, and along with this rise, assessment instruments have emerged that are considered important for the operationalization of charters and policy statements on sustainability and, consequently, guiding the management of institutions (Urbanski & Leal Filho, 2015).

In order for an HEI to carry out an assessment on sustainability, it must plan the development of a set of criteria that address the three dimensions of sustainable development, that is, involving environmental, economic, and social aspects (Lukman & Glavič, 2007). Instruments that present a diagnosis that collaborates to the formulation of an institutional policy are needed (Brandli et al., 2012), which supports the transitions in the processes of teaching, research, and extension and that allows continuous evaluation and systematic management (Roorda & MARS NS, 2008).

The information obtained from this diagnosis is used for the preparation of reports, helping to identify the weaknesses and internal and external strengths of the campus, which, when found, should mobilize adequate planning and implementation of improvement actions in the management (Brandli et al., 2012). In addition, they also make it possible to inform society about the progress of the institution's environmental plan, demonstrate the institution's concern with the environment, and help maintain a database on environmental management programs (Ferreira et al., 2006).

In order to meet expectations and needs, assessment instruments must present some characteristics, namely:

- They must identify large-scale and influential issues that also allow for specific measures. Furthermore, they must provide mechanisms so that it is possible to prioritize issues (Shriberg, 2002 apud Brandli et al., 2012).
- They must be flexible to capture the complexities and differences of the organization, as well as its progress toward sustainability, something made possible by qualitative criteria. However, they must be specific enough so that they can be calculated and compared, characteristic of quantitative criteria (Shriberg, 2002 apud Brandli et al., 2012).
- The distinction is crucial since eco-efficiency indicators measure the use of materials, environmental performance, and legal compliance, while sustainability indicators address the interaction between the environment, society, and economy and aim at zero impact (O'connor, 1995 apud Shriberg, 2002).
- To identify agents of change in the organization, the tools must question "why" and "how" institutions seek sustainability, in addition to "what" has been done (Shriberg, 2002 apud Brandli et al., 2012).
- The assessment tools must be understandable to most actors involved, but understandability must not be sacrificed for accuracy (Shriberg, 2002 apud Brandli et al., 2012).

Brandli et al. (2012) states that when the main objective of including sustainability in institutions (whether through an environmental management system or the direct insertion of the topic in the curriculum) and that students act in favor of sustainability, it needs to assess the effectiveness of these actions; it is necessary to measure their influence, if they in fact contribute to the formation of students' values and construction of a new vision in relation to the environment, and this demonstrates another important role that assessment tools must play.

In the literature, it is possible to find several assessment instruments; in general, they are developed for application in companies and communities, such as the GRI (Global Initiative Report) and the ISO 14000 and ISO 37120 series. These models served as inspiration for others such as the GASU (Graphical Assessment of Sustainability in Universities) and Higher Education 21 (Drahein, 2016). Specific models for higher education institutions such as the Auditing Instrument for Sustainability in Higher Education (AISHE), Campus Sustainability Assessment Framework (CSAF), Sustainability Assessment Questionnaire (SAQ), and the Sustainability Tracking, Assessment and Rating (STARS) are recent and North American or European origin.

Drahein et al. (Drahein, 2016) with the aim of getting to know the sustainability assessment tools in higher education institutions developed an analysis of several models and standards, presented in Table 6.5.

Table 6.5 Presentation of assessment tools

Assessment tool	Description/level or focus	Higher education institutions assessed
Global Reporting Initiative (GRI)	Sustainability report, the GRI Guidelines offer principles, contents, and manual implementation so that different organizations can use them	University of Calgary's (Canada) University of Florida (USA)
Ecological Footprint	Methodology that assesses the consumption pressure of human populations on natural resources	Northeastern University (China); Newcastle (Australia); University of Redlands (USA); University of Toronto (Canada)
Graphical Assessment of Sustainability in Universities (GASU)	The tool is designed to graphically present sustainability efforts at universities and facilitates their analysis, longitudinal comparison, and benchmarking with other universities	University of Leeds (United Kingdom)
Auditing Instrument for Sustainability in Higher Education (AISHE) A	Specific tool for universities presents a set of indicators	University of Passo Fundo (Brazil)
Higher Education 21. (HE 21)	Its objective is to disseminate good sustainability practices in higher education and is a set of indicators for universities	University of Brighton (UK)
Campus Ecology	The book covers eco-efficiency, social, and economic themes	University of Wisconsin–River Falls (USA)
Sustainability Tracking, Assessment, and Rating (STARS)	Its objective is to understand the environmental performance of HEIs	Vancouver Island University (Canada) California State University, Los Angeles (USA)
ISO 14000	Set of standards used for environmental certification in companies in general	University of Glamorgan (United Kingdom) University of Vale do Rio dos Sinos (Brazil)
Campus Sustainability Assessment Framework (CSAF)	Specific tool for universities. Designed to provide support, resources, and assistance in developing solutions for HEIs	University of Prince Edward Island (Canada)
Sustainability Assessment Questionnaire SAQ	Qualitative questionnaire designed to help assess sustainability issues in universities	University of Hawaii at Manoa (USA)
Report Card	Independently assesses campus sustainability activities	Yale University; Butler University (USA) University of Waterloo; University of Toronto (Canada)
GreenMetric	Seeks to classify universities in terms of sustainable actions	Pontifical Catholic University of Rio Grande do Sul (Brazil) Voronezh State University (Russia) University of Kwazulu-Natal (South Africa)

(continued)

Table 6.5 (continued)

Assessment tool	Description/level or focus	Higher education institutions assessed
KAP	It is an analysis structure that allows the study of individual behavior on a psychometric scale. Analyzes the knowledge, attitude, and practice of the university's student population	School of Microbiology, University of Antioquia, Medellin (Colombia); School of Medicine, Co-operative University of Colombia – Medellin, Medellin (Colombia)

Source: Drahein et al. (Drahein, 2016) modified by the authors

These and other models are objects of study by different researchers, whether applying or comparing them. Next, we will briefly discuss some of these tools, seeking to raise their main characteristics.

4.2.1 Global Reporting Initiative (GRI)

The Global Reporting Initiative (GRI) – Guidelines for Sustainability, is one of the most complete tools for evaluating and disclosing the sustainability of companies and has been used worldwide by higher education institutions. The instrument has the GRI sustainability guidelines and consists of measuring, disclosing, and rendering accounts to internal and external stakeholders of organizational performance in relation to the objective of achieving sustainability (de Costa, 2012).

4.2.2 Graphical Assessment of Sustainability in Universities (GASU)

Models for universities were adapted from the GRI, such as the Graphical Assessment of Sustainability in Universities – GASU, which allows you to graphically present the sustainability efforts in universities and facilitates their analysis, longitudinal comparison, and benchmarking with other universities. The great differential of GASU is the comparisons between the universities and the development of the SEI each year; as the model is based on the GRI, its limitations are also similar (Drahein, 2016).

4.2.3 Green Report Card

The Green Report Card was developed by the Sustainable Endowments Institute (SEI), a nonprofit organization founded in 2005 in Cambridge, Massachusetts, USA (Shi & Lai, 2013). The College Sustainability Report Card – 2011 (Report Card) is an independent tool for evaluating campus HEI and its sustainability initiatives. Common in universities in the USA and Canada, the Report Card rating system seeks to encourage sustainability in investment practices, with a focus on HEIs as institutions from the perspective of sustainability (Greenmetric, 2016). The tool, through its 41 indicators, analyzes the environmental management of resources in the functioning of the campuses and sustainable practices, in order to verify if they are in accordance with the sustainability precept. The evaluation focuses on policies and practices in nine main categories: administration, climate change and energy, donation transparency, food and recycling, green buildings, investment priority, shareholder participation, student involvement, and sustainable mobility (de Costa, 2012).

4.2.4 STARS

Sustainability Tracking, Assessment, and Rating (STARS) works by measuring sustainability performance and involves operations, administration, and curriculum. "Launched in 2009, Sustainability Tracking, Assessment and Rating (STARS) is a transparent self-reporting framework for colleges and universities" (Urbanski & Leal Filho, 2015, p. 210). The instrument provides a framework for understanding sustainability in higher education institutions, allows for comparability, provides incentives for continuous improvement, strengthens, and disseminates good sustainability practices across campuses.

STARS has five major areas: the first with regard to academics deals with curriculum and research; the second, called engagement, presents questions about public and campus engagement; the third, operations, which seeks to assess air, climate, energy, food service, buildings, transport, waste, landscape, and water; and the penultimate area, planning and administration, presents questions about investments, planning, and governance, followed, finally, by the area of innovation (Drahein, 2016). As it encompasses long-term goals as well as recognition entry points, it ranges from more structured institutions to institutions that are taking their first steps toward sustainability (STARS, 2014).

4.2.5 GreenMetric

The UI GreenMetric World University Ranking is an important assessment tool for sustainability, started in 2010 and which seeks to measure the efforts of universities in sustainable actions: education aimed at sustainability in universities is worth 18% of the ranking's final score and takes into account the number of courses, research, and publications, educational events and organizations students related to the subject. The results are displayed in the form of a ranking with numerical scores, which facilitate comparisons between universities around the world, in addition to encouraging the constant search for improvement and better rankings. This tool has the following objectives:

- Provide online research results on the current condition and policies related to the Green Campus and Sustainability in Universities around the world.

- Draw the attention of university leaders and stakeholders to combating global climate change, conserving energy and water, recycling waste and ecological transport.
- Identify the universities that lead the way in this regard.
- Publicize efforts to implement ecological policies and manage behavioral change among the academic community in their respective institutions.

Among the criteria for ranking universities in the ranking is the size of the university, zoning profile, green area, electricity consumption, transport, water use, waste management, facilities and infrastructure, energy, climate change, policies, actions, communication, and education. Education is a criterion that began to be evaluated in 2012 due to the "important role of Universities in creating a generation concerned with sustainability" (Greenmetric, 2012).

4.2.6 AISHE

The Auditing Instrument for Sustainability in Higher Education – AISHE – is based on a quality management model developed by the European Foundation for Quality Management and reinforced by INK – Dutch Institute for Quality Management (Drahein, 2016). The AISHE consists of 24 criteria evaluated in 3 stages of development that uses the Deming circle, in which "planning" involves vision, policy, and internal environmental management; "doing" involves teaching objectives and methodology as well as curriculum issues; and the "verification" phase involves the assessment and covers students, employees, and society (Roorda, 2001).

4.2.7 CSAF

The Campus Sustainability Assessment Framework (CSAF) is designed to advocate for policy in the university sector; compare sustainability performance through a common methodology and set of indicators; and facilitate communication and understanding about sustainability among teachers, staff, and students (Cole & Wright, 2005). It covers more than 170 different indicators, organized into 10 main categories or dimensions – water, materials, air, energy, land, health and well-being, community, knowledge, governance, economy, and wealth (Cole, 2003).

4.2.8 SAQ

The Sustainability Assessment Questionnaire (SAQ) for colleges and universities is a qualitative questionnaire designed to help them assess the level of sustainability. The questionnaire has 25 questions allocated into 7 major areas: Curriculum, Research and Scholarships, Operations, Teachers and Staff Development and

Rewards, Services, Student Opportunities, Institutional Mission, Structure, and Planning (Drahein, 2016).

Its objectives are to raise awareness and encourage debate about what sustainability means for higher education, check the sustainability status of the SEI, and thus promote the discussion on the next steps (SAQ, 2015).

4.2.9 KAP

Knowledge, Attitudes, and Practices – KAP, aims to analyze the knowledge, attitudes, and practices about the sustainability of university students; psychometrics is performed under the criteria of consistency, reliability, discriminating power, content validity, and predictive validity (Salas-Zapata & Cardona-Arias, 2020), as transitions to sustainability require changes in Knowledge, Attitudes, and Practices (KAP), and tools that support educational interventions for sustainability and that generate changes in people's decisions and behavior are extremely important.

4.2.10 Other Initiatives

In addition to the assessment instruments presented, there are other initiatives that introduce the experience of concepts into the routine of HEIs, educating not about sustainability, but into sustainability, such as Green Campus and Living Lab initiatives.

4.2.11 Green Campus

The concept of Green Campus emerged as a product of the engagement of universities with sustainable development policies, which was initially disseminated in the United States, Europe, Australia, and New Zealand, later expanding to countries in South America and in the African and Asian continents (Deeke et al., 2008 apud Rodrigues, 2018).

The Green Campus, in addition to generating savings through the conservation of natural resources, reducing waste, and promoting efficient environmental management, must foster equity and social justice, transcending these values to the community by adopting initiatives to reduce the consumption of natural resources; encouraging the recycling of everyday consumption materials; promoting critical questioning of consumption; replacing disposables with durable alternatives and encouraging the consumption of agroecological products, etc. The institution testifies to what is proposed in the classroom (Sorrentino & Nascimento, 2009). By establishing sustainability principles throughout the structure of teaching, research, extension, and management, the SEI links the theoretical perspective of teaching with what is actually practiced on the campus and educates in the practice of sustainability.

For this, the integration of three strategies is foreseen in a systemic way: Environmental Management System, Public Participation and Social Responsibility, and Sustainability in Teaching and Research, with emphasis on the importance of recording the commitment to sustainability in institutional policies and university practices (Alshuwaikhat & Abubakar, 2008).

4.2.12 Living Labs

JPI Urban Europe (2013) defines living labs as:

> a forum to innovate the development of new products, systems, services, and processes, employing working methods to integrate people throughout the development process as users and co-creators, to explore, examine, experiment, test, and evaluate new ideas, scenarios, processes, systems, concepts, and creative solutions in complex and real contexts

They constitute a form of experimental governance, in which parties interested in developing and testing new technologies and ways of life to face the challenges of climate change and the maintenance of urban sustainability (Evans et al., 2015) create the staging of intentional experiments in real-world settings that are rigorously monitored and learned (Voytenko et al., 2016).

The living lab approach emphasizes monitoring and learning that provides a framework for connecting students to applied research; the perspective is to unite researchers, students, consultants, university managers, and even external agents interested in the environment to coproduce knowledge about sustainability, technologies, and services in a real-world configuration; in addition, they are increasingly popular strategies for universities to face the challenges of sustainability as problems applied around built projects, green infrastructure, and low-carbon technologies (Evans et al., 2015).

Living Labs have the potential to strategically frame coproduction processes in two ways: first, by consulting users and stakeholders, as this allows complementary sets of projects to be strategically planned and offer holistic solutions to sustainability challenges; second, by emphasizing the iterative process of experimenting and learning from year to year, they provide a more coherent basis for action over time (Evans et al., 2015).

These two elements are valuable in a university environment, combining the institutional response to sustainability challenges and engaging students in focused and applied projects that clearly contribute to a broader and longer-term sustainability framework (Evans et al., 2015).

König and Evans (2013, p.4), state that:

> living lab-type initiatives that use the University and the city or parts of them as places to experiment with sustainable ways, technologies and lifestyles have become extremely popular throughout the world precisely because they have the power to harness the academic capacity of Universities to address the challenges of sustainable development.

5 Conclusion

The university has the primary role of promoting complex thinking and critical awareness of the academic community, in addition to encouraging communication with other sectors of society. It is, therefore, a socially responsible institution in forming competent citizens to live together, foster, and promote the transition to sustainability in accordance with today's social, political, economic, and environmental demands.

In order for it to be a meaningful process, the transition of universities to education in sustainability, both with regard to pedagogical processes and management processes, needs to be planned, implemented, stimulated, carried out, and monitored based on the situations and specificities of each institution of university education. The evaluation of sustainability on the campus should take place with the aim of identifying weaknesses and strengths, as well as monitoring environmental performance, and not just classifying it for comparison purposes by regulatory structures in higher education.

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Chapter 7
Analysis of the Path of Studies on Financial Education and Sustainability

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Abstract This study aims to analyze the trajectory of sustainability in financial education research. Methodologically, it performs a bibliometric analysis by VOSviewer and CitNetExplorer, exploring the studies in financial education and sustainability regarding the productivity by year, authors, periodicals, institutions, notable works, and words key. The main results found that since 2011 had an exponential growth in publications in the area, highlighting USA as the country with highest contribution of the field. The mainstream is concerning to the didactics of financial education, focusing on social and economic spheres of sustainability. We found out that the assumptions concerning to the financial educations and sustainability issues are incipient. It suggests a better understanding about the area for stimulating insights in the relationship between personal finance management and sustainability.

Keywords Financial education · Sustainability · Sustainable development · Sustainability perspectives

1 Introduction

Due to the financial crisis in 2007, the nation sought for more equity in the economy, providing the balance between the elements of the sustainability (economic, social, and environment (Aleksandrova et al., 2020; Kallis & Norgaard, 2010).

A financially enlightened population can be one of the factors of transition between the world of the traditional economy and the sustainable economy since citizens with a certain degree of proficiency in personal finance can make better decisions when it comes to planning and consuming decisions, investments, credit taking, retirement, protection, and so on (Fox et al. 2005; Hira & Loibl, 2005; Cole et al., 2011; Bucher-Koenen & Lusardi, 2011).

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Countries and institutions partners of Economic Cooperation and Development (OECD) have been encouraged to develop strategies to disseminate financial education (Atkinson & Messy, 2011). Studies such as those by Calderón, Cunha, and De Giorgi (2013) found a positive correlation between the acquisition of knowledge about personal finance and Hibbert, Lawrence & Prakash (2012) the possibility for transforming social realities since most low-income people in developing countries run small businesses. In controversial, the neediest are likely enjoying good financial management benefits, precisely because of the lack of access to information (Phillips, 2001; Haskins, 2001).

Considering that individuals are responsible for making several financial decisions throughout their life, the impacts of these decisions leave the individual sphere and end up affecting the whole society (Mandell & Klein, 2009). Thus, the sustainable development model (triple bottom line – TBL) can also support financial education since it can interact simultaneously with the tripod. In addition, educational actions must be cultivated throughout the individual's life, and the ability to deal with personal finances can lose the power of correction and application, whether not practiced (Fernandes et al., 2014).

However, research in financial education faces some conceptual barriers since it has attracted recent interest, given the significant increase in publications only from the twentieth century. Due to the lack of consensus in the conceptualization of terms, there are gaps about what financial education is (Huston, 2010). There are some studies with controversial results (Johan et al., 2020) and semantics in which generate confusion in the term (Bruhn et al., 2016). Thus, we try to address the following question: "*How are studies on financial education and sustainability discussed in the literature?*"

Firstly, this research is justified by the recent discussions in financial education and sustainability, which bring needs to expand and validate understandings. Secondly, the conceptual stage of these emerging themes requires further exploration of science. Finally, there is no precedent for productivity analysis associated with cluster techniques in the area, characterizing innovative research.

This article aims to analyze the trajectory of sustainability in financial education studies through hybrid techniques for assessing scientific impact and productivity. In addition, the cluster analysis was carried out to identify research themes. The literature was collected from study of the from Web of Science databases. The intention is not to encompass all knowledge about financial education and sustainability. Instead, it intends to provide a comprehension of how these both areas have exchanged themselves from the scholars' point of view.

2 Literature Review

Financial education has already directed public policies in this direction since the 1990s (Grinstein-Weiss et al., 2015). Discussions about the role of financial education grown up exponentially due to the credit crisis that started in 2007, when the financial decision environment, both from a macro and micro point of view, became much more complex (Fernandes et al., 2014; Muñoz, 2019).

The need for financial literacy in the contemporary world is fundamental, given the functions of money in the current political, economic, and social systems (Salter, 2016). Inserted in a system whose money is the primary basis of exchanges and trust, individuals carrying out countless financial transactions throughout their lives need to be literate to deal with this element in a decision environment that is becoming more and more complex (Boshara et al., 2010).

In general, researchers still have controversial approaches concerning to the effects of financial education (Leonard, 2008; Adams & Rau, 2011; Collins & O'Rourke, 2010; Hastings et al., 2013; Hira, 2010; Willis, 2011). However, seminal studies such as Bernheim's (1995, 1998) highlight the adverse effects of the lack of financial literacy in people's lives. It has been a consensus in recent researches (Loke, 2017; Belekhova & Kalachikova, 2018; Tamir & Davidson, 2019; Pangestu & Karnadi, 2020).

According to the literature, understanding the term financial education is not a trivial task. Several terms are intersected or are not well defined (Huston, 2010; Fernandes et al., 2014). For some authors, financial education refers to retirement, investment, management, and the use of credit (Hira & Loibl, 2005). For others, it can mean budget, savings, purchases, and real estate investments/financing (Fox et al., 2005; Cordeiro et al., 2018) or education for insurance (Lin et al., 2019).

Atkinson et al. (2007) relate financial literacy to staying informed and making better consumption choices. Others studies (Yang et al., 2018; Orbanova and Velichova, 2013) relate financial education to the odds of success in ventures. In the other side, Lusardi and Mitchell (2011) point out to the concept of financial capacity, which is the combination of knowledge, skills, and financial attitudes.

Despite the field receives prominence after the Recommendation on Principles and Good Practices in Financial Education and Awareness (OECD, 2005), it is possible to realize that several issues were little explored in the literature. One of them is concerning to the relationship between financial education and sustainability. Yet, when it considers the sustainability, it is not referred to the economic sphere but also social and environmental.

There are few studies trying to understand this relationship, such as Dickmann et al. (2018), Helm et al. (2019), and Kumar and Prakash (2019). Education for personal finances has a much greater potential than economic expectations, once its role is developing citizens much more aware of their environment and society. Thus, it is a subject that deserves attention of the scientific community.

3 Methodological Procedures

According to Pare, Trudel, Jaana, and Kitsiou (2015), reviewing the literature means visiting the conceptual bases that support the study area in search of clarifications, consensus, divergences, and gaps. Therefore, bibliometric studies are indispensable tools for science to develop, considering that this type of investigation enables to

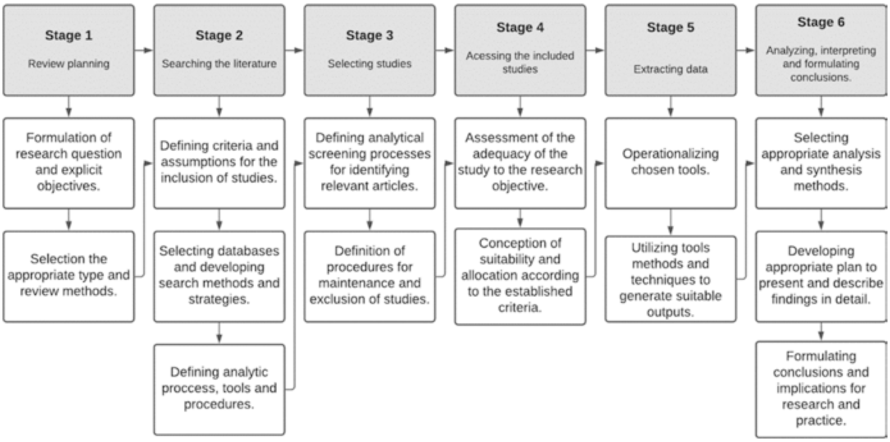


Fig. 7.1 Instantiations of systematicity guidelines in the review process. (Adapted from Paré et al., 2016)

visualize how a given field of science is evolving, which authors, papers, newspapers, and institutions are most prominent. Besides that, it is possible to make inferences about the direction of the following research and reveal gaps that encourage new productions (Sakata et al., 2013; Koseoglu, 2016).

This work performs a descriptive and bibliometric analysis with evaluative and relational techniques guided by Koseoglu (2016) work. The criteria used to assess productivity include per year, authors, references, institutions, countries and journals, and an analysis of the co-occurrence of words; all these involve cluster solutions obtained through the software CitNetExplorer and VOSviewer (Van Eck & Waltman, 2014).

To obtain consistent results, follow the procedures suggested by Paré et al. (2016) for literature reviews approaching systematicity and transparency; the processes are represented in Fig. 7.1. Concomitantly, we sought to balance the sequencing rigor with an interactive approach, in which adjustments and new routes were designed to achieve the objectives.

Stage 1 produced the research question: “How are studies on financial education and sustainability discussed in the literature?”. As well as the general objective, which aimed to answer this central question: “Analyze the trajectory of studies about financial education and sustainability.” For that, hybrid evaluation techniques of scientific impact and productivity were used, in addition to clustering analysis.

Stage 2 defined search strategies and criteria, and in stage 3, a database was extracted from the main collections of the Web of Science (WoS) on April 19, 2021. Was used the research topics: financial and education; (or) financial literacy; (e) sustainability, and only selected publications classified as “articles” published between 1945 and 2021 in categories of WoS directly related to the triple bottom line (see Table 7.1).

Table 7.1 Web of Science categories chosen

Area studies	Ecology	Environmental studies	Multidisciplinary sciences
Business finance	Economics	Family studies	Social issues
Business, sociology	Education educational research	Green sustainable science technology	Social sciences interdisciplinary
Demography	Education scientific disciplines	Humanities multidisciplinary	Social work
Development studies	Environmental sciences	Management	Urban studies

After these refinements, 493 articles were obtained, and a pre-analysis was carried out to assess which articles met the research objectives, characterizing the step 4. All abstracts of papers were read and classified according to the following criteria: (1) discussing financial education as the main topic and (2) relating financial education to one or more pillars of sustainability: social, economic, and environmental. Finally, 18 articles were excluded, in which 4 were not found, making reading impossible, and 14 did not correspond to the study's goal, totalizing 475 included studies. All of these criteria reinforce the research's quality and reliability.

Furthermore, stage 5 refers to the choice of analysis tools and methods of extraction; the software selected in this study are graphical tools for clustering solutions, CitNetExplorer applied to the micro-level analysis, and VOSviewer applied to macro-level analysis (Van Eck & Waltman, 2010, 2014, 2017). The principal resources used in CitNetExplorer are viewing a network of citations, detailing a network of citations, and searching for publications, while in VOSviewer, they are analysis of co-authorship, co-occurrence, and citation.

The extraction process was divided into two phases; first, a productivity analysis was carried out, consisting of the list of the most productive authors, countries, institutions, and the most relevant journals and publications in the portfolio. The second stage, a cluster analysis was performed to determine the quotation networks, research mainstream, and the word co-occurrence map.

The last stage of the research was developed in the next chapter and presented the research findings, highlighting some conclusions and implications for the study and practice of financial education for sustainability.

4 Presentation and Interpretation of Results

Table 7.2 shows 297 articles concerning to financial education for the social pillar through themes concerning to education, social mobility, quality of life, social vulnerability, skill, behavior, and financial literacy. Moreover, 59 articles are related to the financial education and the economic pillar. These studies address to macroeconomic issues such as the role of financial education in economic development, strategies, and business performance; formulation and conduct of government policies;

Table 7.2 Analysis of the discussion of financial education in the spheres of sustainability

Sustainability sphere	(Q) Articles	(%)
Social	297	62.53
Economic	59	12.42
Environmental	0	0.00
Social and economic	110	23.16
Social and environmental	3	0.63
Economic and environmental	3	0.63
Social, economic, and environmental	3	0.63
	475	**100.00**

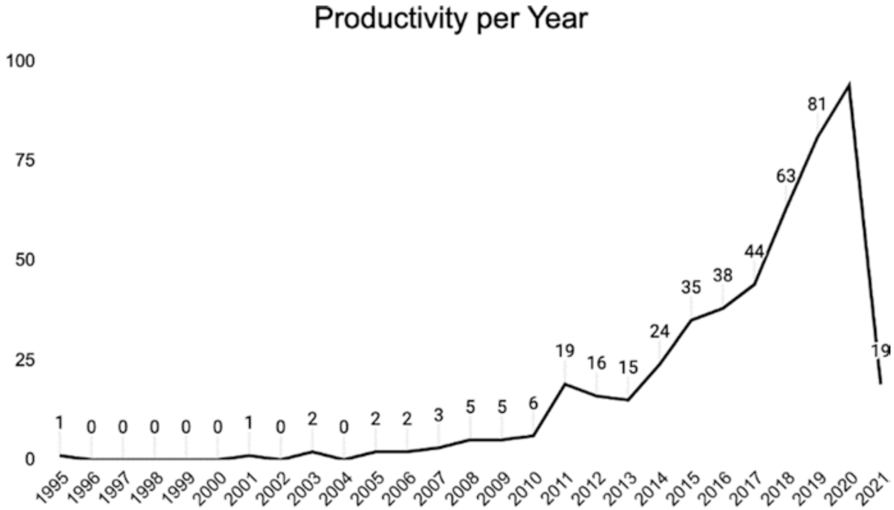
Table 7.3 Statistics for the data set of financial education and sustainability publications

N° of publications	475
N° of author	1,080
N° of organizations	583
N° of countries	69
N° of journals	252
N° of cited references	15,909
N° of citation relations in CitNetExplorer	1,065
N° of citation relations between publications in the data set	1,672

and their relationship with entrepreneurship. Yet, 110 articles cover both the social and the economic spheres simultaneously.

There is no evidence relating to financial education to the environmental sphere of sustainability. However, nine papers addressed the environmental and social pillars (three publications), environmental and economic (three publications), and economic, environmental, and social (three publications). It shows that the debate on financial education is focused on the social and economic spheres; in contrast, the environmental pillar is stagnant, requiring more studies and clarifications, which reinforces the need for this study. It is necessary to clarify the productivity analysis. Complete counting configuration was used and not required to ignore documents with more than 25 collaborations. For the authors' analysis, the author's first name was reduced to the initial letter. In addition, the minimum citation values for co-authorship and citation analysis were not established. We dropped recent works that do not meet the research objective. Table 7.3 summarizes the data of this analysis.

From 475 papers included in the analysis, we observed that 1,080 authors, affiliated in 583 organizations spread across 69 countries, published in 252 different journals. Graphic 7.1 shows the growth of scientific production in financial education related to sustainability. The seminal study was written by Borokhovich, Bricker, Zivney, and Sundaram in 1995, entitled "Financial management (1972–1994) – a retrospective," the study was a bibliographic review concerning to the economic pillar.



Graphic 7.1 Productivity per year in financial education and sustainability

Six years after the first paper, Tennyson and Nguyen (2001) published the "Curriculum mandates of the state and student knowledge in personal finance." This study is linked to the social pillar and analyzed students' performance in tests of financial literacy and intention of future savings, comparing schools where the discipline of financial education was mandatory and schools where that discipline was not obligatory. Then, the area experienced almost a decade of low productivity, with an average of fewer than three articles published per year between 2002 and 2010.

In 2011, there was a substantial increase in publications, making possible to appoint some inferences to justify this volume. The first is the effects of the credit crisis in 2007, known as the subprime crisis, which collapsed the world economy, leading all nations to formulate national financial education strategies.

The second inference explaining the peak of publications in 2020 is the effects of the economic crisis resulting from COVID-19. It slowed the world economy, bringing unemployment and decreasing income of people, demanding more knowledge and ability to deal with finances, personal resources, and scarcity of financial resources.

Further, we analyzed the co-authored and examined the area's productivity in three units of analysis: authors, institutions, and countries. Table 7.4 summarizes the ten results for each unit of study. From 1,080 scholars, Xiao collaborates in 12 articles, followed by Collins, Grinstein-Weiss, and Zia, each one collaborating on 8 papers. The other authors contribute six or fewer publications.

Analyzing the number of citations by these authors, Xiao is also the most cited author with 340 occurrences and is close to Zia, cited 280 times. Zia has the same number of articles as Collins and Grinstein-Weiss (8 articles), the subsequent most popular authors. On the other hand, Zhu produced five papers but did not obtain citations on the network; one of the causes may be the recent publication of these articles (2019-2020).

Table 7.4 The ten most productive authors, organizations, and countries

	(Q) Documents	(%) of 475	citations
Author			
Xiao, J	12	2.53	340
Grinstein-Weiss, M	8	1,68	122
Zia, B	8	1.68	280
Collins, J	8	1.68	181
Serido, J	6	1.26	81
Loke, Y	6	1.26	19
Shim, S	5	1.05	80
Chatterjee, S	5	1.05	72
Birkenmaier, J	5	1.05	33
Zhu, A	5	1.05	0
Organization			
Washington University	15	3.16	144
University Wisconsin	14	2.9	307
University of North Carolina	13	2.74	167
Ohio State University	12	2.53	185
University Rhode Island	12	2.53	340
World Bank	11	2.32	251
University of Georgia	9	1.89	128
University of Missouri	8	1.68	110
Universiti Sains Malaysia	7	1.47	19
National Bureau of Economic Research	7	1.47	31
Country			
United States of America	220	46.32	4426
Brazil	26	5.47	67
People's Republic of China	21	4.42	188
England	20	4.21	336
Malaysia	19	4.00	65
Australia	17	3.58	176
Italy	16	3.37	50
Spain	16	3.37	41
Germany	14	2.95	297
Netherlands	12	2,53	485

Many authors in the field can be positive for developing research, bringing a diversity of debates, and making the soil fertile for developing theories for the future. In this portfolio, of the 1,080 authors, only 170 participate in the most extensive collaboration network, forming 17 clusters, as shown in Fig. 7.2. It is also possible to understand that the prominent authors do not work directly with each other, but their contribution is in the network's nodes.

Next, the co-authoring analysis was through publications developed on the institutions that most promoted publications in the portfolio of 583 papers, Washington

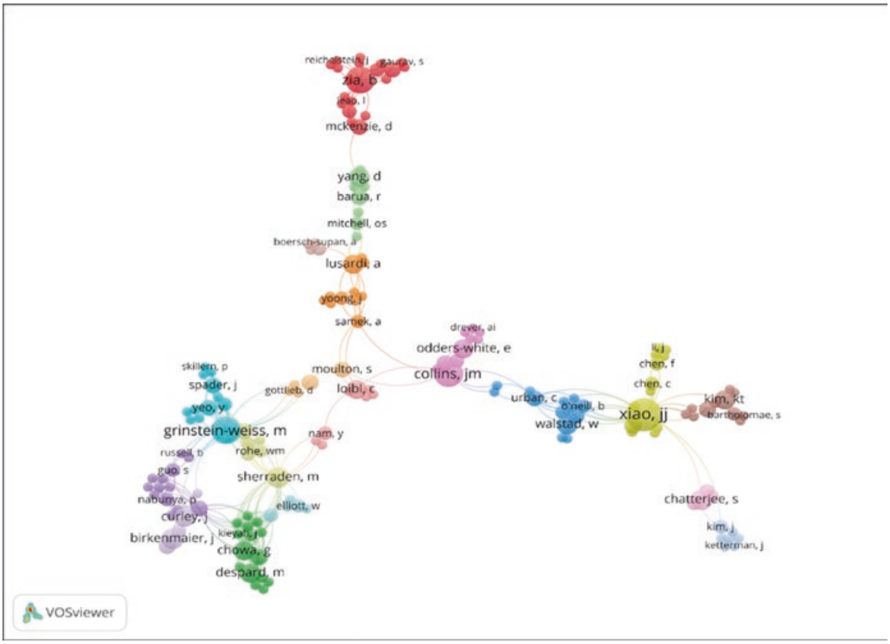


Fig. 7.2 Co-authorship cluster solution – collaboration view by author

University stood out with 15 articles, followed by the World Bank with 11 papers, and, finally, the University of North Carolina with 13 publications. As in the analysis of most productive authors, there were no identified institutions with a concentration of publications; however, of the ten most influential institutions, nine are from the United States.

When analyzing the number of citations of these institutions, the University of Rhode Island with 340 citations is the most referenced in the network, followed by the University of Wisconsin-Madison with 307 citations and the World Bank with 251 occurrences. In this case, Washington University, although it is the institution that most develops work in the area, is not the most cited.

The last unit of analysis of coauthorship is related to the countries with the highest productivity. From 69 that covered the portfolio, the United States appears with 220 papers, which produced almost half of the total publications, corroborating with the previous analysis. Then, Brazil and China appear with 26 and 21 papers, respectively. Thus, the representativeness of the other countries is not as significant as that of the United States, which, in addition to having the most important number of documents, is most cited in papers, with 4,426 citations. At the same time, Brazil is referenced only 67 times, and China is cited 188 times. Other countries, such as England, Germany, and the Netherlands with 20, 14, and 12 papers, have fewer publications but have the highest number of references in the base, with 336, 297, and 485 citations, respectively, behind only the United States.

The productive concentration was with the United States can explain many of the characteristics of the research field, such as the centralization of studies related to sustainability's social and economic pillars and the vacancy of discussion about the environmental pillar. It is also possible to analyze collaboration between countries in publications, as shown in Fig. 7.3. Of the 69, 52 collaborate on the papers; the rest of the publications work in a collaboration bubble.

The "overlay visualization" is used to understand the collaborative relationship between countries and their respective publication densities over the years. The United States is hegemonic in productivity and appears actively collaborating with other countries. Another feature is that US publications had a slow down between 2015 and 2017. Other countries such as China, Brazil, Italy, and Russia are more current in the debates, indicating a decentralization of the discussion in the field.

Closing the coauthorship discussion, the analysis of citations is carried out, covering the papers most cited internally in the portfolio and the prominent journals for the area. Of the 475 documents covering this research, 340 were mentioned at least once in the portfolio. Contrasting to the coauthor analysis in the author's view, except Xiao, the authors who produce the most are not those most cited by the network.

As shown in Table 7.5, the most referenced paper is "Financial literacy, financial education, and downstream financial behaviors" by Fernandes, Lynch, and Netemeyer (2014), with 409 citations on the network. That is, 86% of the papers referenced this work. As this is the first meta-analysis in the field, this paper brought

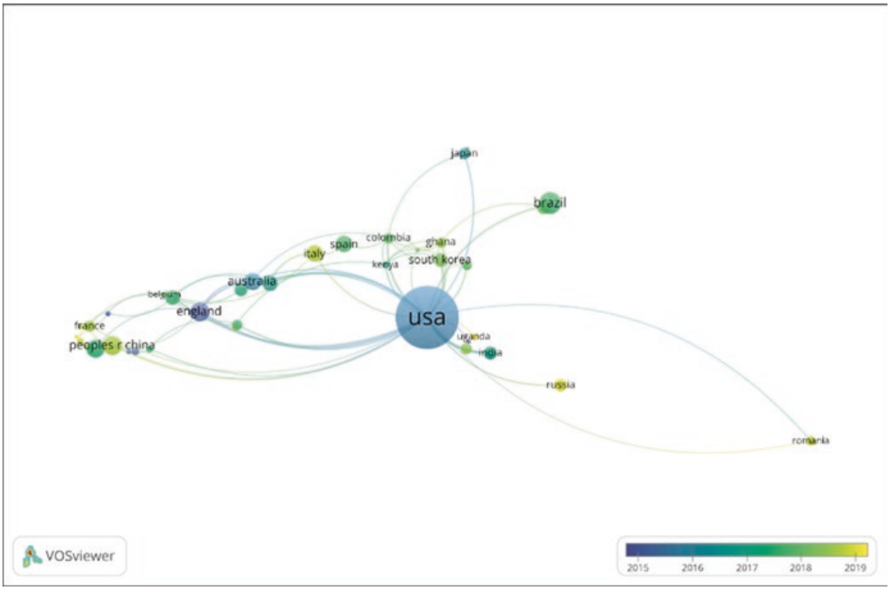


Fig. 7.3 Coauthorship cluster solution – vision of collaboration by countries over the years

Table 7.5 The ten most-cited documents

Title	Authors	(Q) Citations
Financial literacy, financial education, and downstream financial behaviors	Fernandes, Lynch and Netemeyer (2014)	409
Measuring financial literacy	Huston (2010)	364
Transformative service research: an agenda for the future	Anderson, Ostrom, Corus, Fisk, Gallan, Giraldo, Mende, Mulder, Rayburn, Rosenbaum, Shirahada and Williams (2013)	346
The effects of financial education in the workplace: evidence from a survey of households	Bernheim and Garrett (2003)	204
Prices or knowledge? What drives demand for financial services in emerging markets?	Cole, Sampson and Zia (2011)	137
Building the case for financial education	Fox & Bartholomae (2005)	135
Financial literacy and retirement planning in Germany	Bucher-koenen and Lusardi (2011)	115
The financial education fallacy	Willis (2011)	104
Consumer financial capability and financial satisfaction	Li, Yang, Chen, and Chen (2014)	98
The effects of financial education on the financial knowledge of high school students	Walstad, Rebeck and MacDonald (2010)	81

some crucial observations for the research and practice of financial education from a didactic and social perspective, becoming one of the milestones of the area.

Next, the work of Huston (2010) "Measuring financial literacy" is the second most cited with 364 mentions in the network and was a criticism of the vague definition of the terms that involve financial education contemplating the social pillar of sustainability. Finally, Anderson et al. (2013) paper, "Transformative service research: an agenda for the future" with 346 citations highlighted financial education services as one of those that can transform society, including the environmental pillar.

In addition, three studies of this portfolio are related to financial education for the three sustainability tripods. The other studies are also highly relevant, as they address financial education in different contexts – Bernheim and Garrett (2003); Cole, Sampson, and Zia (2011); and Bucher-koenen and Lusardi (2011) – and even offer counterpoints on their effectiveness for social mobility and economic balance (Willis, 2011).

The cluster map based on the internal citations of the portfolio had as inclusion criterion the minimum 5% of occurrences in the network; that is, each paper should have at least 24 citations, which resulted in 54 documents, of which only 42 belonged to the network, generating 7 clusters. From the analysis (Fig. 7.4), it is evident that some of the most cited works end up strongly influencing the network; another relevant feature is that although the highest productivity in the area occurred in 2020, there is no significant work from 2018 to 2019 mentioned in the portfolio.

Concerning the leading journals in this research, we analyzed the sources that published the most articles in the portfolio. Of 252 journals, the most significant for financial education and sustainability area was the Journal of Consumer Affairs (38 publications) and the International Journal of Consumer Studies (17 publications). According to this portfolio, the other sources have few significant indexes (Table 7.6).

It is worth noting that journals about education and sustainability have published little according to this portfolio. It opens space to infer that financial education has been more related to the act of consuming, and thus, it has been treated much more in conjunction with the economic and social pillars. This perspective justifies further investigating the relationship between financial education and sustainability, especially in the environmental pillar.

In co-citation analysis, two aspects were investigated: the works most cited by the articles in the portfolio and the authors, making it possible to understand the roots of the field. For an analysis of the authors who most collaborated in the works cited by the portfolio, a total of 11,055 authors were identified and considered the core placed in Table 7.7.

Lusardi appears as the main author of the works mentioned in the portfolio (723 occurrences), and Xiao (171 occurrences) is one of the most productive and cited authors in the database. The OECD appears with 164 mentions and is one of the main institutions for promoting financial education globally. Except for Mandell

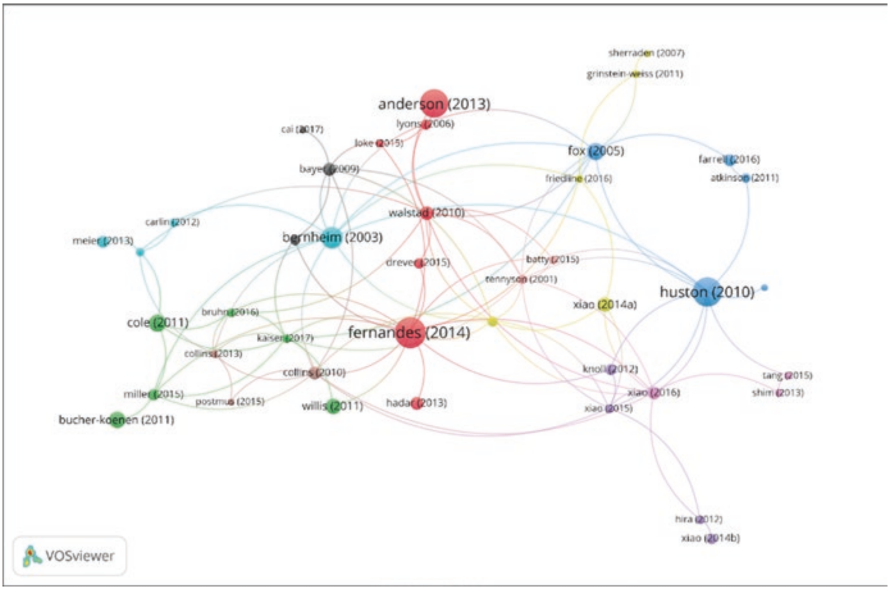


Fig. 7.4 Citation cluster solution – vision by most internal cited documents

Table 7.6 The ten most productive sources

Source	(Q) Documents	(%) 475	Citations
Journal of Consumer Affairs	38	8.00	1,210
International Journal of Consumer Studies	17	3.58	87
Journal of Family and Economic Issues	11	2.32	62
Journal of Financial Counseling and Planning	11	2.32	41
Sustainability	11	2.32	24
Economic of Education Review	10	2.11	83
International Journal of Bank Marketing	10	2.11	59
Children and Youth Services Review	10	2.11	23
Journal of Extension	8	1.68	8
Journal of Pension, Economics & Finance	7	1.47	43

Table 7.7 The ten most-cited external authors

Author	Citations	(%) of 11,055
Lusardi, A	723	6.54
Xiao, J	171	1.55
OECD	164	1.48
Bernheim, B	151	1.37
Mandell, L	108	0.98
Fernandes, D	101	0.91
Huston, S	87	0.79
Collins, J	84	0.76
Willis, L	80	0.72
Cole, S	74	0.67

(108 occurrences), the main authors mentioned externally also appear in previous analyses, confirming their relevance for the development of the area. Regarding the works most referenced by the portfolio, out of a total of 15,909, "The Economic Importance of Financial Literacy: Theory and Evidence" by Lusardi, Mitchell and Curto (2014) stands out with 103 citations. The articles by Fernandes et al. (2014) and Huston (2010) appear again as external references, reinforcing the importance of the works of these authors.

However, in percentage terms, as shown in Table 7.8, the most cited authors are present in less than 1% of the works, punctuating the characteristic of a research field still in an embryonic stage, which needs convergence and conceptual consistency to develop.

When adopting the criterion of a minimum of 2 citations per work, the number of papers cited drops to 2.004, confirming the seminality of some papers. For the cluster chart of the most cited external references, shown in Fig. 7.5, the minimum criterion of 10 citations was adopted, and only 126 works met this requirement. In this analysis, it was possible to identify the formation of three clusters representing the main lines of research. It explains that although it is a recent field, some seminal works stand out and bring cohesion to the discussions in the area.

Table 7.8 The ten most-cited external references

Author	Title	(Q) Citations	(%) of 15,909
Lusardi, Mitchell and Curto (2014)	The Economic Importance of Financial Literacy: Theory and Evidence	103	0.65
Fernandes, Lynch and Netemeyer (2014)	Financial literacy, financial education, and downstream financial behaviors	98	0.62
Huston (2010)	Measuring financial literacy	69	0.43
Lusardi, Mitchell and Curto (2010)	Financial Literacy among the Young	65	0.41
Bernheim, Garrett and Maki (2001)	Education and saving: The long-term effects of high school financial curriculum mandates	62	0.39
Hilgert and Hogarth (2003)	Household Financial Management: The Connection between Knowledge and Behavior	61	0.38
Lusardi and Mitchell (2007)	Financial Literacy and Retirement Preparedness: Evidence and Implications for Financial Education	54	0.34
Lusardi and Mitchell (2007)	Baby Boomer retirement security: The roles of planning, financial literacy, and housing wealth	52	0.33
Hastings, Madrian and Skimmyhorn (2013)	Financial Literacy, Financial Education, and Economic Outcomes	50	0.31
Bernheim and Garrett (2003)	The effects of financial education in the workplace: evidence from a survey of households	45	0.28

After this productivity analysis, of the nine articles related to the environmental pillar of sustainability and the three that work in total, only Anderson et al. (2013) appear as the third most cited work internally in the portfolio. It corroborates with the proposition that the environmental pillar is still little related to financial education. To comprehend the most relevant themes studied in the area, a co-occurrence analysis of keywords was carried out based on the textual data. After this, a historiographic cluster analysis brought the main works that work on these themes.

In all, we found 1,670 keywords and 3,609 occurrences in the database. This study used the criterion of at least 15 occurrences, resulting in 22 main words. Among the most cited terms are "financial literacy with 235 occurrences," "financial education" (178 occurrences), and "education" (72 occurrences). Figure 7.6 presents 4 clusters formed by 19 items that indicate the main aspects of the research.

According to Table 7.9, the red cluster addresses the importance of access to information, linked to behaviors and attitudes toward decisions, especially those related to indebtedness. On the other hand, the green cluster addresses the didactics of financial education from a formal perspective from the perspective of investments and the accumulation of financial resources. In turn, the blue cluster is much more related to the financial inclusion of people without access to the habit of saving and caring for income management. And finally, the yellow cluster addresses the importance of knowledge and skills to develop financial capacity in general.

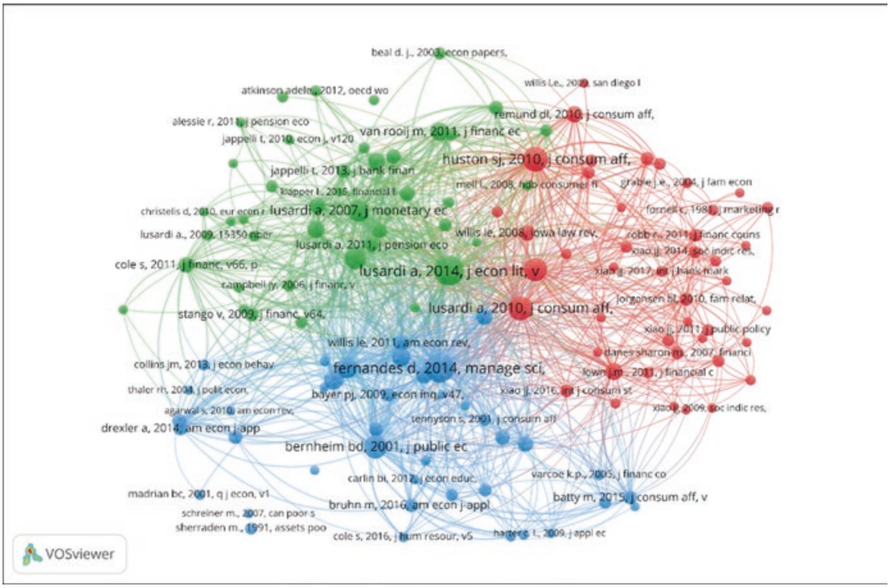


Fig. 7.5 Co-citation cluster solution – vision by most external cited documents

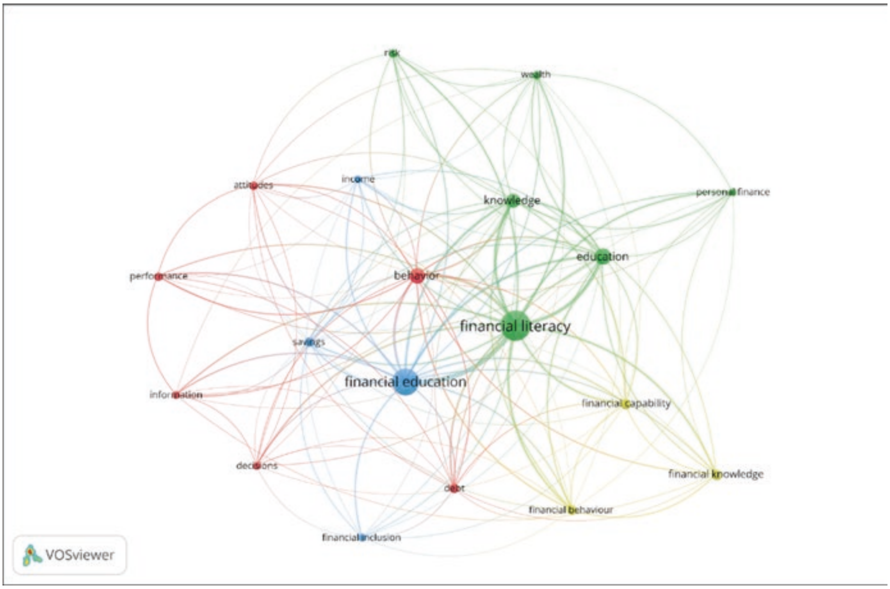


Fig. 7.6 Co-occurrence cluster solution – vision by most used keywords. Note: The following words were excluded from the map: gender-difference, impact, and workplace

Table 7.9 Summary of clustering solution – most used keywords

	Term	Occurrence	relevance (%)
Cluster 1 (red) – 6 items			
Financial education related to the behavioral lines	Attitudes	19	0.53
	Behavior	64	1.77
	Debt	24	0.67
	Decisions	16	0.44
	Information	18	0.50
	Performance	22	0.61
Cluster 2 (green) – 6 items			
Financial education related to didactic content and formal knowledge	Education	72	2.00
	Financial literacy	235	6.51
	Knowledge	53	1.47
	Personal finance	18	0.50
	Risk	20	0.55
	Wealth	20	0.55
Cluster 3 (blue) – 4 items			
Financial education related to practices, planning and savings and investment	Financial education	178	4.93
	Financial inclusion	15	0.42
	Income	15	0.42
	Savings	25	0.69
Cluster 4 (yellow) – 3 items			
Financial education related to a multidisciplinary and philosophical perspective	Financial behavior	26	0.72
	Financial capability	28	0.78
	Financial knowledge	28	0.78

This cluster is also the one that most exchanges with themes from other areas, bringing a more philosophical perspective.

According to this analysis, the research focused on clusters 2 (green) and 3 (blue). It was also found that the word sustainability is not even among the most cited, although it is one of the search filters that generated this database.

These lines of research are confirmed in the CitNetExplorer clustering solutions using the core publications. The red cluster represented in Fig. 7.7 is the most recent in the field and has a time frame between 2011 and 2021. The topics it covers are from the behavioral line, analyzing the cultural and behavioral differences that influence the literacy and management of personal finances; much of the research explores the relationship between specific countries or groups and financial education.

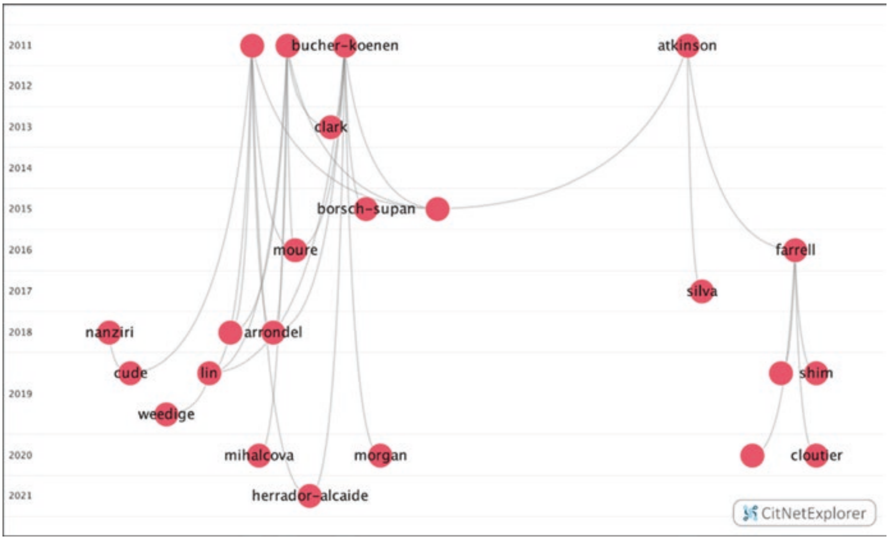


Fig. 7.7 Cluster 1 – behavioral lines

The green cluster (Fig. 7.8) represents the most traditional papers in the area. It investigates the financial education's didactics, for example, what makes up financial education and its role, what content they should cover, among other issues. It has a time frame between 2001 and 2021, which confirms that, although it is the oldest line of research, there are still many open questions, such as the lack of consensus in the conceptualization of terms and difficulty in developing solid concepts and theories.

The blue cluster (Fig. 7.9) is the second most traditional in the field, with a time frame between 2005 and 2021 and deals with the transition between theory and practice of financial education, based on themes such as financial planning, savings, investment, and credit, pointing to a concern with the economic aspects in social life.

The last cluster, although not the most recent, with a time frame between 2007 and 2021, is the one with less research and covers multidisciplinary themes. This relates the field of financial education philosophically with other areas; it was the only cluster to cover research related to the environmental pillar of sustainability. It is still possible to identify that the papers dealing with the environmental pillar do not directly link them. And yet assume weak citation links with other articles, as is the case with Helm et al. (2019) that covers the social and environmental pillar and Anderson et al. (2013) that manage to relate the three pillars (Fig. 7.10).

In general, the number of publications involving financial education and sustainability has been gradually increasing each year, with an average of ≊25 publications per year between 2011 and 2016, rising to ≊60 between 2017 and 2021, growing more than 100%. The largest concentration of productions comes from institutions in the United States that hold ≊46% of the total authorship of the portfolio. Other countries have a very timid parcel in the field; still, Brazil and China occupy the second and third places in the ranking.

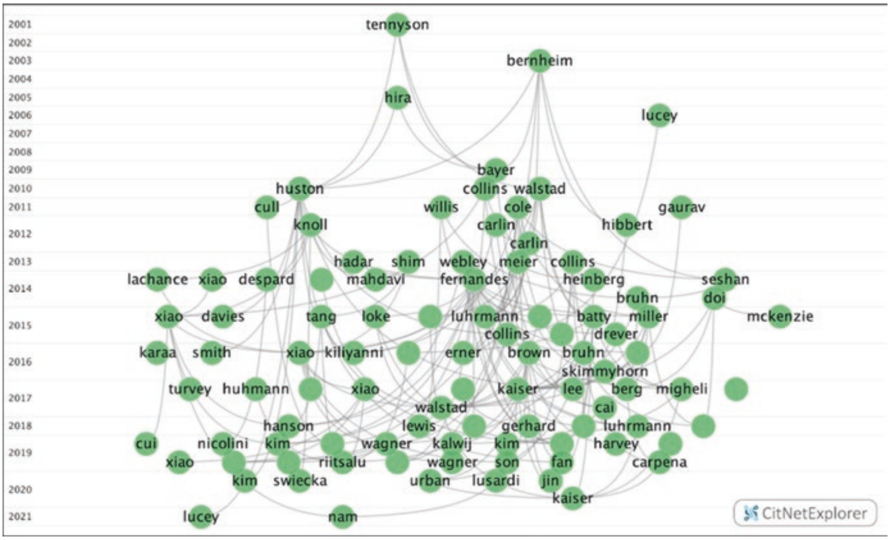


Fig. 7.8 Cluster 2 – didactic lines

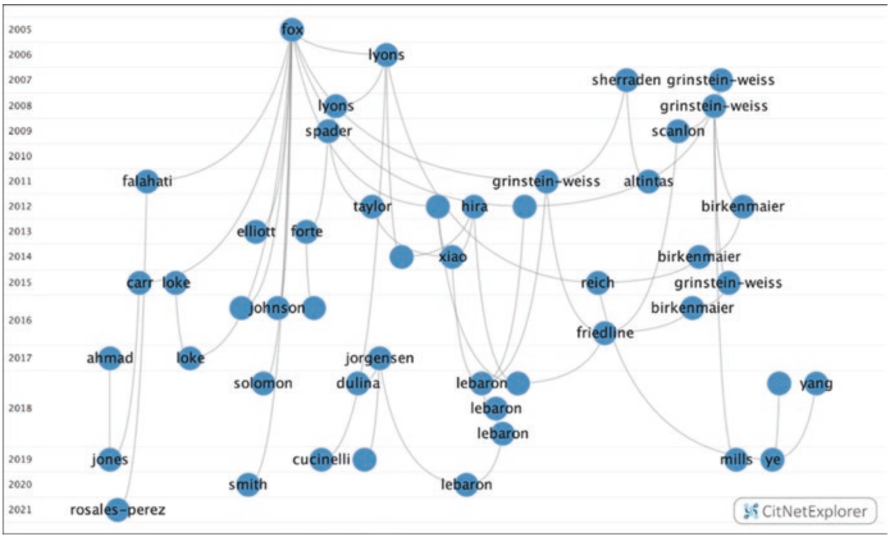


Fig. 7.9 Cluster 3 – practical lines

It was confirmed that there are no traditional institutions of study in the area, although the Washington University leads the ranking of publications by institution, with only 15 papers. From the authors' perspective, Xiao affiliated with the University of Rhode Island is the one who most collaborates with the field (12 articles); followed by Grinstein-Weiss, affiliated with Washington University; Zia affiliated with the World Bank; and Collins affiliated with the University of

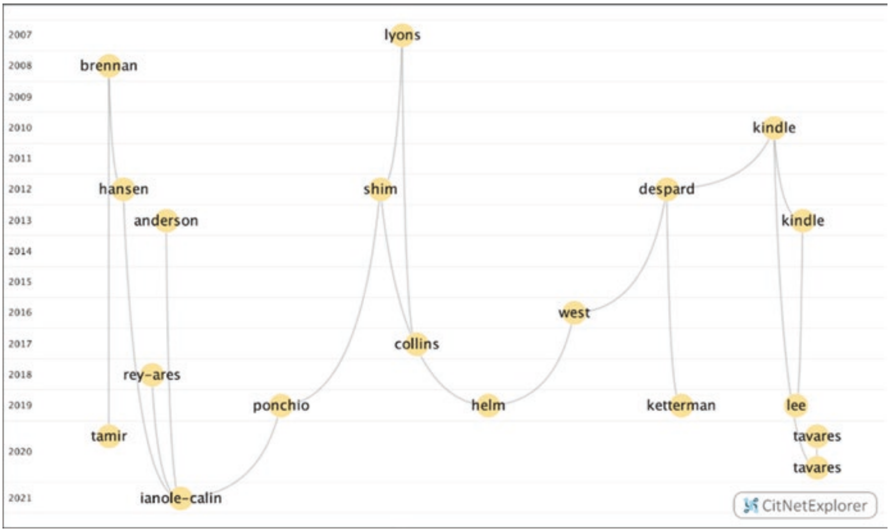


Fig. 7.10 Cluster 4 – philosophical and multidisciplinary lines

Wisconsin, each collaborating on eight documents. The prominent journals in the area are the Journal of Consumer Affairs with 38 papers and the International Journal of Consumer Studies with 17.

The main internal works in the portfolio are those by Fernandes et al. (2014), Huston (2010), and Anderson et al. (2013). According to the papers used in the articles, Lusardi, Mitchell and Curto (2014) appear as the main work. Most of the documents in this study address questions related to didactics, consumption of financial products, indebtedness, well-being, entrepreneurship, retirement, savings, and economics. Even though sustainability is one of the words that originated this database, only nine works address the environmental pillar. Of these, only three manage to work financial education in harmony with the triple bottom line.

In the field stand out four general research lines, divided into clusters, confirmed in the analysis of the occurrence of words. Thus, the results of this study point to a still very shallow discussion between financial education and sustainability in the literature, especially about the environmental pillar. All of this leaves many questions open about the role of financial education in developing a society with fewer inequalities, a less aggressive economy, and a healthier environment.

5 Final Remarks

This research sought to capture an overview of discussions in the financial education and sustainability literature, verifying the distribution of papers according to the year, country, author, institution, and journal, all of this to identify the concentration of research in productivity and impact. In addition, a co-occurrence analysis of words was carried out, and the most popular lines of research in the field were identified. Some analyses were reinforced with cluster solutions for greater detail.

We conclude that studies in financial education and sustainability have gained popularity worldwide since 2011, but the research tradition has focused on the United States. Brazil and China occupy the second and third places, a timid position, but relevant for decentralizing the theme in countries of economic sovereignty and bringing debates to emerging countries.

Financial education needs more internal consensus to show its development potential in other fields of study. This lack of cohesion for the fundamentals of the area perpetuates research that is very contained in its field. And as it was possible to see in the clustering analysis, the principal authors do not work together directly, and few authors dare to come out of the discussion bubble to relate financial education to other topics.

Then, the researchers must spend much effort in the study of financial education and sustainability, especially about the environmental pillar. Limiting the debate on personal finance management to the economic or social pillar only contributes to perpetuating structures predatory of life and well-being.

The purpose of financial education is not just to empower people to manage money as a resource; that would be equivalent to putting warriors on the front lines of a battle with pocket knives, while the opponent has a cannon. The role of financial education focused on sustainability goes further, making up one of the pillars of the formation of citizens and their social and environmental awareness.

The future of studies in financial education and sustainability, far beyond scientific development, also points to developing intelligent solutions to social problems, functioning as a tool to combat inequalities, support healthier economies, and develop a safe and sustainable environment; and this article can be considered as a starting point.

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Chapter 8
Unveiling Diversity and the Unwanted Inequality in Organizational Leadership

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Abstract Diversity in organizations has been mainly considered from the business case paradigm. Firms who foster diversity and equality management (DEM) policies and practices show better performance, net value-added, and legitimacy. Nevertheless, there is still a long way to go, regarding diversity rhetoric and equality, and inclusion practice. Consistent human resource practices in vertical alignment with the strategic core of the business have shown to be a way for firms to truly fulfill the social contract established toward DEM. Drawing from signaling and legitimacy theory under the broader scope of strategic human resources management (SHRM), we argue that leadership can be a proxy for DEM practices and that it can be measured through institutional reports. We analyze leadership diversity in 305 companies through a diversity indicator from the Global Reporting Initiative (GRI). The method used is panel analysis, and eight hypotheses are tested by the GRI diversity indicator which is composed of independent variables, such as the wage gap between genders, gender and age turnover, rules violation, and reported cases of gender discrimination. It was possible to verify that the diversity of gender and ethnicity shows more sensitivity to the variable components than age diversity. Thus, managers should focus more attention on diversity indicators such as wages, respect for rules, turnover causes, and cases of discrimination, as well as the inclusion of minority groups in company leadership, especially those that wish to obtain a greater commitment to sustainability.

Keywords Global Reporting Initiative · Diversity · Leadership · Gender · Ethnicity · Developing countries · Sustainability

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1 Introduction

Sustainability equality considers civilizational advance in economic, environmental, and social foundations (Elkington, 2018): an integrative model for sustainability (Hahn et al., 2015) where no dimension is prioritized (de Oliveira Neto et al., 2018). In the social dimension, sustainability concerns people and society in organizations, whether internal or external. The internal dimension addresses labor relations, training, compensation, and benefits, among other traditional issues of Human Resources Management (HRM), as well as inequalities issues like diversity, gender, race, religion, and age (Souza, 2011).

Diversity debate gains momentum in the globally connected workforce spread around different countries (Urbancová, Hudáková & Fajčíková, 2020). The rise of "anti-pluralism" politics alongside national-oriented populism (Horak et al., 2019), world conflicts, refugee crisis, extremism, and religious diversity are factors that contribute to the complexity of diversity management (Cumming et al., 2020). These matters are present in public debate that ranges from policy discussion (Ortlieb et al., 2019), step into organization dimensions (Cavico & Mujtaba, 2017), and shape the perceptions of individuals: as an employee (Buttner & Lowe, 2017), student (Ghavami & Mistry, 2019), or community members in general (Walton, 2018). In the corporate milieu, significant relevance of the subject due to evidence showing that diversity fosters creativity and innovation (Tuan, 2020) is linked to competitive advantage (Zikic, 2015; Ali, & Konrad, 2017). The Green Human Resources Management movement signals, among other issues, the relevance equity quest gains in organizations (Ehnert et al., 2014). The debate is bridged by the overlapping of strategic HRM and corporate social responsibility (CSR) in perspective to achieve competitive firm advantage and expanded to the bigger picture of business ethics (Järlström et al., 2018).

The strategic gains for the company arise when individuals express their different views and ways of developing processes, achieving goals, and creating work teams, helping companies succeed and improve, fostering innovation and change (Torres & Pérez-Nebra, 2004). The collateral gain comes when companies invest in nondiscriminatory practices, standing out of the crowd of their peers that do not have a socially responsible approach (Wailes & Michelson, 2008). Management environments with a natural level of strategic complexity, like in a hybrid (Lee et al., 2019) or an ambidextrous organization (García-Granero et al., 2018), can benefit from diversity management.

As society becomes heterogeneous, organizations seek to survive in an increasingly competitive world by addressing complex cultural hybridity that characterizes organizations, and a diverse workforce is one way to interface complexity, in and out of the organizations (Pereira & Hanashiro, 2010). Nevertheless, if the quest for diversity is carried out unchecked, companies may experience unwanted inequality and inclusion backlashes. Access is not inclusion: the company may even have half of its workforce of women, but they may receive lower wages, be the least represented in leadership positions, and experience higher turnover. Báez et al. (2018)

identified significant gender gaps regarding women in dimensions like presence, salary, and seniority at tourism companies. The same frame of “present yet under-represented” applies to individuals with special needs, different generations, ethnic groups, and so on (Ylöstalo, 2016).

Thus, organizations need to be aware of these issues and disclose how they manage diversity without putting inequality aside. This can be done through sustainability reports, aligned with frameworks, guidelines, metrics, and procedural justice (Kundu et al., 2019), to set together policy, practices, and signal commitment exposing firms to public scrutiny, therefore influencing deeper and surface levels of diversity in a decoupling-proof way.

The Global Reporting Initiative (GRI) is widely used, and it is the best-known sustainability reporting model (Alaraji & Aljuhishi, 2020). However, adherence to the GRI guidelines in some regions, such as Latin America, is still tiny. Brazil is the third country in the GRI global ranking, just after the United States and Spain (GRI, 2020), and plays a vital role in the economic and political context globally; at the same time, it is an emerging economy with high levels of unemployment, poverty, and social exclusion.

The organizational policies for diversity are still unclear in the Brazilian management literature (Saraiva & Irigaray, 2009); therefore, it is critical to understand how organizational practices are being developed toward diversity and equality. Building upon the diversity and equality, signaling and legitimacy theory, considering the literature gap and the relevance of the GRI for Brazilian context, this study comes up with the research question: **“***Are diversity indicators of GRI related to diversity leadership in Brazilian companies*?**”**

We explore linkages between GRI indicators for diversity in Brazilian companies with the presence of women, indigenous, elderly, young, and Afro-descendant employees. In the GRI report, diversity policy indicator is composed of the wage ratio between genders, cases of discrimination, rape, harassment, age and gender turnover, gender composition, and other minorities. These variables together compose the leadership policy indicator. We assume companies that report GRI will present a superior performance in the leadership policy indicators. However, we want to know to what extent this influences its natural leadership diversity and how it could support our assumption that leaders act as a proxy for DEM in an SHRM approach through its potential of consistent signaling and legitimacy.

1.1 Guaranteeing the Golden Ticket Is Not Enough

The recognition of cultural diversity has been the object of numerous research. In the 1990s, diversity was crafted in the World Culture and Development Commission report, and the document denominated “Our creative diversity,” which corollary translates the requirement of the virtue of tolerance. In 2001, UNESCO considered that respect for cultural diversity is a right and an essential element for policies intended to promote dialogue among peoples (Rodrigues & Abramowicz, 2013).

Diversity is configured as the heterogeneity of race, ethnicity, gender, sexual orientation, socioeconomic status, age, physical abilities, religious beliefs, political beliefs, and other ideologies. It means understanding each individual as unique and recognizing individual differences, focusing on acceptance and respect, going beyond tolerance, and celebrating its rich dimensions (Patrick & Kumar, 2012). The way diversity and equality are framed in business gradually evolved from legal compliance and affirmative actions (Mor Barak et al., 2016) to a nonexclusive view for competitive advantage (Richard, Roh & Pieper, 2013). Workforce diversity contributes to organizational performance, net value, customer relations, innovation, creativity, and problem-solving and generates a positive image (Mor Barak et al., 2016; Ruiz-Jiménez et al., 2016).

Cultural diversity implicates respecting choices, work behavior, and the development of careers (Byars-Winston et al., 2015). Heitner et al. (2013) and Puente-Palacios et al. (2008) highlight the importance of leaders valuing diversity and recognizing abilities of workers so that individuals see themselves as equally capable. Most of the initiatives related to the success of DEM concern leadership.

Conversely, failures in diversity management lead to conflict and dysfunctional behaviors, causing severe consequences for the organization (Shore et al., 2009). Managers must establish diversity programs considering the communities' cultural values and practices.

Diversity can be categorized into two domains: (I) the surface (or visible) level, which comprises aspects like gender, age, ethnicity, and race, and the (II) deep level, which includes the less visible ones like education, motivation, job tenure, and so on (Mor Barak et al., 2016). The simplistic approach of the diversity in companies happens due to poor conceptions that shape itself "empty vessels programs" (Ahmed, 2012) where different groups and expectations are thrown in without regarding historical or cultural aspects and power relations that influence organizational structure (Dobusch, 2017).

While diversity usually is approached in numbers, equality is addressed by its impact. It is the difference between giving golden tickets in "a statistical fashion" or truly safeguarding all hues of the diverse workforce through the whole chocolate factory. Several companies have been searching to implement inclusion business cases in their strategy, organizational process, and CSR activities (Bilimoria et al., 2008). Several scholars agree that increasing diversity is not sufficient as an HMR strategy: companies need to create policies and practices that manage diversity and promote an inclusive environment (Mor Barak et al., 2016). The workforce should feel safe to bring their authentic and unassimilated self to the workplace.

The diversity and equality management (DEM) policies and practices appear to be a proper way to address diversity. Alike what happens with HRM, research on DEM supports that to be successful, and diversity and equality practices should integrate the core of a firm's human resources management.

From the SHRM theory, DEM relies on the assumption that a diverse workforce can improve company performance when their strategic needs are supported by diversity (Ali & Konrad, 2017). Pasztor (2019) highlights the relevance of communicating diversity in three main ways: (I) asset fostered by HRM and corporate values, (II) excellence and competitive advantage, and (III) structural mechanism supported by several initiatives like mentoring, networking, diversity training, and governance. Firms have constantly been trying to include as many stakeholders as they can to address their social contract (Carroll & Shabana, 2010) and therefore do the "right thing" (Mor Barak et al., 2016).

1.2 Consistent Signaling Diversity and Equity Through Leadership

Leaders are seen as ethical stewards of organizations. Their status is grounded in trustworthiness: good leaders honor their personal and organizational values in a way that impacts employees and society. Nevertheless, gaps between leaders and followers are related in research, and it resonates in commitment issues, wealth creation, and increased transaction costs (Caldwell, & Hayes, 2010). Companies that embed diversity in their leadership compositions communicate a consistent message, both to internal followers and external stakeholders. To see your gender and age group represented in non-predefined levels of decision-making sends a solid message to the workforce that can be converted into a commitment to the company. Through the consumer's eyes, a public statement from an employee of your ethnic group signals that the company respects and considers you in their consumer base: "by then, for then," is the kind of perception harder to walk by but also harder to decouple.

Leadership is a broad topic that overlaps many organizational theories. Therefore, this is carried out within the DEM approach: relations among leadership, legitimacy, and diversity have been identified in many studies (Bhattacharya et al., 2008). Legitimacy concerns are nuclear for companies since it is one of the main motivations for diversity policy implementations. Defined by Suchman (1995) and further explored by Singh and Point (2009), legitimacy can be categorized on pragmatic, moral, and cognitive dimensions: "Pragmatic legitimacy is related to the self-interest of the actors and audience, while moral and cognitive legitimacy implies the interest of the wider organization and society" (Singh & Point, 2009, p. 25).

The modern company can tackle complex challenges: absorb them in a resilient way and keep it going through times where social clashes torn apart reputations in a matter of hours. In the overwhelming world of communications, the modern organization is the one who does the right thing and is competent enough to tell the history. Usually, it is hard to make the "good deeds" reach stakeholders; information is lost among the channels and decoupled between parties. Signaling theory connects DEM with organizational performance through the way the firm communicates its commitment with values like fair treatment and inclusion to a broader spectrum of social groups: this generates interface feedback with stakeholders who value diversity and social justice and, in turn, could support firm with investments, legitimacy, and new human resources (Ali & Konrad, 2017).

Receivers read signals differently, calibrating them according to their assumptions and values and changing the strength and meaning of the messages (Suazo et al., 2009; Connelly et al., 2011). Calibration can also respond to environmental distortions: receivers experience issues in observing signals or even feel deceived by misleading or ambiguous signals. On the other end, signalers may feel tempted to false signaling when they do not have quality. The signal costs outweigh the costs of achieving the desired aspect and emitting valid signals (Connelly et al., 2011).

With proper signaling, diversity fosters a positive firm image even in controversial industry environments (Du & Vieira, 2012); nevertheless, legitimacy is a complex and multifaceted construct: addressing it without proper concern of information asymmetry gaps can lead to decoupling (Singh & Point, 2009) between what is shown in the firm website and the reports and what the stakeholders observe, through, i.e., peer relations. Organizational legitimacy is defined by the combination of technical considerations of the industry and institutional pressures of the environment. Thus the legitimacy pattern is defined by the internal strategic allocation of resources to "get the job done" but also by a necessity to comply with stakeholders by "doing the right thing" (Suchman, 1995).

2 Method

The methods of the study comprise data panel analysis to emphasize variable linkages over time. Carried out by STATA software, the approach is a multivariate statistical technique popular in social sciences. Data are analyzed over a time series. From an epistemological perspective, the researcher tries to understand how a ratio varied over time. This suggests using cross-sectional or longitudinal data analysis, with variations between 5 years in the GRI reports from the Brazilian context.

The hypotheses of the study show that the composition of leadership in companies can be influenced by contextual conditions (Kemp et al., 2015; Chawla & Sharma, 2016) such as proportion of wages between men and women, number of reported cases of discrimination, and cases law violation, in addition to the turnover of employees varying by age and gender. Therefore, it is necessary to suggest relations on the theoretical findings to fill the gaps left by the literature.

The variable components of diversity are the proportion of wages between gender, the number of cases of violation, the number of reported cases of discrimination, and the turnover of men, women, and age group. Also, in panel analysis, we consider time perspective as an independent variable to measure time variability (longitudinal effect) to compose the eight hypotheses of this study (Fig. 8.1).

The sample consisted of 305 companies (N) with 5 years of observation: results in 1525 inputs or sample observations in the function of time and variables.

H1: Diversity indicator influences the gender ratio in organizational leadership
H2: Diversity indicator influences the employees up to 30 years old ratio in organizational leadership
H3: Diversity indicator influences the employees from 30 to 50 years old ratio in organizational leadership
H4: Diversity indicator influences the presence of employees over 50 years old ratio in organizational leadership
H5: Diversity indicator influences the presence of Afro-descendant or mixed races employees ratio in organizational leadership
H6: Diversity indicator influences the presence of employees ratio in organizational leadership
H7: Diversity indicator influences the presence of indigenous employees ratio in organizational leadership
H8: Diversity indicator influences the presence of employees with special needs ratio in organizational leadership

Fig. 8.1 Hypothesis

3 Results and Discussion

3.1 Descriptive Data Analysis

The first command to be used in Stata is the "xtset" + "variable name." The ideal variable presents the result as "strongly balanced," i.e., the variable is perfect for use in a panel. Unfortunately, only the Business Year (ordinal), X2, and X3 variables were considered by Stata as strongly balanced. This command was applied to all variables, whether y or x, and all presented as "balanced," i.e., can work but have "missing values" or values not reported by the companies.

The Stata command "xset" indicates that the database is a balanced panel analysis by year variable. For each company, there is no shortage of data for the corresponding years, enabling the submission of data to panel analysis. The command "xtsum ya x10 x11 x12 x13 x14 x2 x3" is possible to describe the sample data. The analysis shows that N (sample size) was 305 companies with 1523 observations, the average of the variables remained within the expected range, and the standard deviation was considered heterogeneous. While variables such as X3 obtained a high standard deviation, others had a standard deviation of zero. This means that few companies reported any case of code of ethics violation on this sample, and none of them reported having experienced cases of discrimination in legal proceedings such as harassment and/or sexual or moral violence, obtaining no dispersion.

3.2 Fixed and Random Effects on Panel Analysis

The Hausman test is used to decide whether fixed or random effects will make the analysis. The test is required to verify the influence of time on the relationship between the variables. Even if the intercept is different between the companies, they do not vary with time; therefore, time is irrelevant. In the case of validation of this suggestion, panel analysis is of fixed effects between the data. However, in the random effects, the average intercept of companies can even be equal, but they vary over the analysis period. In the case of a statistically significant p-value (below 5%), the result of the Hausman test determines the use of fixed effects. In case of no significant p-value, time determines the variation in the data and is considered a random effect of the sample.

From Table 8.1, it is possible to observe that the probability of test f is much lower than 5%, which demonstrates the robustness of the model adopted. However, Table 8.1 shows the variables X10 and X12 are statistically significant (p-value less than 5%) and demonstrate that they are the biggest influences on ya (women in leadership). The variables X11, X14, and especially X3 do not represent influence on ya. Note that the variable x2 has been omitted from the test because its number was so low that it did not have any value to be analyzed. Only women's turnover (X10) and the turnover of up to 30 years of age (X12) influence the female leadership composition in the analyzed companies.

To progress the Hausman test, it is necessary to compare the relationship between the fixed effects, and the command used is "Statistics-Postestimation-ManageEstimationResults-StoreinMemory." Thus, Stata retains in its memory the test results as "fixed." The probability is also very high in random effects, and the variables that demonstrate statistical significance in influencing ya variation are X10 and X12.

The most suitable model is presented by the command "Specific Hausman," and the results show that Prob>chi2 = 0.4987. The probability is very high, greater than 5%, rejecting the fixed effects model and accepting the random model. Thus, it is possible to understand that time is significant in the variation of the relationship between the variables found.

Table 8.1 Random effects

Random effects GLS regression	Number of obs	= 1516
Group variable: companies	Number of groups	= 305
R-sq: within = 0.0477	Obs per group: min	= 2
Between = 0.0561	avg	= 5.0
Overall = 0.0491	max	= 5
Wald chi2(6)		*= 77.72*
corr(u_i, X) = 0 (assumed)		
Prob > chi2		*= 0.001*

3.3 Hypothesis Results

H1 assumes that the diversity of variables influences the composition of women in the leadership of organizations that reported GRI within the period from 2009 to 2013. All are positively correlated, *accepting hypothesis 1*. The dependent variables show influence starting from X10 in 18.99% and X11 in 12.76%, and the one that does not correlate is X3, and all others have low correlation. Due to the results of the relationship presented, X2 was eliminated from the sample. There are very few instances through the sample, which impedes its consideration in the study and is missing.

H1 assumes that the diversity of variables influences the composition of women in the leadership of organizations that reported GRI within the period from 2009 to 2013. All are positively correlated, accepting hypothesis 1. The dependent variables show influence starting from X10 in 18.99% and X11 in 12, 76%, and the one that does not correlate is X3, and all others have low correlation. Due to the results of the relationship presented, X2 was eliminated from the sample. There are very few instances through the sample, which impedes its consideration in the study and is missing.

Hypothesis 3 is given by the composition of the diversity of variable composition of employees from 30 to 50 years of age in the leadership of organizations that reported GRI within the period from 2009 to 2013. In this case, X10 has the highest correlation of 15%, and X3 the least, being insignificant. The variable X2 was again eliminated. X11 has a reasonable improvement in the influence in which it is concluded that hypothesis 3 can be partially accepted. Thus, as shown in the analyzed theory, the diversity of leadership between 30 and 50 years of age can be influenced by the model factors and other factors that may be latent to the model. Thus, it is believed that the reasons that lead companies to structure the leadership of this age group are not the policies or actions of diversity implemented by them, being partially accepted.

The data show a high correlation from the independent variables X10 (89.8%), X11 (0.75%), X12 (85.5%), and so on. X10 and X12 represent the highest correlation. In this case, *hypothesis 4 is accepted* and can be said that much of the relationship that makes up the leadership of the over 50 years of age group is influenced by male turnover of employees and influenced by a growth of the value from 2009 to 2013.

Hypothesis H5 is accepted, showing more excellent distribution between the dependent variables than the variable components of the leadership of Afro-descendant or mixed-race employees in the leadership of organizations that reported GRI from 2009 to 2013. This shows that there is evidence that the variables of the composition of diversity do not affect this dimension over time.

Hypothesis 6 is supported by the decreasing values from X10, i.e., it can be attributed to the variables of the composition of diversity, and their most significant influence also occurs by variable X10, showing the evolution of the indicator over time. It is possible to affirm that the variables of the composition of diversity positively influence the leadership composition concerning factors.

Hypotheses 7 and 8 were also supported, with values from 0.15 (15%) to 0.20 (20%) in X10 homogeneously distributed to X3. Again, variable X2 had no influence. This shows the leadership composition of employees and people with special needs in the leadership of organizations that reported GRI from 2009 to 2013. However, since no growth is revealed (concentration of influence in X10) in this period, it is possible to say that the diversity of leadership composition aspects relating to these assumptions remained the same.

4 Conclusions

They are saying that diversity and inclusion foster innovation and booster competitivity is quite commonplace and say that firms still struggle to comply with non-decoupled organizational diversity and equality management (Cho et al., 2017). Organizations need to be aware of the complexity to foster a heterogeneous workforce so that their quest for diversity does not end up in an announced inequality in the workplace and a decoupled rhetoric in their reports. When it comes to DEM, the real accountability is needed in the same fashion, and it is applied to sales, revenue, and other financial performance metrics.

The model used here is one more option to foster accountability in DEM. It showed that hypotheses 1, 4, 5, 6, 7, and 8 were accepted, which lead to the conclusion that investing in structural aspects of diversity composition is a vector of fostering representation in the leadership of women (hypothesis 1), over 50 years of age (hypothesis 4), Afro-descendant or mixed-race (hypothesis 5), Asian and Oriental (hypothesis 6), indigenous (hypothesis 7), and people with special needs (hypothesis 8). In a time-frame perspective, the panel analysis showed that only hypotheses 3 and 6 (30 to 50 years old and the composition of Asian and Oriental) had an evolution. This result is not necessarily related to the diversity policies but to the belief that the employee profile will change due to the qualification increase.

The influence of diversity components in employee leadership of over 50 years of age (hypothesis 3) proved to be partially accepted. Therefore diversity policies have little influence in determining the presence of this age group in the company. Combining this with the rejection of hypothesis 2 (leadership in the 30–50 years of age group), we conclude that age range is one point that diversity policies have less influence on. Conversely, ethnic and gender characterization showed more consistent results in response to the variable components of diversity proposed by the GRI.

In practical terms, organizations can leverage these results to transform the current diversity policy into a more effective policy toward leadership. The innocuousness of some policies is known, but regarding ethnic and gender issues, companies must continue investing in isonomic wage policies in the organization of committees to debate violation of code ethics and are evident in disclosing cases of discrimination.

4.1 Implications

The business case demanded nowadays presumes a good thing if your workforce looks way more similar to your customer base. In practical terms, organizations can leverage these results to transform the current diversity policy into a more effective policy toward leadership. Dobusch (2017) points out that most managerial problems are due to motivation rather than structural problems, which lead diversity to focus on the individual level and only surface touch the organizational structure. The application of metrics can fetch empirical evidence and reinforce models on both surface and deep-level diversity aspects. Practical implications rely on evidence-based evidence to guide managerial decisions to improve organizational performance and make workplace experience better for employees (Mor Barak et al., 2016).

The innocuousness of some policies is known, but concerning ethnic and gender issues, it is essential that companies continue investing in isonomic wage policies, debate committees of cases of violation of the code of ethics, and are transparent in disclosing cases of discrimination, which reinforces the studies of Ortlieb et al. (2019); it is apparent that companies or at least a minority report all cases of legal problems concerning harassment of any nature.

The limitations of the work circled the issue of missing values that had to be extracted in large quantities because the companies are not required to report all indicators every year, which meant that the accuracy of the data loses strength.

As search suggestions, this work addresses the same question found by Saraiva and Irigaray (2009) "To what extent indeed do organizations prioritize and actualize their diversity policies?" Further studies can be drawn from the GRI database and the integrated report focusing on impunity of discriminatory conduct, the effectiveness of implementing codes of ethics, and the presence of social responsibility policies.

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Chapter 9
Critical and Instrumental Perspectives of Interdisciplinarity for Business Education

Flavio Martins, Luciana Cezarino, and Lara Liboni

Abstract Sustainable Development Education is considered one of the main vectors for a sustainability transition. Sustainability is a broad field, inherently occupied by different knowledge areas that drink from each other to address the complexity of safeguarding the biosphere for the current and future human and nonhuman inhabitants. With the advent of new frameworks addressing sustainable development under a wider and more detailed lens, such as Aichi Targets, Millennium Development Goals, and ultimately the Sustainable Development Goals, the call for interdisciplinarity becomes even more needed. Interdisciplinarity can be seen as combining methods, theoretical approaches, and epistemological perspectives in diverse working groups for problem-solving; interdisciplinarity can also assume a critical perspective, grounded on the real-world problem needs. We assume that critical and instrumental perspectives, combined in the higher education milieu, can be the answer for educating leaders that hold the theoretical repertoire and the practical competencies that enable them to be agents of changing realities.

Keywords Interdisciplinarity · Critical · Instrumental · Education for sustainable development · Education for sustainability

This chapter is a revised and improved part of the theoretical framework of the author's dissertation thesis: "Martins (2021)".

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1 Introduction: The Generous Vision

Sustainable development is understood here, in short, as a way of creating a world where people share well-being on a healthy planet, with a paradigm change toward "an economy in service of life" (Laszlo et al., 2017)—a more analytical lens, building up in the *Our Common Future* document (Brundtland Commission, 1987). Sustainable development is "the goal of integrating economic activity with environmental integrity, social concerns and effective governance systems while maximizing the well-being of the current generation, fairly sharing the cost and benefits, without compromising the potential for the next generations to meet their own needs" (Annan-Diab & Molinari, 2017, p. 74).

The Brazilian economist, José Luiz da Veiga, calls sustainability a "generous vision of the future" (da Veiga, 2015). The intergenerational perspective and sustainability are indissociable constructs and have been sewed together since the last century when humanity became aware of its annihilation power. The technological advances of an anthropocentric society give humanity the possibility to unleash havoc on the life-supporting systems of the planet and, therefore, demand from this very humanity new ethics for the technological society (Jonas, 1973), ethics that now will address the future life forms, either human or nonhuman.

To sustainability integration be effective, it must cross the boundaries of juxtaposed models of the so-called weak sustainability approach. The economic dimension is usually prioritized at the expense of the social and environmental dimensions (Mulia et al., 2016). One of the main components to make this happen involves the emergence of new leaders and a more profound perspective: a new way of nesting leaderships. They might only act as agents of change if they are nested in contexts that provide innovative and flexible education outside the narrowed views of thematics and knowledge areas (Robertson, 2017).

Therefore, teaching is nuclear for bringing the sustainable development agenda to the center of decision-making in government and corporations and our everyday life choices. The United Nations (UN) has played an essential role in leveraging education to the status of an accelerator for sustainability: 2005–2014 was declared the UN Decade for Education for Sustainable Development (Wals, 2012); after 1 year, the SDGs framework was implemented and the SDG 4 – Quality Education is considered one of the main enablers of sustainable development (Vladimirova & Le Blanc, 2016).

2 Interdisciplinarity Genesis

The classification and visualization of knowledge have been structured in an interconnected way since it was registered. In the Judeo-Christian Greco-Roman world, this has been done through a structure that resembles trees with branches in a hierarchical format: these branches grow in content until they collapse under their OWN weight (Weingart, 2013). This single-rooted tree is a metaphor for the unity of knowledge and is gradually replaced by a format with juxtaposed and loosely connected disciplines (Yeo, 1991). As we know it today, the structuration of knowledge in disciplines is recent, dating from 200 years, and it is already into another transformation (Weingart, 2010).

Disciplines are knowledge areas that are historically delineated by departmentalization, which can be "characterized by their special filtering and interpreting devices" (Miller, 1982, p. 4). The concept of "worldview" is especially relevant for discipline understanding. Since our world is splintered in different and specialized ways, disciplines are among the measures that can be used to categorize it.

The fall of the "knowledge world tree" branches left gaps among previously connected (Weingart, 2013). Since disciplines are multifaceted, they need to reconnect the components in specific points and create new linkages among topics, setting up a call for interwovenness. What we address here is the boundary-crossing of the disciplines, likewise with an interdisciplinary approach. For this work purposes, we address the construct through one of its first definitions:

> Interdisciplinary is an adjective describing the interaction among two or more different disciplines. This interaction may range from simple communication of ideas to the mutual integration of organising concepts, methodology, procedures, epistemology, terminology, data, and organisation of research and education in a relatively large field. An interdisciplinary group consists of persons trained in different areas of knowledge (disciplines) with other concepts, methods, and data and terms organised into a joint effort on a common problem with continuous intercommunication among the participants from the various disciplines.

Addressing different areas of previously organized knowledge in an integrated way is more a gradient than a static typology definition: it stays somewhere between the juxtaposed organized knowledge in loosely connected disciplines and a fully integrated approach. This last stage of interdisciplinarity, usually referred as transdisciplinarity, can be seen as the full merge of the curricular grid, a place where there are no visible boundaries between the disciplines (Heckhausen, 1972); or even in a deeper perspective, boundaries are irrelevant for the proposed knowledge structure.

In a metaphorical approach, we could say that the amount of knowledge accumulated causes a "reverse osmosis of knowledge," where the fields are each day more specialized: more concentrated. The same way the water is pressured through an artificially developed membrane to be separated from the main solution, the thematics are therefore pressured by the specialization needed to address in detail each day a growing amount of knowledge that is purified in small parts: the discipline content.

The same way as happens in the natural world, there is an almost natural movement trying to restore the integration of the knowledge all together again in one batch: the process of natural osmosis. The motivation fostering this "knowledge osmosis" dates back to one of the founders of social sciences: Auguste Comte stressed that "felicitous development of the spirit of detail otherwise impossible (…) spontaneously tends (…) to snuff out the spirit of togetherness, or at least to undermine it profoundly" (Kapp, 1961, p.60 apud Miller, 1981).

Interdisciplinarity has drawn a lot of attention from academia and scholars; after the 1960s, this interest fosters the advance in the field; nevertheless, it is somehow hindered by the lack of common standards for defining, operationalizing (Klein, 2006; Aboelela et al., 2007), and measuring interdisciplinarity (Huutoniemi et al., 2010).

One of the first attempts to represent the interdisciplinarity relation among thematics is the works of the physicist and historian John D. Bernal: his conceptual model represents a tree with branches that end up in 100 disciplines; therefore, they are structured in a way that resembles the old tree of knowledge hierarchical structure, and it shows sideways connections, representing both the specialization and the interconnections among thematics (Bernal, 1944). A few years later, in 1968, another work, from Francis Narin and George Benn, represented the knowledge that distant areas connected themselves under a common scope that could be visualized in a web format without much of a defined hierarchy (Weingart, 2013). In the first half of the twentieth century, the interdisciplinarity was focused on general studies, gradually expanding to other subjects; in the 1990s, it was possible to observe a broader scope of interdisciplinarity ranging from thematics like urban and environmental studies, cognitive science, technology, and social studies.

Cezarino and Corrêa (2019) summarized the main interdisciplinarity schools of thinking by their research goals and structure, theoretical grounding, and dimension (Table 9.1).

The first primary interdisciplinary typology was developed in 1970 in France; it defines *Interdisciplinarity* as “the integration of concepts and methods of teaching and research” (Apostel et al., 1972, p. 1). Aboelela et al. (2007) address efforts to synthesize the main boundaries in this gradient approach in main categories according to the degree of synthesis informed by the main field of interdisciplinary research (Lattuca, 2002; Klein, 2010; Rosenfield, 1992) in similar, yet not the same, typologies that range from least to more integration:

Table 9.1 Theoretical origins of the concept of interdisciplinarity

<table>
<tr><th>Schools</th><th>French</th><th>Nordic</th><th>Anglo-Saxon</th><th>Brazilian</th></tr>
<tr><td>Decades 1970s–1990s</td><td colspan="2">Philosophical and epistemological perspectives (internal interactions)</td><td></td><td></td></tr>
<tr><td>90 and beyond</td><td></td><td colspan="2">Instrumental perspective (external interactions)</td><td>Phenomenological perspective</td></tr>
<tr><td>Objective</td><td colspan="2">Contextual summary: hierarchically structure of disciplines and meta-disciplines</td><td>Addressing society needs</td><td>New teaching methods</td></tr>
<tr><td>Characteristics</td><td colspan="2">Unification of scientific knowledge: reflection on disciplinary knowledge in interaction</td><td>Utilitarian perspective of knowledge</td><td>Linkages between research and teaching</td></tr>
<tr><td>Dimension</td><td colspan="2">Academic</td><td>Project-based</td><td>Didactics</td></tr>
</table>

Source: Cezarino and Corrêa (2019)

- Informed disciplinarity, synthetic disciplinarity, and transdisciplinary (Lattuca, 2002).
- Instrumental interdisciplinarity, epistemological interdisciplinarity, and transdisciplinary (Klein, 2010).
- Multidisciplinary, interdisciplinary, and transdisciplinary (Rosenfield, 1992).
- Separated disciplines, discipline-based, interdisciplinary, and total integration (Kysilka, 1998).

Among many terminologies, the "core vocabulary" for interdisciplinary typologies is composed of the triad: "multidisciplinary," "interdisciplinary," and "transdisciplinary"; Klein (2010) expands and refines these definitions in many hues species and genus of interdisciplinarity (Table 9.2).

The gradient of interdisciplinarity among the categorizations goes from pseudo and juxtaposing forms of interdisciplinarity, passes along the advanced degree of contextualized and blended approach, and ends in transformative typologies, which either eliminate the boundaries and/or fully transform the subject matter. This integration hue is pressured by international demand for interdisciplinarity (Holley, 2009). A paradigm change in course considers the conventional theoretical and analytical boundaries of disciplines less suited to address today's global issues (Darian-Smith & McCarty, 2016).

Among the many dimensions of interdisciplinarity, we draw the debate over the perspectives of a critical interdisciplinarity and the instrumental interdisciplinarity, which Klein (2010) addresses as a major fault line in the interdisciplinary debate.

Table 9.2 Interdisciplinarity taxonomies

Multidisciplinary	*Interdisciplinary*	*Transdisciplinarity*
• Juxtaposing • Sequencing • Coordinating	• Integrating • Interacting • Linking • Focusing • Blending	• Transcending • Transgressing • Transforming
Complementing	*Hybridizing*	
• Encyclopedic ID • Indiscriminate ID • Pseudo ID	• Systematic integration • Transsector interaction	
• *Partial Integration* **<--------------------------------->** *Full Integration*		
Contextualizing ID Auxiliary ID Composite ID	Supplementary ID Generalizing ID	Conceptual ID Structural ID/unifying ID Integrative ID
Degrees of collaboration Shared ID <--------------> Cooperative ID		
• Narrow versus Broad or Wide ID • Methodological versus Theoretical ID • Bridge Building versus Restructuring • Instrumental versus Critical ID • Endogenous versus Exogenous ID		

Source: Klein (2010)

This gap resonates with the discussion over the natural ambiguity of the interdisciplinary concept: from one point of view, there is much effort rebuilding the educational projects to address the multi- and transdisciplinary of society demands; at the same time, educators still have to exercise an education that fits in the conventional molds (Fazenda, 1998).

2.1 Focus on the Society Issues: The Critical Dimension of Interdisciplinarity

Addressing interdisciplinarity as the interaction of two or many disciplines is a loose concept that allows us to set a range of interpretations ranging from a communication of ideas and concepts to key constructs of epistemology, terminology, procedure, data, and the organization of research and teaching relating them (Fazenda, 2008, p. 2). Lenoir et al. (2001) address an initial categorization of interdisciplinarity in a two-faceted approach: the scientific ordering and social ordering.

The first focuses on the core of scientific knowledge: multifaceted. It expands beyond the limitations of the curriculum in a movement that incorporates the epistemological development of specific knowledge with an interdisciplinary vector. The second has its epicenter outside the curriculum written structure, in the real-world social, political, and economic demands (Fazenda, 2008) to which we could add the environmental debate. These two dimensions relate to a separate mind-body duality perspective in a static frame, where the thinking is seized from the action (Lattuca, 2001). Fazenda (2008) sees it as a pendular movement that goes from scientific knowledge abstraction to the point where a practical application is nuclear. This movement has been the object of interdisciplinary research of many specialists like Klein (1984), Lynton (1985), and Huutoniemi et al. (2010).

Amidst all of this, Lenoir et al. (2001) conceive a third way, characterized as "Interdisciplinarity in a Brazilian way," and are focused on the meaning, intentionality, and functionality of the teaching role. Without abdicating the two poles, it goes further and applies an interactional motion focused on the role of the human being, teacher, and student in the educational milieu.

This movement blends the scientific specificity of disciplines with the utmost demands of the contemporary world in a transboundary fashion but does not intend to achieve homogeneity. The rewiring of knowledge is a constant movement in contemporary times; it is heterogeneous and diverse due to its ever-changing background represented by the inherent evolution of scientific fields and changes in the configuration of the globalized world.

The loose patchwork of themes is not static and sterile. Therefore, it is composed of living pieces of fabric that are intertwined by many hands and, once knitted, needs constant fine-tuning, evaluation, appreciation, revision, and detailing (Guimarães, 2008). Thus, the interdisciplinary bridging is diverse and grounded in a critical, reflexive, and enthusiastic dialogue (Tavares, 2008) among students and educators and, therefore, at the institutional level.

Universities have been built upon departmental structures: this sectioning of knowledge reflects all representations of the academic milieu like research, education, career progressions, and project funding. Also, universities are detached from their communities in their untouchable ivory towers. This configuration does not seem to foster cross-border bridging and relates to the ambiguous perception of pursuing interdisciplinarity at a theoretical level while teaching inside rigid models (Fazenda, 1997).

Lattuca (2002) approaches the concept of interdisciplinarity through the perspective of “space”: the same gaps identified among disciplines are also reflected in the organizational structure of colleges and universities: research and teaching must be learned by both the cognitive and abstract dimension and by the material structures of an educational institution. Interdisciplinarity is a requirement of the contemporary world: it favors both understanding knowledge per se and addressing global issues. It seeks to make sense, especially in the educational institution’s mission and educator’s role (Tavares, 2008). Today’s problems are challenging and complex. Nevertheless, “moments of great complexity favor interdisciplinary thinking” (Tavares, 2008, p. 1). To this reasoning, it is nuclear that learning does not be detached from context: cognition and learning only occur through social interaction (Lattuca, 2002).

3 Upstreaming CSR: The Principles for Responsible Management Education Role

The Principles for Responsible Management Education (PRME) is an educational branch of the Global Compact. It was created under the assumption that companies play a crucial role in sustainable development (Lozano, 2012; Lo & Kwan, 2017). In this context, leadership is responsible for decisions toward change to a new paradigm. Therefore, educating leadership for sustainability is of utmost relevance for the UN community (Haertle et al., 2017). The group results from cooperative efforts carried by a group of 60 deans, academics, and representatives of top-tier business schools worldwide. This task force was coordinated by the GC and was presented in 2007 at the Global Compact Leaders Summit held in Geneva. The PRME mission stressed by the UN General-Secretary Ban-Ki-Moon was to bring together universal values and business into classrooms (Escudero, 2011). Ten years after its foundation, the initiative has become the most significant organized relation between UN and management-related academia, business schools, and universities (Haertle et al., 2017).

The Principles for Responsible Management Education (UN-PRME) initiative is an effort to embed international values of the Global Compact framework like human rights, environment protection, and anti-corruption in the business education context (Alcaraz & Thiruvattal, 2010). Changing schools is the critical path for truly integrating SD in society (de Assumpção & Neto, 2020); thus, the long-term thinking business rises from companies and goes upstream into the higher education sources of the twenty-first-century leadership. PRME is acting on a coherent upstreaming of the demands toward business schools, by acting as an education dimension of Global Compact, one of the most essential international corporate social responsibility (CSR) initiatives (Orzes et al., 2020), and PRME holds great potential to act as a paradigm-change initiative.

Both PRME and GC being under the UN structure follow policy guidelines of the 2030 Agenda and the Sustainable Development Goals (SDG) framework. The UN agenda for sustainable development has been signed by 193 countries and is known for its broad spectrum of civilizational objectives, multi-stakeholder applicability, and participatory processes. The 2030 Agenda, in essence, is universal (Loewe & Rippin, 2015). Looking through the lens of business education to the 17 goals and 169 targets of the SDGs framework, we identify themes that are closer to the spectrum of business education and are commonplace in sustainability studies.

Simultaneously, goals like the SDG 16, a political goal, are somehow novel in the sustainable development debate (Sanahuja & Tezanos Vázquez, 2017), but not in business education, since it approaches many topics in ethics, transparency, and governance. Interdisciplinary unfoldings can be the opportunity to link or connect pedagogical practices in business schools and their willingness to develop leadership toward SDGs.

UNPRME-schools represent a growing group of business schools worldwide that endorse this challenge and actively seek to contribute to progress with innovative solutions in research and education. Helping businesses understand and embrace the SDGs opportunity will be crucial for business schools in the next decade (Muff et al., 2017, p. 364). We selected the UN-PRME signatories schools aligned with a broad international approach for sustainable development: the 2030 Agenda and its SDGs framework. The roadmap process of the method until the final scope is related to Fig. 9.1—a purposeful sampling of the PRME schools. There are 836 PRME signatory institutions, of which 37 are in the Champions group. Through the lens of PRME schools, the Champions group is a purposeful sample (Sandelowski, 1995).

4 PRME Harbors Interdisciplinarity in a "Brazilian Way"

There are a total of 21 countries on all continents where there is at least 1 PRME champion school, and this means that region has a locally contextualized advocacy and fostering of the agenda contextually. Brazil is among the very few countries that holds a national chapter "for itself." Despite being grounded on a global agenda, local context plays an essential role in how business schools commit themselves to PRME (Wersun, 2017).

The Brazilian context of an emerging country with its sociocultural idiosyncrasies creates a specific ecosystem for flourishment of responsible management

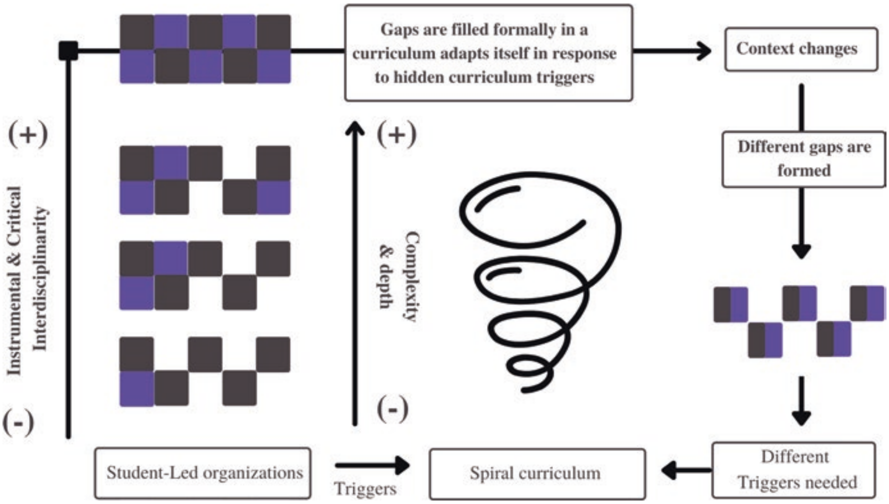

Fig. 9.1 Student organizations trigger spiral curriculum movements toward formal-hidden curriculum interactions. (Source: Elaborated by authors)

education. Our business schools face different challenges that are not always aligned to the predominant western business schools model. When it comes to SDG fulfillment, Brazil ranks at 61 in the SDG Index database (SDG Index, 2021); in the meanwhile, most PRME Champion schools are located in the upper level of the rank, composed by countries such as the United Kingdom and France, who long surpassed challenges faced by Brazilian people, such as the lack of sanitation and highest levels of inequality. The benchmark reporting of PRME schools, indicated as modeling of reporting, comes from schools situated at Finland (SDGIndex Rank 1), Denmark (SDG Index Rank 3), and Australia (SDG Index Rank 35).

4.1 Students Organizations Triggering Interdisciplinarity

Therefore, we present here a case of the PRME reports (sharing information in progress) from a Brazilian PRME signatory, the School of Economics, Business Administration and Accounting of Ribeirão Preto, University of Sao Paulo (FEA-RP/USP). The school is located in the countryside of the state of Sao Paulo, and it was the first public funded Brazilian business school to become a PRME signatory in 2012.

We looked upon the series of reports to identify how the school harbors interdisciplinarity into their pedagogical practices. The reports indicate a growing number of student-led initiatives, grounded on the promotion of service-learning in the community surrounding the school. The amount of the reports dedicated exclusively to portrait the students suggests that they are the focal point for responsible management education in the school. The student teams or fraternities act in a loose format when it comes to academic bureaucracy, and they seem to address topics orbiting around corporate social responsibility and the "elective version" of core courses, such as social finances or social entrepreneurship.

Business curriculum usually is not enough to educate leaders, both from the perspective of specific competencies demanded by companies and from transformational potential called by wicked problems. Service-learning activities have been addressed as prodigal ways to enhance students employability (Mtawa et al., 2021) and the development of a wide array of competencies, such as system thinking, leadership, and normative and ethical competence (Halberstadt et al., 2019) (Table 9.3).

The curricular grid of the specific school does not indicate any formal discipline directed to pedagogical development of students; therefore, they are not focused, at any level, at forming professionals able to teach and to educate new professionals into their future workplaces. It is expected therefore that the students organize themselves: the workshops, lectures, and community education projects, despite any formal capitalization from the school. What can be considered a pedagogical result was not pedagogically planned (Bernstein & Solomon, 1999). When teaching-learning outcomes happen outside the limits of a formal curriculum, it can be called hidden curriculum or cocurricular activities (Peck, 2017).

Borges et al. (2017) address this movement of student self-organization as a response from the community to the lack of offering undergraduate courses that fulfill their needs and desires. When it comes to "needs," we are led to interpret the management education goal as the means to grant students the technical competencies to generate value for the organizations they are intent to work for or create. Management education drawn from the interdisciplinarity domain categorized under the umbrella of professional preparation aimed at applied solution of problems (Smelser, 2004). It could be therefore classified into an instrumental perceptive of a curriculum, which is by default interdisciplinary (Klein, 2010). From this perspective, joining fraternities, sororities, student organizations, and campus activities can lead to a better transition from university to professional marketplace (Peck, 2017) (Table 9.4).

Nevertheless, students do not report only the call for professional skills, and they also, each day more, carry a sense of civic responsibility and an inclination toward sustainable development objectives. One of the oldest projects carried out by the institution's Academic Center is a mobilization for blood donation during the new year's students receptions, among other projects. The commitment with

Table 9.3 Summary of student-led activities in the reports

Report year	Total pages	Percentual dedicated to student-led community activities (%)	N° Student organizations
2013	28	42.86	4
2016	39	51.28	9
2018	62	29.03	14
2020	50	58.82	15

Source: Elaborated by the authors

Table 9.4 Summary of connections between student organizations and curriculum*

		Curriculum Alignment*						
Student association	Focus / Mission**	Mandatory / Core	Elective	2013	2016	2018	2020	
Academic Athletic Association	Focused on the organizational dimension of faculty, and promotion of well-being among students.	N/A						
Academic Center	Focused on the organizational dimension of faculty, specially in representing students at the multi stakeholder decision making boards.	N/A						
Agrocare	Foster the education of leaders for modern agribusiness.		Strategy/Marketing in Agribusiness related disciplines					
AIESEC Ribeirão Preto	Foster internationalization of students		International Law and Internationalization related					
iTeam – USP/RP	Reception and assistance of exchange students	N/A	disciplines					
Caiapós Club	Fostering and learning about liberalism ideals and theory.	Economic theory	N/A					
Enactus FEA-RP	Development of transformational leaderships.	Corporate Social Responsibility	Responsible Education and Social entrepreneurship related disciplines					
Entrepreneurs Center	Foster entrepreneurship study and consultancy	Entrepreneurship	Responsible Education and Social entrepreneurship related disciplines					

(continued)

Tab. 9.4 (continued)

Financial Market Club	Foster finances study and consultancy	Finances chain of disciplines	Social Entrepreneurship and Social Finance					
Gaming Club	Study and practice of gamification approaches and educational games	N/A	N/A					
Insertus Business Club	Study of thematics: Investment Banking, Strategic Consulting e Quantitative Finance	Finances chain of disciplines	N/A					
Junior consulting company	Consultancy services	Business Modelling	Strategic Planning in Organizations					
Neuron	Study and forecast of technologies for futureproof careers	Decision Making tools	Information Technology Applied to Administration					
NEXOS	Public administration studies and joint projects	Public Administration	Innovation and Project Management in Public Organizations					
University Volunteer Center	Foster volunteering among the students in the campus.	Corporate Social Responsibility	Responsible Education and Social entrepreneurship related disciplines					

*Drawn from School Curricular Structure (FEA-RP/USP, 2021)

Source: Elaborated by authors

sustainability-related subjects reflects on a willingness to apply the same principles into career (Okręglicka, 2018); nevertheless, the curriculum seems not to be enough to fulfill this call. Students from FEA-RP reported to deal with sustainability and ethical concerns in their organizations (Borges et al., 2017); for instance, the NEXOS organization developed, in 2018, an app for surveillance of procurements of their municipalities to foster efficiency in the public purse expenditures.

All the student activities reported are connected, at some degree, with interaction beyond university walls. The Financial Market Club holds a project to teach basic finances for public school K-12 students; the Entrepreneurs Center trains hundreds of new entrepreneurs per year: people who could not afford a consultancy service and with their training have a higher chance of success in their business. Service learning is reported as a trigger from ethical and critical reflections and fostering competencies for sustainable development learning (Molderez & Fonseca, 2018). This connection with community and society problems, with thematics that percolates both core, elective, and hidden curriculum needs, holds the prerogatives of the critical interdisciplinarity perspective: the one that is grounded on society issues (Klein, 2010). Thematics that might be considered cause of discomfort in some milieu are also easily fostered by the student bodies. The Academic Athletic Association has been promoting activities to fight women harassment in university parties. The Caiápos Club, Academic Center, and the NEXOS usually are connected with thematics that carry a strong political debate component for the Brazilian context, such as public service efficiency, and these interactions are known for fostering civic engagement (Huda et al., 2018).

5 Conclusion and Framework Proposal

This work walked into some of the business education shortcomings through a perspective of interdisciplinary that is both critical and instrumental, in order to fulfill both organizations career demands and personal aspirations and able to answer the call for a sensemaking education that is both reflexive and grounded on societal challenges.

Schools which are signatory of PRME's principles are expected to foster a critical and reflexive view of RME (Solitander et al., 2012) and to educate new leaders in a "futureproof curriculum" (Winfield & Ndlovu, 2019). We argue that the student projects carried under the perspective of an alternative or auxiliary curriculum have a long-lasting impact. Woodward (2019) addresses the movement that some pedagogical activities deflagrate as a perspective of spiral curriculum: the momentum rose from focal actions and spread upon the topics, revisiting same thematics and constantly exposing the students to the topics with an increasing level of depth or complexity through all its course.

Therefore, we draw from the 2019 PRME report of the institution (Fig. 9.2) and bring into account the student-led projects as ways to trigger interdisciplinarity from both critical and instrumental perspective into a perspective that works as a

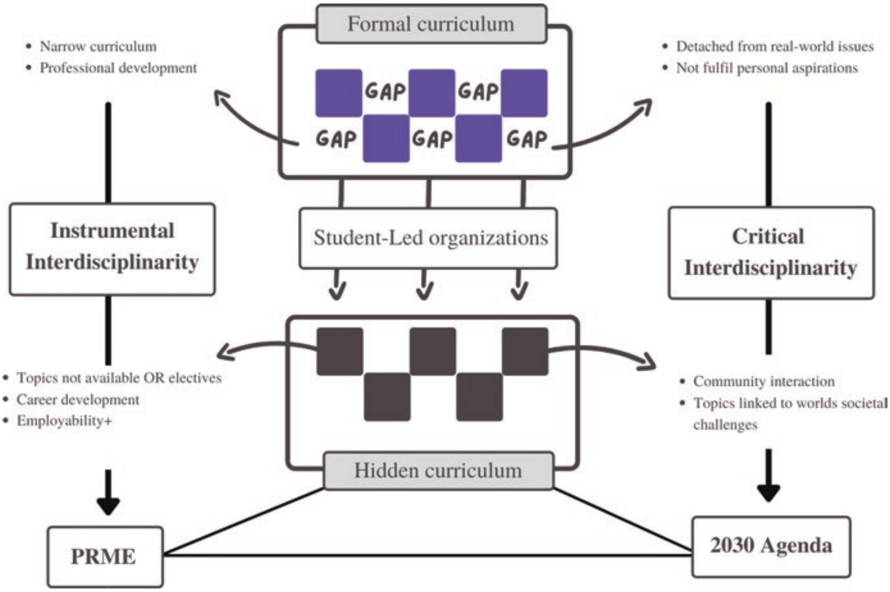

Fig. 9.2 Hidden curriculum built upon critical and instrumental interdisciplinarity. (Source: Elaborated by authors)

reflexive movement of the pedagogical relations and outcomes of the school, with a leverage point in the formal curriculum gaps. In this milieu, PRME and the SDGs framework act as modulators of this spiral movement.

The gaps in curriculum stimulate the student organizations to rise; once the gap is filled through a cocurricular pedagogical output, it has a potential to spread up into the curriculum, gaining deep and eventually modifying the formal curricula.

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Chapter 10
Who Pays for Corporate Social Responsibility?: Proposal for an Externalization Index of CSR Costs

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Abstract Although corporate social responsibility (CSR) aims to improve the positive impacts of companies on society and the environment, most studies focus on the benefits that these practices generate for companies and not on the benefits they generate for the society, which is why this chapter aims to establish if companies assume the costs associated with social responsibility or if, on the contrary, they transfer these to third parties or society as a whole. Based on the above, the theory of social costs was taken as a reference to develop an index that allows determining the relationship between CSR practices and six levels of transfer or externalization of associated CSR costs. The empirical contrast of the index was carried out in a sample of 7233 Colombian companies, due not only to the convenience and timeliness of the information but also to the country's performance in terms of corporate social responsibility. The findings show that firms have a moderate degree of externalization of their CSR costs and pass these on to different stakeholders, especially the state in general and third parties in particular such as employees, consumers, and suppliers. These results then show the need for the concept and practice of CSR to include more specific guidelines and parameters, among which stands out the proposal to recognize as corporate social responsibility actions only those recorded as a reserve in the accounting books of companies allowing with this measure that CSR actions are assumed directly by the organization that obtains the benefits. By doing this, the associated costs transfer to third parties or society is avoided, making CSR a more responsible practice.

Keywords CSR · Social costs · Cost externalization · Colombian companies · Profitability · Externalization index

> No state, no company wants to take over their social and global responsibilities, since they only measure responsibilities based on their cost. (ZAKI LAIIDI)

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1 Introduction

The idea that corporate social responsibility (CSR) can be valuable and even profitable for a company has generated an unusual interest from companies and other sectors of society interested in its possible results and scope (Abreu & Badii, 2007; Moore et al., 2012).

Prestigious academics (Ackerman & Bauer, 1976; Carroll, 1979, 1991; Drucker, 1984; Freeman, 1984; Williams, 1986; Desjardins, 1990; Cortina, 1997; Porter & Kramer, 2006) and international institutions such as the Global Compact of the United Nations, the Global Reporting Initiative (GRI), the International Organization for Standardization (ISO), and the Organization for Economic Cooperation and Development (OECD) propose that being responsible with society generates a series of benefits that can be profitable for companies (Ángeles Gil Estallo et al., 2007).

Despite these evident convergences and affinities on CSR, there is still an unresolved debate regarding who assumes the costs derived from its implementation. On the one hand, Robins (2008) affirms that these initiatives are in charge of the same company and as such, the potential costs that this implies, which can be enormous, are reason enough to prevent its obligation since with this, the true role that the company fulfills in society would be blurred. On the other hand, Johnston (2011) asserts that CSR should only be used to correct the costs that the company's operations impose on society, thus preventing the company from using it as a promotional and market element, without taking care of the adverse effects it creates on society, thus promoting a more constructive business role with society. The positions refer to Robin's and Johnston's not only ratify the diversity that has been presented in the face of the various positions on the nature and raison d'être of CSR (Garriga and Melé, 2004 and Dahlsrud, 2008) but also motivates us to look for elements that give shine on the true scope of the CSR concept.

For the above reasons, this document proposes the design of an index that allows identifying who bears the costs associated with CSR, in order to shed light on the debate, whether it is the company (Robins, 2008) or the society (Johnston, 2011), as well such as the opportunities for improvement that the CSR concept may have based on these results. The index proposed here is built based on the theory of social costs (TSC) initially exposed under externality (Coase, 1960), which recognizes the notion of the impact caused by productive activity from the economic point of view.

Although the concept of externality is not exempt from criticism and limitations because it is limited to economic valuations of the companies' external costs, it represents an approximation to confront in monetary terms the costs that a particular actor or the society in question assume. The costs can be assumed by the shares of a particular company (Pigou Arthur, 1920; Coase, 1960; Buchanan, 1969), thus facilitating the identification and subsequent characterization of the scope of CSR practices and the actual agents that bear these costs.

Finally, the index presented was empirically tested in a sample of 7233 companies from different economic sectors that claim to carry out CSR practices in

Colombia. Among the reasons for the sample selection, the availability of the information but also due to the validity that it can give a country like Colombia with an outstanding performance in CSR since it is the seventh country that carries out the most sustainability reports under the Global Reporting Initiative standards (2016), it has the 8th Local Network of the United Nations Global Compact by the number of adherents among 68 countries (UN Global Compact, 2021), and it is the 11th country out of 36 on the Dow Jones Sustainability Index with 12 companies on the global list, with 2 of them at the top of the list (RobecoSAM AG, 2019).

2 Literature Review

2.1 The Theoretical Debate of Who Assumes CSR

Various studies show the growing relevance of CSR in companies from different economic sectors and sizes around the world (Mögele & Tropp, 2010; Jha, 2013; Grover, 2014). Some of them have dedicated their efforts to studying the benefits it brings to organizations (Carroll & Shabana, 2010), in terms of increasing image or reputation (Stuebs & Sun, 2011), improving investment capacity due to reduced costs (Porter & Kramer, 2011), and the reduction of operational risks (Jo & Na, 2012) or tax incentives (Huseynov & Klamm, 2012).

Other studies argue that beyond the moral obligations, social responsibility brings economic benefits, making use of this managerial management tool, especially in some economic sectors, and has increased notably (McWilliams et al., 2006; Marin et al., 2012; Husted et al., 2015), obtaining even positive relationships between the social and financial development of organizations (Waddock & Graves, 1997; Roman et al., 1999; Margolis et al., 2009).

All these studies have tried to test the economic benefits that the application of CSR practices brings to the organization, to establish motivators and incentives for their application and implementation, that is the business case of CSR. However, these same benefits have been the starting point of important criticisms about the clarity and convenience of handling social responsibility strategies (Baudillard, 2007). Despite their systematic efforts, the contributions made to society are not evident (Salamon, 1999), and in many cases, it is branded as a simple marketing maneuver that little or nothing contributes to the social purpose it promotes (Christensen & Murphy, 2004; Stoeckl & Luedicke, 2015).

Even though the CSR practices undertaken by a company, at least in theory, contribute to sustainable development and a better relationship with different actors (Bhattacharya et al., 2009; Calabrese et al., 2013). Furthermore, it is recognized that an important challenge of CSR is to be more accountable to stakeholders (Peršić et al., 2017), and there are not many studies that show the benefits received by society or stakeholders nor who assumes the costs of this implementation.

As part of that discussion is Robins' proposal (2008), who affirms that although much is said about the benefits of CSR, very little attention has been drawn to the costs generated by it and who bears them. The author argues that due to the inevitable costs that CSR actions impose on companies, this should not be binding, but voluntary, not only because it is part of the spirit of CSR but because it could be disastrous for the contribution that the company makes to society by forcing it to contribute without knowing if the company is capable of doing it.

These arguments are supported by the principle of discretion of CSR since, according to Robins, the costs associated with it could only be financed with gross profit since, if they are recorded as a legitimate business expense, it is not discretionary CSR. Additionally, he considers that CSR practices can also be tax-deductible, thus allowing costs to be shared between shareholders and the states or governments to which companies pay their taxes (Robins, 2008, p. 334).

In the same sense, Robins warns that CSR cannot necessarily be willingly assumed by companies since it has not been possible to demonstrate that it can be directly responsible for the companies' benefits. Although the correlations between financial success and CSR are frequent, this does not imply causality, which is why it is not a sufficient argument to promote its obligatory nature.

Furthermore, the author suggests, "At its heart, the CSR movement is a moral and ethical one" (Robins, 2008, p. 337), and business practices are only a reflection of the context where they operate. Thus, CSR decisions by managers must be driven by ethical forces and not the market. So it would not be convenient to avoid the voluntary commitment of companies to do the good but, on the contrary, encourage them to contribute to society and not pressure them with generic obligations that can be counterproductive with situations such as "imposing potentially costly burdens on the unqualified and the unwilling" (Robins, p. 339).

For his part, Johnston (2011) warns that although CSR has a discourse of social contribution and support to the environment, the efforts made only seek benefits for companies, without reducing the negative impacts that the operation produces on society. This statement is supported by the fact that all productive activity not only implies costs for society, currently known as externalities, but also that managers are motivated to generate them, due not only to the pressure of the shareholders and the practices of the stock market to obtain higher returns but for the permissiveness of the law.

Johnston considers that laws and regulations are not sufficient to ensure that companies' operations cover their social costs, making viable, with less private costs, certain productive activities that are harmful or potentially harmful to society. Business organizations say they carry out CSR actions generating many benefits for the company such as image and reputation and shareholders with higher returns on their investment, but without taking into account its adverse impacts on society and the environment, that is, without internalizing its externalities, which generates an incomplete application of CSR. Therefore, Johnston proposes that CSR implies voluntarily assuming full responsibility for the effects generated in society, thus achieving a CSR that goes beyond the benefit for the company or the business case to achieve a true win-win for the company and society (pp. 222).

For Johnston, companies are better positioned to identify the impacts of their operation more efficiently than state institutions, replacing regulations or the market itself and reducing transaction costs more effectively, thus, achieving an important theoretical step for CSR, moving forward euphemisms such as to make the world a better place to a CSR that avoids that profits are not obtained from the costs generated to society, and thus acting on the sources of damage that do not allow the world to improve.

However, in the absence of sufficient empirical evidence to resolve this debate, the need arises for an objective mechanism that allows us to identify how close to reality each proposal is.

2.2 An Index as an Answer

Faced with the theoretical discussion on who assumes the costs associated with CSR, the company (Robins) or society (Johnston), the construction of a mathematical model is proposed that allows to recognize through an index number the agent that assumes the costs associated with CSR practices, which will be called the CSR Cost Externalization Index (CEI).

The proposed index is based on the social costs theory (TSC) since it considers both positive and negative effects in the economic system, which are not registered in the pricing mechanism. However, they generate a series of information failures in the same system, causing inefficiencies in allocating resources (Coase, 1960).

In this sense, it is necessary to identify whether or not CSR practices have been recorded in the pricing mechanism or financial information systems, known internationally as accounting, which accounts for the operational and financial performance of the company in the past. However, it does not consider the indirect effects generated by the company's transactions, thus posing an imbalance in the model of maximum social welfare (Pindyck & Rubinfeld, 2001).

On the other hand, the practices of companies associated with CSR have different expressions, which range from selfless contribution to vulnerable communities or determined participation in the search for solutions to significant social problems (Kotler & Lee, 2005) to the adoption of international criteria and standards in their operation (i.e., United Nations, GRI, ISO26000, OECD).

The index is then based on the proposal of a relationship model between CSR practices and TSC (see Fig. 10.1), based on theoretical contributions, among which the evolution and role of the company in contemporary society stand out (Coase, 1960, 1988) along with its effects on society both of its logic and its operation (Williamson, 1979, 1981; Ostrom, 2001), and the proposal for self-regulation of CSR (International Standards Organization, 2010; Global Reporting Initiative, 2018).

As shown in Fig. 10.1, the CSR cost externalization index (CEI) is based on a model of CSR practices characterization against the theory of social costs. It takes into account the following components: two primary sources of information that are (1) the types of actions associated with CSR carried out by the company and (2)

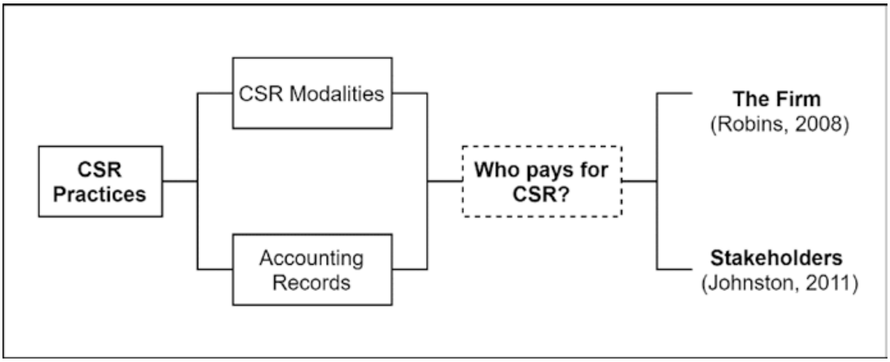

Fig. 10.1 CSR cost externalization index based on theory of social costs

how these actions are formalized or not in the company's accounting, which allows defining (3) the stakeholders who assume the costs associated with CSR practices.

2.2.1 CSR Modality

The first element analyzed is made up of the alternatives or expressions with which CSR can be carried out, which for the purposes of this work are called modalities, which are supported by the groups of CSR practices proposed by Rangan et al. (2015) called by the authors "philanthropic" and "operational efficiency." The philanthropic group contemplates well-intentioned social activities but that do not necessarily seek a benefit for the firm, which may include social contribution and community aid activities. As seen by Sharma and Hart (2014), these activities are an appendix or saddlebag of the organization, which although it can contribute socially, does not reduce the harmful effects of the company's operation.

Meanwhile, the operational efficiency group refers to companies' CSR actions aimed to improve their impact on society or the environment in many cases, reducing negative impacts on society through increased efficiency by the organization. Generally, these types of practices are part of the activities recognized by international standards and references such as UN Global Compact, GRI, OECD, ISO 26000, which, in addition to being associated with the value chain of companies, have the purpose of improving the performance of the organization. Table 10.1 presents the CSR activities taken into account for the construction of the index.

2.2.2 Registry

The second element analyzed refers to the alternatives with which CSR practices can be registered in a company's accounting books, called in this case registry, which allows establishing their relationship with social costs and their externalization or transfer. The accounting valuation of social activities by companies is

Table 10.1 CSR modalities based on Kotler and Lee (2005) and Rangan et al. (2015)

Group 1: Philanthropic	Group 2: Operational effectiveness
Contributions toward community	Environment
Social and community projects	Human rights
Donations	Labor aspects
Social marketing	Transparency and anti-corruption
Commitment to social causes	Freedom of competition
Cause-related marketing	Suppliers and distributors
Volunteering	Clients and consumers

assigned in only two possible options. The first occurs when the CSR actions have not involved any outlay, so it is impossible to include it in the accounting system. The second one occurs when CSR initiatives do involve a disbursement and requires companies to record the amounts allocated to these activities in their accounting system.

Currently, most of the world's countries, at least 175, use the same system for recording their transactions, known as International Financial Reporting Standards (IFRS) (IFRS Foundation, 2021), which determines the use and presentation of financial statements for all companies in countries that adopt them.

At the moment of the data collection (2012–2013) in Colombia, the country was in the process of adopting IFRS standards; meanwhile, a uniform structure called the Single Accounts Plan (PUC in spanish) was enforced. The Single Accounts Plan was created under Decree 2649, 2650 of 1993, Decrees 1915 of 2003, 3361 of 2003, and Law 901 of 2004, which obliges Colombian companies to uniformly register economic operations under the same standard catalogue which allows the transparency of the accounting information in addition to its clarity, reliability, and comparability (*Decreto 2650 de 1993*, 1993). In this sense, for this work, the following registration options were considered based on the Colombian PUC: no registry, cost, operating expense, nonoperating expense, tax deduction, and reserves.

2.2.3 Stakeholders

The index's third dimension addresses who are responsible for the costs associated with CSR efforts, for which it is necessary to analyze the actors that, based on the theory of social costs, may be affected by the CSR actions of companies.

In order to establish the possible actors, the stakeholders proposed by Freeman (1984) will be taken as a reference: shareholders, employees, suppliers, clients/users, and society. As with the CSR modality used and the type of registration, it is possible to link the stakeholder targeted by the CSR practice. However, it is necessary to consider the specific CSR practice carried out by the company. This relationship can be seen in Table 10.2.

The relationship observed in Table 10.2 is highly relevant for determining the agents involved in CSR practices, which gives rise to proposing the categories of cost externalization of CSR practices.

Table 10.2 Modality: Registry relationship with associated stakeholders

Record type	CSR modality	Modality description	Stakeholders
No registry	Philanthropic	Involves employees and contractors during working hours	Employees
		Invite the customer or consumer to buy or contribute to a social cause	Clients/users
	Operating efficiency	It involves demanding a CSR practice from a supplier	Suppliers
Cost	Philanthropic Operating efficiency	It is registered as a cost, which affects the price of the product or service	Clients/users Shareholders Society (state)
Operating expense		It is registered as operating expenses, although it does not affect the price of the good or service directly and it does affect the value of the tax paid and the net profit	Clients/users Shareholders Society (state)
Nonoperating expense		It is registered as a nonoperating expense, it only affects the value of the tax paid and the net profit	Shareholders Society (state)
Reserves		It is charged to the reserves and especially to those destined to charity and civics; it affects the profits of the year to be distributed	Shareholders
Tax deduction	Philanthropic Operating efficiency	It is deducted from the taxes payable either because a previous donation or a deductible investment was configured; it affects the value of the tax payable and the net profit	Shareholders Society (state)

2.3 *Proposed Behavioral Categories*

The companies' alternatives of CSR actions present two basic options focused on the modality and the type of registry used. The type of accounting record and the CSR modalities make it possible to identify, based on their intensity, three types of externalization related to CSR practices, namely, assumed, shared, and transferred (Fig. 10.2), according to the capacity of the firms to transfer the costs to the different social actors that may be affected by assuming these costs.

The first category, *assumed*, occurs when the CSR practice(s) are registered in the accounting system in the reserves account (*Decreto 2650 de 1993*, 1993). This means that the shareholders internalize the CSR-associated costs and are included in the price mechanism, therefore preventing third parties or society from absorbing them. If the type of modality chosen is part of the operational effectiveness group due to the relationship with the decisions and the company's operation, it is considered that it assumes more effectively the external cost than philanthropic CSR modalities.

An example of the assumed category, both in philanthropic and operational efficiency groups, is a company's voluntary choice to establish a reserve either for charity, sustainability, or social responsibility. With which the shareholders assume

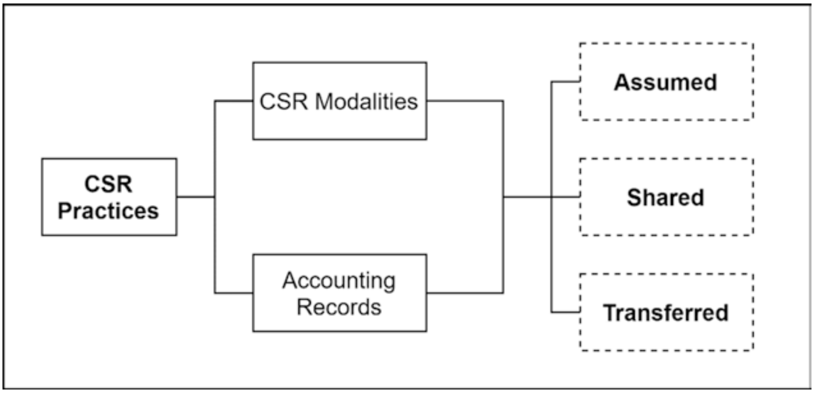

Fig. 10.2 CSR cost externalization categories

the costs corresponding to those actions and to the extent that these practices further reduce their impact on society or the environment, such as the practices of the operational efficiency group, the company would internalize with greater intensity its adverse operations' effects.

The second category, *shared*, is characterized by CSR costs being distributed among different actors and presented when the CSR actions of the operational efficiency group and the philanthropic group are recorded as a cost, operating expense, or nonoperating expense. Although each of these three alternatives is similar and represents small changes in the subjects or actors affected by the transfers of CSR actions, the difference lies, as in the previous point, in the type of the chosen modality, since if it belongs to the operational efficiency group, there is less transfer to society.

As an example of this category, let us say an industrial company, as a CSR action, offers a new product whose added value is the reduction of environmental impact (generating fewer emissions or with compostable or recyclable packaging). When the costs associated with the innovation of this product or CSR practice are recorded as a cost or as an operating expense, they are not borne solely and exclusively by the shareholder, as in the previous case but are also shared with consumers and the state, since the consumer assumes part of this value in accounting since the cost or operating expense is part of the paid retail price, the state, which is affected with fewer taxes collected and the shareholders, with less profits. If this environmental practice had been registered as a nonoperating expense, those affected would only have been the government, with fewer taxes and the shareholder, with fewer profits and no longer the consumer, since the nonoperating expense was not recovered by the company and is not part of the product retail price.

In any of the previous cases, if the modality chosen by the same company instead of directly reducing the impact of its operation had been related to the philanthropic CSR modality, such as carrying out a *cause-related marketing* campaign, the internalization would be less since the proposed practice would not reduce the environmental impact of the firm's operation.

Finally, the third category, *transferred*, refers to cases in which CSR actions are fully externalized and transmitted to the state or third parties. On the one hand, this category includes CSR practices whose associated costs are deducted from taxes through a donation. The associated costs are fully transferred to the state since the company uses those resources (i.e., the taxes it had to pay) to carry out their CSR practices. On the other hand, there are also various options to address CSR that are not recorded in the books because they do not involve disbursements and, legally, should not be included in companies' accounting. Since, in the types of assignment without registration, they are generally not assumed monetarily by the company, there is the possibility that third parties are the ones who assume them.

The first example of the third category may occur when a company, in a legitimate way, donates a certain amount of money to a foundation that promotes a social project aligned to its corporate values. When this amount is deducted from taxes, a CSR costs transfer is configured to the state because, although the CSR action is decided and carried out by the company, it was partly financed with the taxes that the company must have paid to the government. In this case, the state is the legitimate owner of these resources, whose budget for public works or activities of public and community interest is being reduced.

A second example may occur when a company decides to make a volunteer program within the framework of its CSR strategy, considering that volunteering does not require disbursement for the payment of employees who, in a discretionary manner, decided to participate in the company activities. In this case, the volunteer employees, although they have carried out the activities during working hours, they often must complete the activities assigned in their work plan in their free time, assuming the CSR costs of this particular practice.

2.4 The Proposed Externalization Index

Based on the aforementioned CSR costs transfer categories and considering the level of influence of CSR actions on associated stakeholders, a primary numerical assignment is made, which represents, depending on the intensity, the level of externalization associated with each of the categories already submitted. The numbering above ranges from 0 to 5, where 0 represents Robins's (2008) position and 5 that of Johnston (2011).

The first level, represented by 0, indicates a null level of CSR costs externalization which is characterized by at least one practice of the operational efficiency group, which is registered as a reserve, and which represents the position of Robins, that is, it considers that the company internalizes its CSR. The second level (1) also refers to CSR practices registered in the company's reserves, but in this case, it uses philanthropic CSR modalities, generating higher externalization levels. The next two levels (2) and (3) are characterized by recording in the cost accounts, operating

Table 10.3 Base table of the CSR costs externalization index

Registry type	CSR modality	Externalization category	Index scale	Who pays for CSR
Reserve	Operating efficiency	Assumed	0	Shareholders
Reserve	Philanthropic	Assumed	1	
Cost	Operating efficiency	Shared	2	Clients Shareholders Society (state)
Operative expense				
Nonoperative expense				
Cost	Philanthropic	Shared	3	
Operative expense				
Nonoperative expense				
Donations	Operating efficiency	Transferred	4	Society (state) Third parties
Not registered				
Donations	Philanthropic	Transferred	5	
Not registered				

expense or nonoperating expense, but in the case of level (2), they use operational efficiency CSR modalities and level (3) those of the philanthropic group. The next level (4) considers operational efficiency CSR practices registered either as a donation or not registered at all. Finally, level five (5) indicates the highest level of CSR costs externalization; in addition to not being linked to business operations (philanthropic CSR modalities), these practices are either not registered or are deducted from taxes. This last category is related to Johnston's (2011) position, which considers that CSR does not necessarily pay for the negative impacts it generates on society and the environment. Table 10.3 integrates all the elements previously described that make up the CSR cost externalization index.

In order to resolve the debate about who really pays the costs of CSR practices, a multidimensional six-level index is proposed to structure a calculation procedure for the CEI. This proposed procedure generates a scale from zero (0) to five (5) from the previous values. For this, the following standard table is constructed (Table 10.4).

3 Methods

The present study used a quantitative approach with a nonexperimental design, the scope of which was descriptive and explanatory in cross-section. The study population consisted of companies from various productive sectors (primary, secondary, and tertiary) and sizes by the number of employees that practice corporate social responsibility in Colombia (Ministerio de Comercio, 2011).

Since there is no specific information regarding the companies that claim to carry out CSR actions in Colombia, it was decided to take as the population universe the

Table 10.4 Standard table for measurement of the CSR costs externalization index

CSR Modalities	Accounting Record					
	Reserves	Cost	Operating expense	Non-operating expense	Tax deduction	No registry
Environment	0	2	2	2	4	4
Human rights	0	2	2	2	4	4
Labor aspects	0	2	2	2	4	4
Transparency and anticorruption	0	2	2	2	4	4
Freedom of competition	0	2	2	2	4	4
Suppliers and distributors	0	2	2	2	4	4
Clients and consumers	0	2	2	2	4	4
Contributions towards community	1	3	3	3	5	5
Social community projects	1	3	3	3	5	5
Donations	1	3	3	3	5	5
Social marketing	1	3	3	3	5	5
Commitment to social causes	1	3	3	3	5	5
Cause-related marketing	1	3	3	3	5	5
Volunteering	1	3	3	3	5	5

Note. Gray scales indicate the externalization level considering the accounting record type used and the CSR modality

set of companies at the national level that report practices associated with CSR form 31 of the Superintendency of Societies (SS). The SS is a technical body attached to the Ministry of Commerce, Industry and Tourism, with legal status, administrative autonomy, and its own assets, which exercises the inspection, surveillance, and control of commercial companies in Colombia.

Through a convenience sampling method, 27,000 organizations attached to the superintendency were surveyed. The data collection was carried out via a census by applying a standardized instrument to the entire target population. The survey was targeted at the person in charge of the social responsibility; otherwise, it was sought that a high-level manager was the one who answered the instrument. Of the instruments sent, only 18,897 usable responses were obtained, and of these, a total of 7233 organizations reported performing social responsibility practices; this last group contains the units of analysis of the present study.

3.1 Measuring Instrument

The measurement instrument was designed based on three groups of variables: description, practice, and performance. In order to identify the characteristics of the analysis units, discover the behaviors associated with the CSR practices and their financial performance, respectively.

The description variables discriminated the organizations participating in the research by *productive sector*, *size*, *and age of the firms*. The practice variables (second group) made it possible to recognize the actions carried out by the units of analysis regarding the phenomenon studied. In this group, there are two variables: *CSR investment*, which is a dichotomous variable that determines whether the company invested monetary and nonmonetary resources in CSR activities. The second variable, *modality registration*, indicated the type of CSR activity that the companies support and, secondly, the type of record with which the organizations registered it in their books.

Finally, the performance variable used to contrast the possible relationships and influences between the study variables was profitability, measured by the *return of assets index (ROA)*, since it is one of the most used economic performance variables to recognize the return on the investment made in a social responsibility activity (Margolis et al., 2009).

The proposed questionnaire was divided into three sections. The first inquired about the descriptions variables. The second section contains the instructions for completing the survey, and the third section includes the questions related to its CSR practices and recording.

In particular, this study addresses the construction of an externalization index from the CSR modality and accounting records information. The instrument's design investigated in each case the records of the different CSR modalities, obtaining detailed information. For illustrative purposes, the data for a random company is shown in Table 10.5.

3.2 Data Collection

Once the agreement with the Superintendency of Companies was made, it was proposed to obtain the information for this study directly or from a primary source, taking advantage of some of the information-gathering activities that the entity carries out periodically and systematically, in this case, the Business Practices Report, also known as Report 31 (Superintendencia de Sociedades, 2011).

The procedure defined to obtain the information was to send a questionnaire or form by e-mail to the legal representatives of the companies inspected, monitored, and controlled by the Superintendency of Companies. In the letter, the legal representatives of the firms were requested to answer the form. It is necessary to bear in mind that there is a different registry for each of the 14 modalities, which means that each company can have registries in several categories simultaneously, which makes it difficult to assign a single value.

The data collection was carried out with an electronic application—STORM USER 2.2—under the calendar of presentation of business reports of the Superintendency of Companies, on December 31, 2012, information that was collected with delivery deadlines according to the last two digits of the NIT of the companies, between Monday, May 6, and Monday, May 20, 2013.

Table 10.5 Data from a random chosen company. It is possible to observe the record in each of the CSR modalities

	Accounting record						
CSR modalities	Reserves	Cost	Operating expense	Nonoperating expense	Tax deduction	No registry	Don't know / Not available
Environment	0	0	0	1	0	0	0
Human rights	0	0	0	0	0	1	0
Labor aspects	0	0	0	0	0	1	0
Transparency and anticorruption	0	0	0	0	0	1	0
Freedom of competition	0	0	0	0	0	0	0
Suppliers and distributors	0	0	0	0	0	1	0
Clients and consumers	0	0	0	0	0	1	0
Contributions toward community	0	0	0	0	0	1	0
Social community projects	0	0	0	0	0	0	0
Donations	0	0	0	1	0	0	0
Social marketing	0	0	0	0	0	0	0
Commitment to social causes	0	0	0	1	0	0	0
Cause-related marketing	0	0	0	1	0	0	0
Volunteering	0	0	0	0	0	0	0

Note: The matrix shows dichotomous variables responses where 0 = a negative answer; 1 = positive answer

3.3 Proposed Index

The statistical analysis was carried out in three stages: univariate, bivariate, and multivariate, for which association tests were performed depending on the type of variables. The association between two categorical variables was tested with a chi-square test (Ho, 2014). The Kruskall-Wallis test (Corder & Foreman, 2014) was performed to measure the association between a categorical and a continuous variable. Moreover, to measure the association between two continuous variables, Spearman's correlation coefficient (Studenmund, 2014) was implemented.

The following steps are proposed to calculate the index:

1. Establish the registration data for each of the CSR modalities. In the same order as in Table 10.4.
2. Check the values in the standard table.
3. Obtain the average of these values.

Notably, the calculation of the CSR CEI is easy and intuitive for use in companies. It is important to highlight that the index's usability and calculation easiness were prioritized over its sophistication.

The submitted proposal makes use of the information from registers and modalities. However, it is necessary to discuss their insufficiency and ask whether the information regarding the amounts recorded could be more useful. This would be recorded as one of the difficulties inherent in constructing the index and could be part of future work.

It is relevant to bear in mind that measuring the company's accounting records prevents social desirability bias. Taking the information in another way, for example, using a questionnaire on the perception/opinion of the managers could generate data on what is desirable rather than what is real.

3.4 Index Validation

The index validation requires a multivariate analysis that examines the relationship between the CSR modalities and the accounting records since without this relationship, it is impossible to argue about the theoretical operation presented or the scores awarded in the standard table. In these results, it would be expected that the philanthropic CSR modalities are related to records in which the costs are shared or externalized, while the operational CSR modalities relate to the least externalizing records.

Next, the correlation of the index with the modalities and records that show the greatest tendencies toward the externalization of CSR costs is corroborated. This analysis is accompanied by visual approaches that corroborate the behaviors mentioned in the data. For these purposes, Pearson's linear correlations and principal component analysis (PCA) are used, which allow corroborating both numerically and visually the behavior of the data.

4 Results

The results are presented below, according to the information obtained in the data collection exercise and the methodological design proposed in the previous section.

4.1 Modality

Regarding the CSR modality that the firms in the sample carry out, Fig. 10.3 presents the most popular initiatives in the Colombian context. It stands out with more than 90% of activities focused on the environment, human rights, the workplace, suppliers, and customers/consumers. In general, there is a preference of companies for the operational modalities of CSR.

The modalities least valued by the participants were cause-related marketing, social marketing, and volunteering. Taking the model of Rangan et al. (2015) as a reference, it can be seen that the modalities used most frequently by the participants are associated with group 2, related to operative efficiency, and those that are least associated with group 1, previously called charitable or philanthropic.

4.2 Registry

Based on what was stated in the literature review, companies have seven possibilities to record in their accounting the amounts allocated to social responsibility activities. In total, considering the responses of the 7233 firms that carry out some type of CSR, the results indicate that 89.98% of the firms in the sample do not record these activities in their accounting, 53% do so as operating expenses, 41.24% as nonoperating expense, and 24.24% record it as cost, while only 4.94% record it to deduct taxes, whereas 6.3% of the participants do not know, and only 0.6% of the sample record it as a reserve (Fig. 10.4).

When analyzing the modality and accounting record of the social responsibility activity results, a matrix is obtained where each type of CSR modality is registered or not by the companies. Table 10.6 presents this information.

The findings in Table 10.6 reflect that a large percentage of the most popular CSR activities among the firms in the sample is not recorded in accounting. Likewise, there is a very low percentage of social initiatives registered as a reserve, that is, that are absorbed by their shareholders. In turn, it is striking that a relatively low percentage of companies record CSR activities as tax deductible (Table 10.7).

4.3 CSR Cost Externalization Level

By crossing the CSR modality type and its corresponding accounting record, an index number is obtained for each company that measures the level of CSR costs externalization. At the minimum level (0) are the companies that internalize these

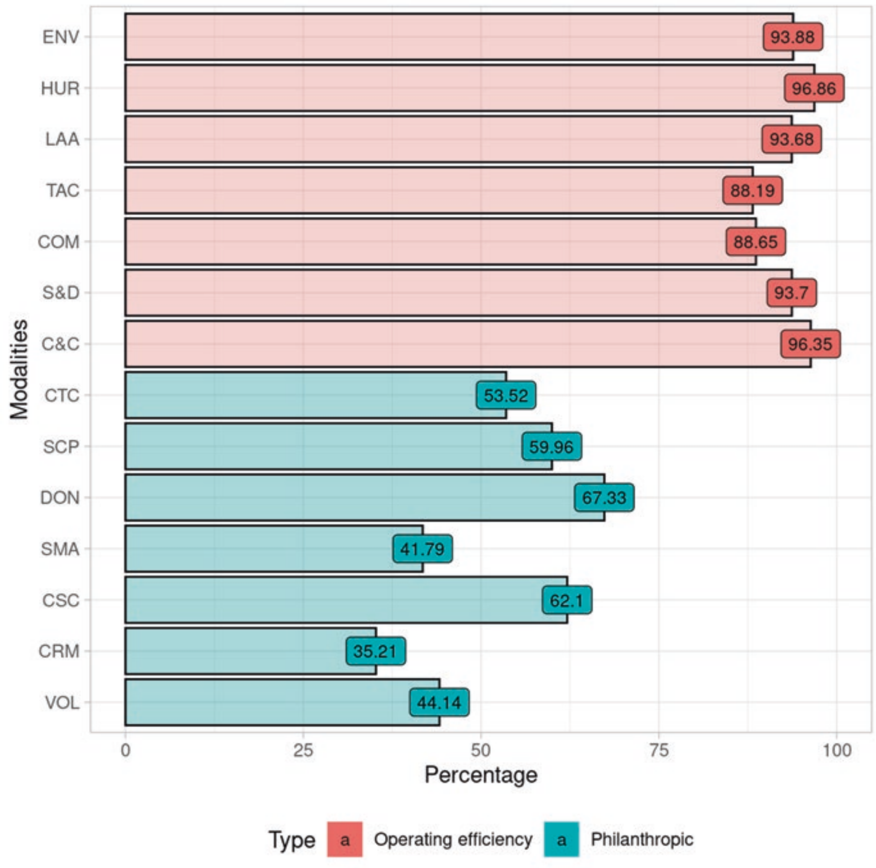

Fig. 10.3 CSR modality carried out by companies in the sample (*N* = 7, 233). (Note: Each bar shows the percentage of companies that responded to this option. Each company could answer several options)

costs, coinciding with Johnston's (2011) position. At the highest level (5) are those whose behavior coincides with Robins' (2008) theoretical position. The results are presented in Table 10.8.

According to this classification, the companies are distributed as follows (Fig. 10.5):

Based on the data in Tables 10.8 and 10.9, it can be established that the companies represented in the sample are on average at the third level of cost externalization of 3.62. Likewise, companies tend to transfer the costs because they prefer records other than the one that does not generate any type of, that is, the reserve.

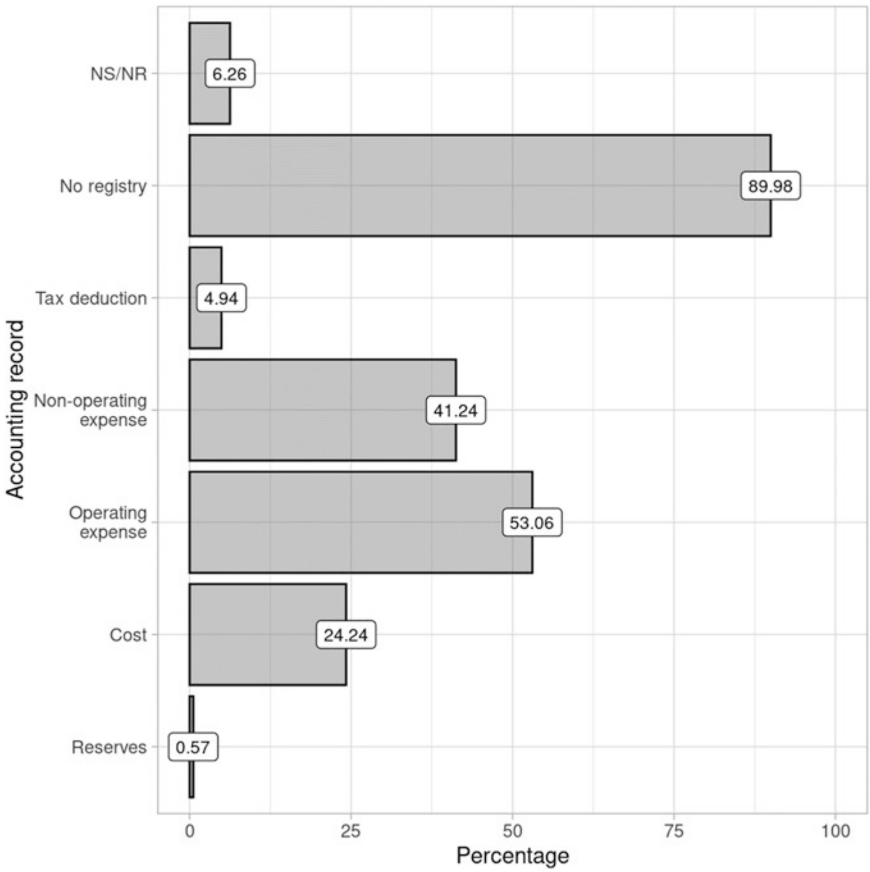

Fig. 10.4 The Figure shows the use of the different records in CSR accounting in the sample. (Note: Each bar shows the percentage of companies that responded to this option. Each company could answer several options)

4.4 Registry Analysis

As seen in Table 10.5, each company's data is consigned in a matrix of CSR modalities and accounting records. In this order, it is possible to obtain the data corresponding to the records by adding the columns of these matrices. In this way, the most used records information is obtained for each company in the sample. With this information, the first principal component analysis is carried out, which is shown below (Fig. 10.6).

It is possible to observe an apparent association between reserves and cost records, followed by the tax discount and no response option. On the other hand, operating expenses are lower and nonoperating expenses even lower. Adding to the extreme direction shown by the no-register option, this allows us to interpret the

Table 10.6 CSR Modality and Accounting Record relationship in percentages (*N* = 7233)

		Accounting record				
CSR modalities	Reserves (%)	Cost (%)	Operating expense (%)	Nonoperating expense (%)	Tax deduction (%)	No registry (%)
Environment	0.1	14.9	22.3	8.9	0.3	45.5
Human rights	0.1	3.8	14.9	6	0.1	71
Labor aspects	0.1	7.9	36.5	7.3	0.1	39.6
Transparency and anticorruption	0.1	2.2	12	5.5	0.1	67.3
Freedom of competition	0.1	2.1	9	3.9	0	72.8
Suppliers and distributors	0.1	3.7	11.3	3.7	0.1	73.3
Clients and consumers	0.1	4.1	14.4	4.2	0.1	72
Contributions toward community	0.1	3.9	10.1	12.9	0.8	24.6
Social community projects	0.1	3.5	9.4	10.4	0.4	35.2
Donations	0.2	2.5	10.8	30.4	4.2	18.3
Social marketing	0.1	2	10	5.1	0.1	24.2
Commitment to social causes	0.2	3	9.5	16.1	0.6	32
Cause-related marketing	0.1	2.8	5.7	4.1	0.1	21.8
Volunteering	0.1	2.4	9.1	5.9	0.1	26

Note: In the table, in each cell is the percentage of companies that answered that option. Each company can answer several options

Table 10.7 CSR modality type according to its Accounting record in percentages (*N* = 7233)

		Accounting record				
CSR modality type	Reserves (%)	Cost (%)	Operating expense (%)	Nonoperating expense (%)	Tax deduction (%)	No registry (%)
Philanthropic	0.3	9.7	27.9	36.9	4.6	64.8
Operational effectiveness	0.3	21.4	48.1	16.7	0.5	87.5

Note: In each cell, the percentage of companies that answered that option is shown. Each company can answer several options

graph according to its axes. On the horizontal axis is the registration information. On the right-hand side will be the companies that register, while those that do not register on the left. Likewise, the vertical axis contains the CSR costs externalization information, placing the reservation and cost records at the top and the nonoperating expense records at the bottom (Fig. 10.7).

Table 10.8 Descriptive statistics of the proposed CSR externalization index ($N = 7233$)

Statistical	Value
Minimum	0.72
Maximum	5.00
Average	3.62
Median	3.77
Standard deviation	0.62

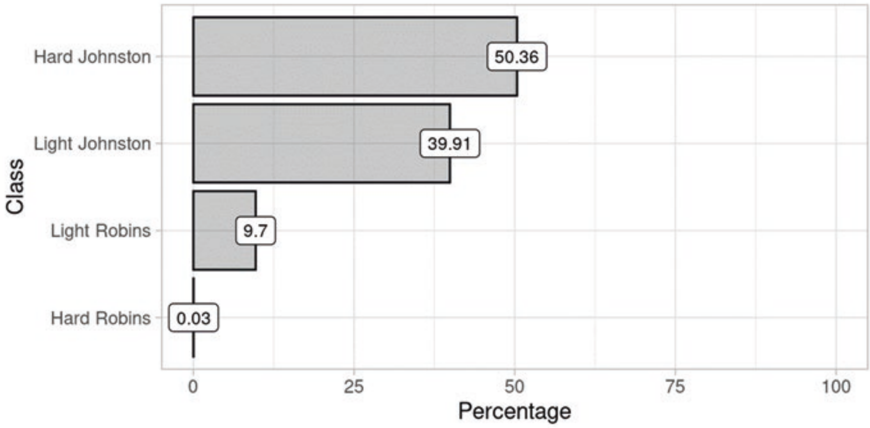

Fig. 10.5 Distribution of companies according to their classification in the CSR costs externalization index

However, when reviewing the correlation matrix, it is found that they are very weak, and therefore it could not be said that there is a general trend.

4.5 Modality Analysis

Following the same logic presented, the CSR modalities data are obtained. Each company's data is registered in a matrix, which in its columns contains the data of the accounting records and in its rows those of the CSR modalities (Table 10.5). Consequently, when adding the rows, the data corresponding to the frequency of implementation are obtained from one of the modalities. The principal component analysis is carried out with these data, whose circle of correlations is presented below (Fig. 10.8).

The figure shows a clear differentiation between two trends. In the upper right zone of the circle are the modalities of the operational efficiency group, while in the circle's lower right, the modalities belonging to the philanthropic group are located. This is corroborated in the correlation matrix (Fig. 10.9).

Table 10.9 Classification of companies according to their CSR costs externalization index

Index level ranges	Class
0–1.25	Robins strong
1.25–2.5	Robins weak
2.5–3.75	Johnston weak
3.75–5	Johnston strong

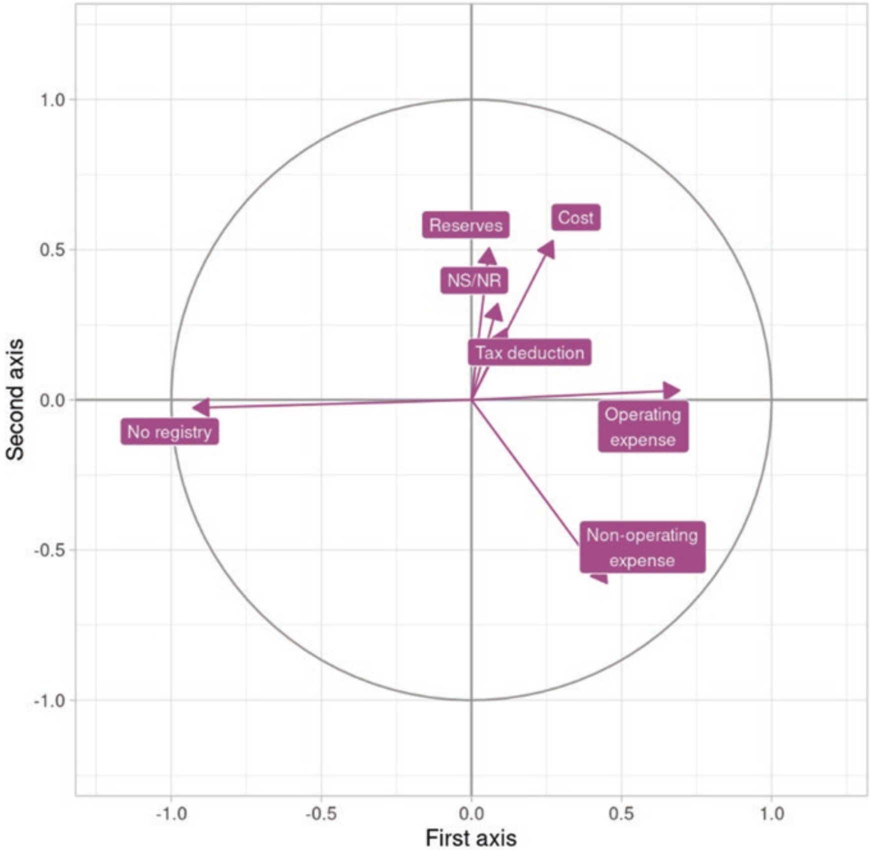

Fig. 10.6 Registry correlation circle. (Note. First axis (y) contains CSR costs externalization information. Second axis (x) shows if the companies record or not the CSR associated costs in their books)

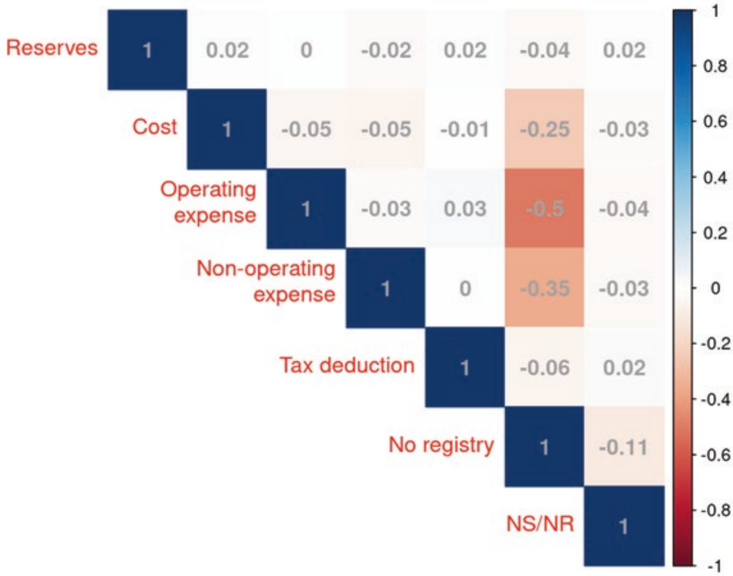

Fig. 10.7 CSR costs accounting records correlation matrix

However, when reviewing the correlation matrix, it is found that they are much stronger than in the case of the accounting records and present two clear trends, distributed in two groups: operational and philanthropic CSR modalities.

4.6 Overall Analysis

By analyzing both results simultaneously, it is possible to examine the relationships between the information corresponding to the record and the modalities (Fig. 10.10).

When analyzing the main components, the relationship between the CSR modalities of the operating efficiency group with the records related to reserve and cost is observed. The philanthropic group modalities are closer to the operating and nonoperating expenses record type. The point cloud is then displayed from the joint principal component analysis. This makes it possible to map all the companies in the sample (Fig. 10.11).

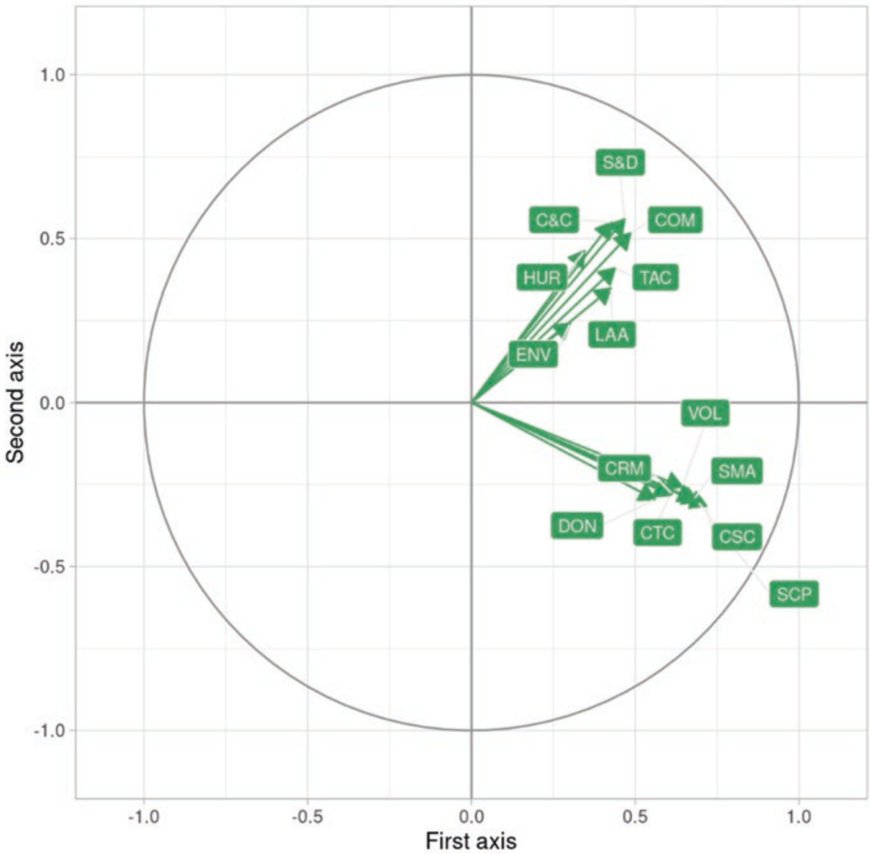

Fig. 10.8 Circle of correlations corresponding to the CSR modalities implemented by companies

This point cloud shows how most companies accumulate negative values on the horizontal axis and central values on the vertical axis. The point cloud shape also shows a trend toward the upper right area of the plane and another toward the lower right area. By including the CSR costs externalization index as a color, higher externalization values are observed for companies in the left sector of the graph. Likewise, the low externalization values are found in the upper right quadrant. The lower right quadrant presents intermediate values. This is consistent with the analysis done previously. The relationship of the index with the CSR modalities and records of greater or lesser cost transfering is visible in the graph (Fig. 10.12).

However, it is necessary to corroborate these graph interpretations by means of correlation hypothesis tests that are applied between each indicator and the proposed index (Table 10.10).

The correlational analysis shows that the proposed index is adequately correlated with the indicators that corroborate a property that seemed evident at first due to the

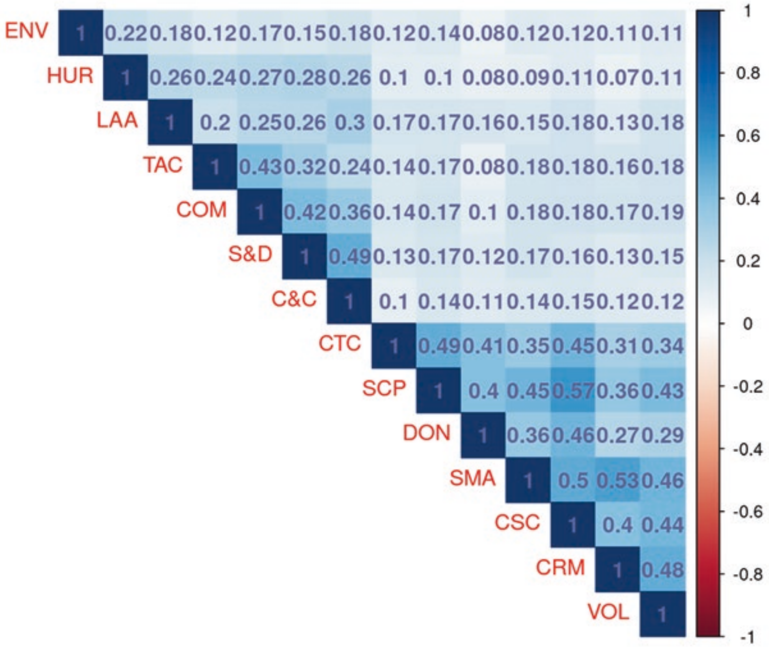

Fig. 10.9 CSR modality correlation matrix

construction of the index. Thus, it presents a weak, positive, and significant correlation with the operating efficiency CSR modalities group; slightly stronger, positive, and significant correlations with all forms of the philanthropic group; and a single weak, negative, and significant correlation with the type of employees. These results validate the association of the index with philanthropic modalities. Likewise, the index presents significant correlations with all accounting records, positive for tax deductions and not recording, and negative for the rest.

5 Discussion

Based on the results obtained in this research, and in line with the debate between Robins and Johnston about who pays for CSR, it was possible to resolve it with the companies that perform CSR in Colombia. The results are varied, showing that CSR practices from both the philanthropic and the operational efficiency group are reported. As for the accounting records, the results show that reserves, cost,

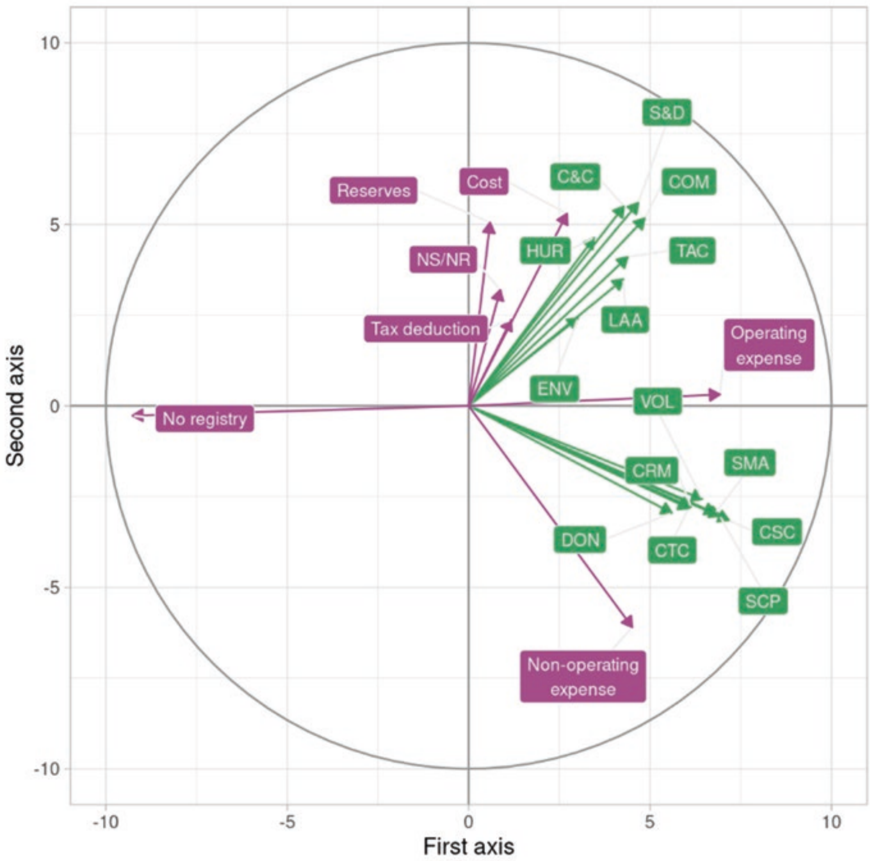

Fig. 10.10 Circle of correlations between CSR modality and accounting records

operating expenses, nonoperating expenses, and donations that are deducted from taxes, as well as practices without any registration, are used by Colombian firms to registry their CSR practices. Thus, the findings show businesses in every of the index's levels. The most frequent practices are found in levels (2), (4), and five (5).

However, to avoid confusion or misreading, the index interpretation was not carried out around the initial behavioral categories but through an interpretation table in four externalization levels, allowing us to see the positions of the authors studied. As a result, it was found that more than half of the companies in the sample present the highest level of externalization possible (Johnston Strong), and less than 10% of the sample internalized the costs of CSR (Robins). Moreover, on average, the sample companies (3.62) show a general tendency to transfer their CSR costs.

These results allow us to affirm that the companies that carry out CSR in Colombia are closer to Johnston's position than to Robins', since, according to the model, these companies do not assume the costs associated with CSR and transfer

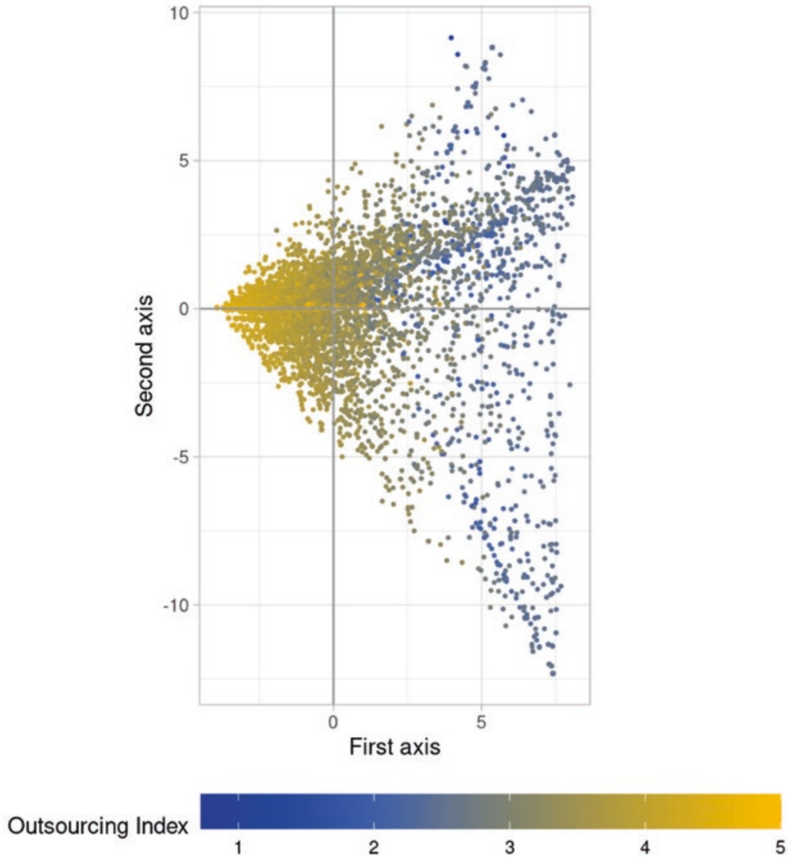

Fig. 10.11 Point cloud in the CSR modality-accounting records factorial plane

these to the state in general or any particular third parties such as employees, suppliers, or customers.

Thus, it can be inferred a general tendency to transfer these costs, which can be derived from external factors, rather than from the intrinsic motivations of CSR reported by Parker (2014), which can generate the perception that CSR is an overcost rather than as an investment, which motivates its externalization.

Against Robins' perspective, it can also be stated that contrary to what he assumed, CSR actions are not only financed with *gross profit* (Robins, 2008). Rather, as supported by the results, CSR practices are charged to costs, operating expenses, and nonoperating expenses, and they are not even recorded in the companies' accounts. Consequently, regarding the assertion that "…if CSR practices are accounted for as a legitimate business expense, that is, an operating expense, they are not voluntary or discretionary and therefore they are not really CSR" (Robins, 2008, p.334), most of CSR definitions (Dahlsrud, 2008) are related with firm

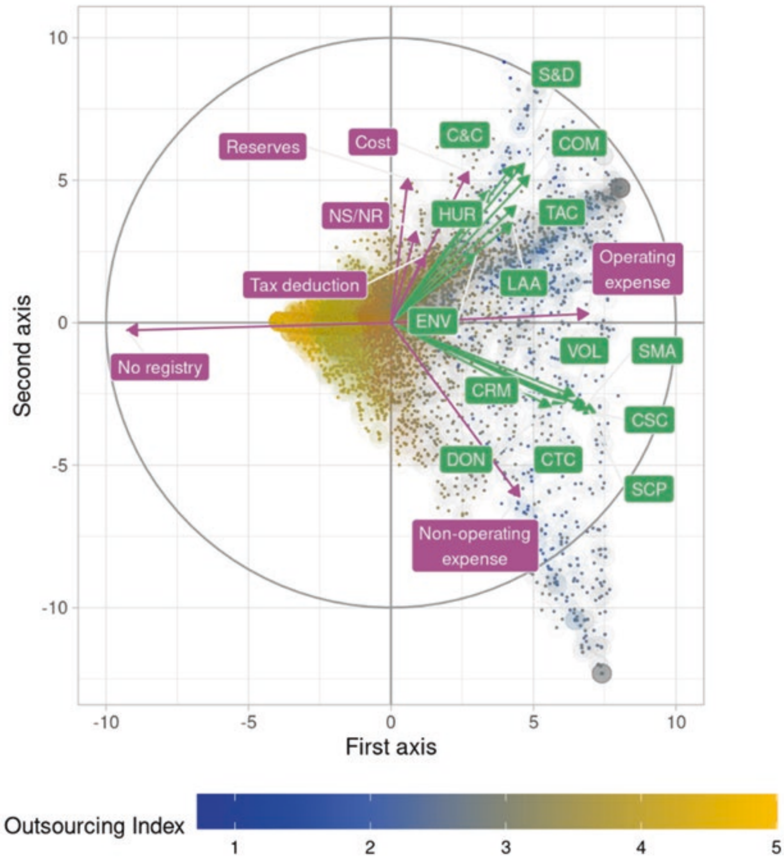

Fig. 10.12 Joint graph with CSR modalities, the accounting records and the CSR costs externalization index

operations and decision-making process, which does not imply an obligation for the company as stated by Robins, since the voluntariness in the definition does not derive from the type of account where the CSR action is registered but from the condition to overcome the obligations that the law in these senses associated with CSR, and has imposed on companies.

At the same time, Robins is right in that CSR activities can be tax deductible, as was also evidenced in the results. However, he is wrong that CSR is paid jointly by shareholders and the state with this type of registry. Although the company can legitimately use the tax deduction obtained in a discretionary manner through an authorized third party (social organization), it does not mean that these resources are their property (*Decreto 624 de 1989*, 1989; *Decreto 2650 de 1993*, 1993).

This tax deduction for donations is an expense that the state assumes and not the shareholder and does so to support organizations that are committed to finding

Table 10.10 Pearson's correlation hypothesis tests between the variables and the proposed index

Indicator	Correlation	P value	Type
Environment	−0.0314777	<0.01	Modality
Human rights	0.0158644	0.1781	Modality
Labor aspects	−0.0802503	<0.01	Modality
Transparency and anticorruption	−0.0083532	0.4783	Modality
Freedom of competition	0.0200289	0.0891	Modality
Suppliers and distributors	−0.0085100	0.4701	Modality
Clients and consumers	−0.0099967	0.3961	Modality
Contributions toward community	−0.0677750	<0.01	Modality
Social community projects	−0.0326442	<0.01	Modality
Donations	−0.0593880	<0.01	Modality
Social marketing	−0.0132445	0.2609	Modality
Commitment to social causes	−0.0515136	<0.01	Modality
Cause-related marketing	−0.0006865	0.9535	Modality
Volunteering	−0.0582985	<0.01	Modality
Cost	−0.3109943	<0.01	Registry
Tax deduction	0.0344310	<0.01	Registry
Nonoperative expense	−0.4435823	<0.01	Registry
Operative expense	−0.6179538	<0.01	Registry
Not registered	0.8837997	<0.01	Registry
Don't know/not available	0.0118543	0.3143	Registry
Reserve	−0.1133799	<0.01	Registry

solutions to societal problems since they not only contribute to the solution of this problem, but they can do it in more efficient ways than state institutions, thus reducing the state's transaction costs (Yunus, 2010).

Finally, Robins emphasizes that CSR cannot be made mandatory for companies since the studies that defend the benefits obtained by companies due to its application are not conclusive since most of these do not imply causality (Robins, 2008, pp 335). However, recent studies have found that CSR has a significant positive relationship with the financial performance of companies due to mediating variables such as reputation and competitive advantage (Saeidi et al., 2015), stakeholder influence capacity (Barnett & Salomon, 2012), profit management (Javed & Ahmad, 2020), and intellectual capital (Jain et al., 2017). This supports the idea that CSR indeed does have a causal influence on financial performance, contrary to Robins' statement. On the other hand, from Johnston's perspective, there is an alternative vision of CSR that includes the effects of the company's operation, which are evident in particular cases and are not taken into account by Robins.

In the CSR literature, the relevance of external costs, which are considered a failure of perfect market competition since it generates effects that can be both positive and negative in third parties or society (Krugman, 2008) is paramount, since social costs can arise in each decision made in economic activity and represent everything that society assumes (Kapp, 1950). Thus, CSR could be used as a mechanism to distract attention from the source that generates the externality itself. Adding to the lack of background knowledge regarding the externalization capacity of companies and the cost of CSR actions (Huang & Watson, 2015), this position is quite novel insofar as taking into account the dominant profit maximization logic (Friedman, 1970). Companies would tend to transfer their costs due to the pressure to seek better returns on investment in the short term, possibly affecting third parties or society with the negative impacts of the operation.

Thus, Robins (2008) proposes that a company that is in charge of reducing the negative impacts of its operation on society or the environment within the framework of CSR is aligned with the theory of social security (Coase, 1960), allowing the reduction of transaction costs for society by avoiding the use of inefficient, ineffective, and very costly legal and judicial mechanisms from the government (Williamson, 1981; Coase, 1988) as well as promoting CSR practices, which can be much more effective and constructive with stakeholders, which is one of the most important business challenges today (Peršić et al., 2017).

In this sense, CSR practices that are not tied to the operation of the company and its decision-making process and are not registered constitute an external cost to society (Antheaume, 2004), and it would be very convenient in the same logic as Huang and Watson (2015) suggest to continue researching the costs associated with CSR, which is why the index proposed here can help both to identify the degree of intensity with which the costs are transferred as it is to promote that this type of practice begins to disappear and even to be prohibited.

To conclude the discussion, it is important to highlight that the proposal presented here is not without limitations since the lack of amounts registered in the levels of externalization and proposed indices prevents knowing the true economic impact of the externalized CSR practices in companies. However, the measurement carried out based on the accounting records constitutes a strength of the proposed methodology since it reduces the social desirability bias regarding subjective perceptions (Fisher, 1993).

Regarding possible future research, it would be desirable that the methodologies proposed here can be put into practice in other geographical contexts or various economic sectors to know the generalization or not of the behaviors studied from another perspective. It would also be convenient that the motivation for finding more precise results allows future research to overcome current limitations such as insufficient information.

It is also expected that the findings of this work inspire new lines of research on discussing the true impact of corporate social responsibility vis-à-vis its different stakeholders since it is they who bear the greatest extent of the costs of these practices despite, as they have shown in various studies, that this brings direct benefits for the companies.

6 Conclusions

Based on the theory of social costs, this research results show the empirical contrast of the proposed CSR costs externalization index, discovering that companies, based on the concept of externality, can have a greater or lesser capacity to transfer these costs to third parties (Kapp, 1950; Coase, 1960).

The calculation of the proposed index generates a measurement with values between 0 and 5 where 0 is the scenario where the company assumes all the costs and 5 is the scenario where the company transfers them completely. The index development was divided into two activities. Firstly, a principal component analysis on the registration and modality data was performed, followed by a correlational analysis of the data from the proposed index and the main components. As a result, the internal consistency of the proposed index is obtained. As a central finding, it is verified that Colombian companies tend to transfer their costs with an average score of 3.62.

Despite the diversity of CSR practices of the companies studied, the results show a clear trend toward Johnston's position (cost externalization), since 50.36% of the CSR practices studied seek to transfer the costs associated with these practices, while the Robins' position (cost internalization) is only assumed by 0.03% of the sample. Among the findings, it can be highlighted that Colombian companies carry out CSR practices to a greater extent (79.28% on average) aligned to the operational efficiency group (i.e., human rights, environment, employees, customers, and suppliers) with those of the group philanthropic (46.29% on average) (Rangan et al., 2015). This suggests that Colombian organizations are changing the philanthropy paradigm of Latin American CSR (Correa et al., 2004) to more strategic management (McElhaney, 2007).

On the other hand, the lack in the use of the donation registry type is surprising (4.94%) since more effective use of the legitimate resources that Colombian legislation has available was expected. However, the participating companies opted to a greater extent not to register their CSR practices (89.98%), while they recorded their CSR practices as costs (24.24%), operating expenses (53.06%), and nonoperating expenses (41.24%) and, as was foreseeable, only (0.57%) registered their CSR practices as a reserve. However, the results of this study are exclusively limited to Colombian companies, so their external validity should be considered with caution. Future lines of research could improve and apply the proposed index and apply it in different countries to identify variables of the institutional context that could affect externalization levels.

Finally, it can then be inferred that the concept of CSR is limited and that its definitions and scope do not allow establishing who bears the costs associated with its implementation. Therefore, it is suggested that CSR actions be only recognized when these are recorded as a reserve to ensure that the one who pays for these actions is the company itself, which is ultimately the one who obtains its revenues and benefits from its application.

The benefit of registering CSR investments as a reserve is that it would motivate companies to use social responsibility practices more strategically and less in a philanthropic manner since shareholders would demand direct benefits for the company, avoiding using CSR as a screen or greenwashing mechanism, promoting the reduction of the firms' operation's impact toward its stakeholders or having a more constructive operation with society and the environment, thus consolidating a more responsible CSR.

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Chapter 11
Emerging Civilian UAV Innovations Promoting Sustainability in Indian Agri-Insurance Through Embedding Culture-Specific Values

Anjan Chamuah and Rajbeer Singh

Abstract Agri-insurance, a loss-stabilizing measure among farmers, is a complex process in a diverse democracy like India with varied sociocultural norms and weather anomalies. The advent of emerging civilian unmanned aerial vehicle (UAV) innovations in agri-insurance has simplified crop damage assessment, crop cutting experiment, and claim settlement. The deployment and governance of the civilian UAVs involve diverse actors and stakeholders. The responsible innovation (RI) approach, which takes care of emerging technology, governance, and sustainability issues, explores the challenges of civilian UAV innovations amidst varied culture-specific values in Indian society. An extensive literature survey is conducted by deploying a literature survey questionnaire. Gathered literature is analyzed to fulfill the objectives of sustainability in agri-insurance innovations. The findings highlight that the evolving regulations and laws make UAV governance intricate. However, the dimensions of RI, anticipation, deliberation, reflexivity, participation, and responsiveness help in responsible collaboration among actors and stakeholders of UAV innovations in agri-insurance applications. The different features of civilian UAVs promote safety, privacy, autonomy, transparency, trust, and accountability, further juxtaposing social, economic, and environmental sustainability. Training to pilots, adhering to prescribed regulations, and involving local farmers and stakeholders promote the responsible deployment of civilian UAVs.

Keywords Agri-insurance · Regulations · Unmanned aerial vehicle · Values · Sustainability

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1 Introduction

Civil unmanned aerial vehicle (UAV) is also known as a drone and is an autonomous technology that is remotely controlled. Civilian UAV is a new and emerging technology for Indian agriculture insurance. The technology is new and emerging for its diverse applications and usage, impacting the economy and society (Rotolo et al., 2015). The technology is also trying to provide solutions to some problems associated with crop insurance like crop damage assessment, crop cutting experiments (CCE), and capturing a real-time image. The capability of the technology to collect data related to crop loss and damage is possible due to the features endowed in designing the technology like a multispectral camera, a global positioning system (GPS), sensors, wireless routers, and a video transmitter (Xiang & Tian, 2011). The drone technology equipped with such advanced features monitors and assesses damages in agriculture unhindered in adverse weather conditions (Honkavaara et al., 2013).

The technology is proving to be a practical resource not only in agriculture but also in other areas like archaeological prospecting, disaster management, mining, infrastructure management, prevention of illegal poaching of animals in wildlife, traffic management, delivery services, media, and entertainment. The global market of the drone is increasing every year. It is around 100 billion dollar by 2020 (GoldmanSachs, n.d.). The Indian government has made civil UAV mandatory since 2016 under Pradhan Mantri Fasal Bima Yojana (PMFBY). In PMFBY, civil UAV will be used as a CCE tool to estimate crop production and yield, which also augment in settlement of claims.

However, the deployment and implementation of new technology also raise many issues and challenges regarding monitoring, regulation, and governance. The emerging technologies are said to be in the R&D stage (Brey, 2012); henceforth, the ethical issues relating to their deployment, governance, and impact on society are uncertain and not known reliably (Brey, 2012). It can also have an impact on the culture-specific values (Setiawan & Singh, 2015; Singh & Kroesen, 2012) of the society where it is deployed further impacting social, economic, and environmental sustainability. Technology is not only a machine; it is a methodology and a sociotechnical system (Bijker et al., 1987; Carlsson & Stankiewicz, 1991), which has social, political, and cultural implications (Winner, 2001). Apart from the physical world, technology shapes the ethical, legal, and social environment in which we live (Jasanoff, 2016) as much as we shape technology (Sandler, 2014). Thus, technology shapes our daily life and activities, the space we inhabit, and our conceptions of sociability (Sandler, 2014).

Perhaps, the Indian society is diverse with different sociocultural norms and values; infusing technology without taking care of the prevailing norms and value systems can herald an irresponsible innovation (Von Schomberg, 2013). Henceforth, promoting values like responsibility, accountability, transparency, affordability, efficiency, and trust can make innovations ethically acceptable, societally desirable, and sustainable (Von Schomberg, 2013) in the governance and deployment of new technology. The study is focusing on the values by adopting responsible innovation (RI) as a theoretical framework.

The chapter is looking at the issue of sustainability from a systems perspective considering a balance between the environment, society, and the economy. The definition of sustainability that is used in the chapter is as follows:

> Sustainability is the integration of environmental health, social equity, and economic vitality to create thriving, healthy, diverse, and resilient communities for this generation and generations to come. The practice of sustainability recognizes how these issues are interconnected and require a systems approach and an acknowledgment of complexity (UCLA, 2016, p. 2).

New and emerging technology like civil UAV has the potential to impact society, the economy, and the environment (Brey, 2012; Rotolo et al., 2015). Henceforth, responsible use, deployment, and governance of the technology are of utmost importance for achieving the objectives of sustainability in Indian agri-insurance. Indian agriculture can be seen as a system and a contentious mixture of technological, societal, institutional, and physical variance.

Furthermore, the paper looks at anticipating challenges associated with regulation, monitoring, governance, and the implications of values as a research problem. "Anticipation" helps us in rehearsing, exercising, or practicing a capacity in a logically prior way (Guston, 2014) to understand the impacts of innovations and possible applications (Setiawan et al., 2018). Moreover, the study would address as research questions *how the framework of RI helps in addressing the challenges of sustainability associated with civil UAV deployment? What are the factors affecting values in the deployment of civil UAVs in Indian agri-insurance?* The research questions are formulated by reviewing and finding gaps in literature in similar areas, namely, Barbier & Elzen (2012), Gago et al. (2015), Davis & Langham (1995), National Research Council (2010), Avtar & Watanabe (2020), and so on. By adopting the framework of RI, this chapter would also like to focus on the culture-specific values embedded in our society, how the different values are shaped by the advent of new and emerging technology.

The next Sect. 2, describes the RI framework and explains how it can help in anticipating the responsible deployment of civil UAV. Section 3 explains the entire process of data collection and analysis of the paper. The current state of UAV regulations and governance is discussed in Sect. 4. Section 5 elaborates on value implications in Indian society after the introduction of new technology. The main findings are discussed in Sect. 6. Section 7 provides the concluding remark about the study.

2 Responsible Innovation

Research and innovation are essential for technological progress, human welfare, and societal development (Hoop et al., 2016). According to Schomberg & Blok (2019), the RI or Responsible Research and Innovation (RRI) is a subdomain within the philosophy of technology. De Hoop et al. (2016) emphasize that RI is grounded in pragmatic innovation processes. The RI is a process-based approach (Chamuah & Singh, 2020b; Setiawan et al., 2019; Zahinos et al., 2013) and takes into account the ethical and social aspects while also considering economic, social, cultural, and environmental concerns (Lubberink et al., 2019) of new technology. Because RI is process-focused, all ethical reflections are considered procedural prescriptions (Bourban & Rochel, 2020), realizing values shared by society (Hoop et al., 2016).

The current focus of the study is the deploying process of civil UAV, which is a new and emerging technology, needs care, responsibility, and accountability for governance in Indian agriculture insurance. According to Stilgoe, Owen, and Macnaghten (2013), the RI approach also takes care of the future of technology through collective stewardship of science and innovation at present. It also focuses on guiding innovations in the desired direction to have the right impact on society (Lubberink et al., 2019). Henceforth, Von Schomberg's (2013) description of responsible research and innovation, which talks about ethics, society, and sustainability, is reproduced hereafter:

> A transparent, interactive process by which societal actors and innovators become mutually responsive to each other with a view to the (ethical) acceptability, sustainability and societal desirability of the innovation process and its marketable products (in order to allow a proper embedding of scientific and technological advances in our society) (Von Schomberg, 2013, p. 19).

The responsible innovation approaches have thus been introduced to prevent the adoption failure and adverse effects of innovation by introducing responsibility aspects in innovation (Engelhard et al., 2015).

Moreover, the RI framework is providing a new approach to technology governance. It provides a broader foresight and impacts assessment for new technologies beyond their market benefits and risks (Von Schomberg, 2013). Another widely used definition of RRI proposed in the Rome Declaration states that "RRI is an ongoing process of aligning research and innovation to the values, needs, and expectations of the society (European Commission, 2014)." So, embedding values like responsibility and accountability to withstand societal expectations is crucial (Chamuah & Singh, 2020a) in the effective governance of emerging technology. The governance and deployment of new technology also demand the utmost care to obtain sustainability (social, economic, and environmental). Thus, according to Singh and Kroesen (2012), RI takes care of specific values during the innovation process through its five dimensions. The definition of RI, proposed by Singh and Kroesen (2012), is reproduced hereafter:

> Responsible innovation means to be caring or ensuring care for certain values for social, economic and environmental sustainability by engaging in anticipation, reflexivity, deliberation, responsiveness and participation for bringing up any change in any idea, product, process, method, way of doing business, technology, etc. in order to bring them into a specific market or use them in a society (Singh & Kroesen, 2012, p. 4).

This definition thus represents that the goals of RI are to embed specific values by fulfilling the objectives of social, economic, and environmental sustainability

(Setiawan et al., 2019; Singh & Kroesen, 2012). The process is ensuring the accountability of the actors by engaging in anticipation, reflexivity, deliberation, responsiveness, and participation (Setiawan et al., 2019; Setiawan & Singh, 2015). These five dimensions also act as a guiding principle for RI. Responsible innovation is an iterative development process that combines a step-by-step impact analysis of a project with the imperatives of creativity stimulation throughout development phases (Pavie, 2019; Xavier et al., 2014). Social, economic, and environmental performance impacts are monitored throughout the entire lifecycle, and corrective actions are anticipated accordingly through reintegration into previous development phases (Xavier et al., 2014).

The approaches like national innovation system (NIS), technological innovation system (TIS), sectoral systems of innovation (SSI), regional innovation system (RIS), and open innovation (OI) (Asheim & Gertler, 2006; Bergek et al., 2008; Carlsson & Stankiewicz, 1991; Chesbrough et al., 2008; Doloreux & Parto, 2005; Freeman, 1995; Lundvall, 2007; Malerba, 2002; Malerba & Mani, 2009; Markard & Truffer, 2008; Nelson, 1993) cannot satisfy all of the expectations connected with the governance of emerging technology, although they variously provide knowledge, expertise, and a methodological toolbox for RI research and policy communities (Grunwald, 2011). RI is a top-down approach, which addresses the perceived anomalies in the dominant innovation paradigm (Timmermans & Blok, 2018). The major novelty and practical relevance of RI are in integrating existing approaches and in making an explicit link between innovation and responsibility (Bourban & Rochel, 2020; Stilgoe et al., 2013). The integrating of approaches means that existing responsibilities need to be addressed as a whole, framing RI as responsibility for society at large, with closer attention to societal context and a broader spectrum of actors capable of reflecting on their values and research and innovation-related responsibilities (Genus & Iskandarova, 2018; Grunwald, 2011).

RRI is a cluster of ideas for promoting an idea of science governance primarily about responsible processes instead of processes that are not supervised responsibly (Burget et al., 2017). Additionally, RRI is endowed with two sentiments: one, to assert human control over the future; second, to infuse ethicality in all parts of human life (Hühn, 2018). Furthermore, the adopted theory helps in caring for culture-specific values in a diverse democracy like India endowed with varied socio-cultural aspects. RI approach plays a critical role in the adequate and timely inclusion of values in the deployment and development of technology (Taebi et al., 2014), assuming the values to adhere to social and ethical considerations (van de Kaa et al., 2020). Further, caring for values in a democracy can only herald the effective governance of emerging technology. Care, responsiveness, and sustainability ingrained in the RI approach (Burget et al., 2017) further make it more suitable to study new and emerging technology like civil UAV in Indian crop insurance applications. So, the RI approach is most suitable for delving into these issues of innovations.

Henceforth, the approach of RI is adopted as a theoretical framework for the study. The next section explains how the research is conducted; tools and methods deployed in data collection are elaborated.

3 Methodology

The research is exploratory and qualitative, anticipating civil UAVs' prospects in Indian agriculture insurance through the perspective of RI. An extensive literature survey is conducted to understand the nuances and theoretical underpinnings in drone deployment, agriculture insurance, values, and responsible innovation. The literature survey is aided by a literature survey questionnaire (LSQ) (Chamuah & Singh, 2020a), consisting of questions that guided and directed the literature survey process.

The LSQ consisted of questions concerning civil UAVs, emerging technology, responsible innovation, sustainability, sustainable agriculture, crop insurance, Indian agriculture, governance issues, drone regulations, values, ethics, and culture. The LSQ provided a direction to the research and guided in finding the research gap. The gathered literature is reviewed systematically, which further aided in the formulation of the study's research questions.

The gathered literature is coded according to the research objectives. Furthermore, the research questions are addressed from the qualitatively analyzed secondary data from various sources.

The next section describes the current scenario of civil UAV deployment in the Indian agriculture scenario.

4 Current Scenario

4.1 Agriculture Insurance

India is an agriculture-based country. More than 50% of the Indian workforce is employed in this sector, accounting for 18% of India's gross domestic product (GDP) (L, 2015). Post green revolution in India introduced high yielding crops (HYC) to the farmland (Eliazer Nelson et al., 2019). The introduction of the HYC also craved the demand for more water. According to the Indian Council of Agricultural Research's (ICAR) classification of Indian agroecological zones, if the cropped area is irrigated more than 25%, it is called the irrigated area, otherwise rainfed (Fan & Hazell, 2000). Sadly, more than 53% of the area is still rainfed (Gulati et al., 2018). More than 44% of India's land areas are under various dry conditions as of June 2019 (Kapil, 2019). The increased demand for water pushes farmers to walls, along with the water problem. However, in the monsoon season, heavy rainfall causes floods to affect states like Assam, Bihar, and Kerala. Perennial floods cause massive losses to crops, livestock, human, and property. In crops, pathological damages are also caused by microorganisms like bacteria, viruses, fungus, and nematodes. The damages caused by microbes deteriorate crop germination and growth causing crop loss and damage.

India faces susceptible weather anomalies, climate change, and pest infestation, which impacts agricultural output. The worst sufferers of weather, climate, and water crisis are the farmers. As a result, various crop insurance schemes have been introduced in Agricultural Policy in India to mitigate agricultural production uncertainties and give farmers a sustained income. Many area-based and weather-based crop insurance scheme was introduced, but both the schemes have drawbacks to meet the challenge to settle the claims swiftly (NAIR, 2010). These schemes are not mutually exclusive; instead, they are complementary to each other. Therefore, it becomes of utmost importance to find a solution that swiftly assesses the damage and settles the claims.

In changing times where technology facilitates every public and private domain, the introduction of drones or UAVs to facilitate crop insurance schemes is anticipated as a path-breaking step to assess the yield and quick settlement of the claims (Sridhar, 2018). PMFBY is a new insurance scheme approved by the Government of India in 2016. In this scheme, the use of UAV technology is made mandatory for surveillance of the insured crops (Ministry of Agriculture & Farmers Welfare, 2019). The cost incurred for the use of technology such as smartphones, UAVs, and handheld devices for the conduct of CCE will be shared between central/state government/union territories on a 50:50 basis (Ministry of Agriculture & Farmers Welfare, 2018). All farmers in India, including sharecroppers and tenant farmers growing the notified crops in the notified areas, are eligible for coverage under PMFBY. However, eligible farmers should have an interest in crop insurance for the notified crops. On the other hand, the non-loanee farmers are required to produce necessary documentary evidence of land records prevailing in the state records of rights (ROR), land possession certificate (LPC), and or applicable contract, agreement, and other documents certified by the concerned state government (in case of sharecroppers and tenant farmers) (Ministry of Agriculture & Farmers Welfare, 2019).

Now, the question arises that how is PMFBY is different from other insurance schemes such as the National Agriculture Insurance Scheme (NAIS) and the Modified National Agriculture Insurance Scheme (MNAIS). What are the unique features of PMFBY that make it significant from other insurance schemes? Table 11.1 shows how PMFBY is better than NAIS and MNAIS.

Table 11.1 shows that the premium rate in PMFBY is also lower than in the NAIS. The postharvest losses and localized risk coverage are also more in PMFBY than NAIS and MNAIS resulting in more inclusion of rural farmers. Additionally, the use of technology like civil UAVs is made mandatory under PMFBY.

The existing research highlights that civil UAV is efficient in conducting CCE and crop damage assessment (Canada, 2014; Xiang & Tian, 2011). UAVs can operate at any time of the day, and the images can be captured from a required angle and directions of the agricultural land (Raj et al., 2019). The height of the operation can also be controlled and monitored by the drone pilot. Furthermore, the instantaneous supply of remote agriculture field data promotes quick settlement of claims among the insured farmers. Thus, the advent of UAV in agriculture insurance has removed the mediator who at times manipulates the data for their benefit. The technology has rebuilt the loss faith of farmers in agri-insurance schemes.

Table 11.1 Features in NAIS, MNAIS, and PMFBY

Sl no	Feature	NAIS (1990)	MNAIS (2010)	PMFBY (2016)
1	Premium rate	Low	High	Lower than even NAIS
2	One season-one premium	Yes	No	Yes
3	Insurance amount cover	Full	Capped	Full
4	On account payment	No	Yes	Yes
5	Localized risk coverage	No	Hail storm Landslide	Hail storm Landslide Inundation
6	Postharvest losses coverage	No	Coastal areas for cyclonic rain	All India for cyclonic rain+ unseasonal rain
7	Prevented sowing coverage	No	Yes	Yes
8	Use of technology (for quicker settlement of claims)	No	Intended	Mandatory
9	Awareness	No	No	Yes (target to double coverage to 50%)

Source: PIB (2016)

The next section describes the civil UAV technology and current regulation structure in India.

4.2 Civil UAV

Drone technology is new to India. It is not yet deployed in all the states in India. DGCA, India, has categorized UAVs into five categories based on weight: nano (up to 250 gm), micro (>250 g to <2 kg), mini (>2 kg to<25 kg), small (>25 kg to<150 kg), and large (>150 kg) (DGCA, 2016). Figure 11.1 shows the five types of civil UAVs in India and their specified height of operation.

In Fig. 11.1, the different categories of UAVs are shown according to their weights. Nano UAVs are allowed to fly 50 feet from the ground, whereas, the other drones are allowed to fly 200 feet above the ground. Drones (micro, mini, small, and large) to fly above 200 feet from the ground require an unmanned aircraft operator permit (UAOP) from DGCA.

The policy for drone regulation is implemented in December 2018 by the DGCA, Ministry of Civil Aviation. The regulations for the drone are not yet fully developed, still evolving. Some of the formal institutions (North, 1991) governing civilian UAVs in India are tabulated in Table 11.2.

The digital sky platform has divided the Indian airspace into three categories: *red*, *yellow*, *and green* (Sasi & Singh, 2020). Figure 11.2 explains how the three colors distinguish the airspace in India for the flying of drones.

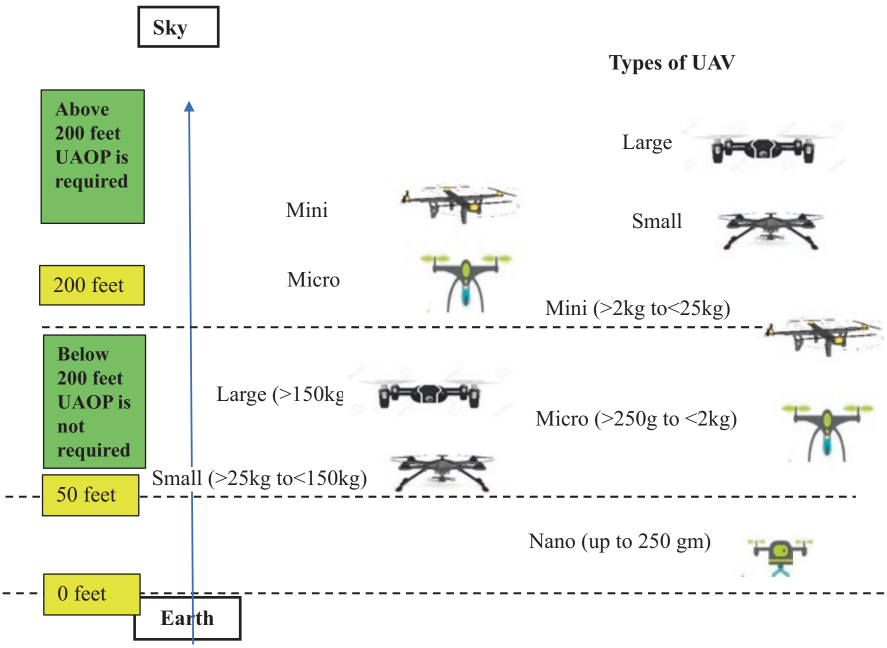

Fig. 11.1 Types of civilian UAV in India. (Source: Author's analysis, mainly based on data from DGCA, 2018 circular on UAV)

Table 11.2 Formal institutions governing civil UAV operation

Particulars	Purpose
Unique identification number (UIN)	License for UAV operation
Unmanned aircraft operator permit (UAOP)	To fly a UAV above 200 ft above ground level
Unmanned traffic management (UTM)	Regulates the drone air traffic
Digital sky	Online maintenance of all administrative and procedural measures related to UAVs

Source: DGCA (2016, 2018)

Figure 11.2 illustrates how the Director General of Civil Aviation (DGCA) has categorized the Indian airspace into three flying zones. The three colors, *red, green, and yellow,* which are also used in Indian traffic signals that indicate *stop*, *wait*, *and go*, are very efficiently used to portray the airspace for flying drones, which also requires permission, clearance, and enrollment in the digital sky platform controlled by DGCA.

The governance of civil UAVs in India is a humongous task involving a diversity of actors and stakeholders ranging from different ministries to civil society. The central actors formulating laws and regulations for UAV operation are the Director

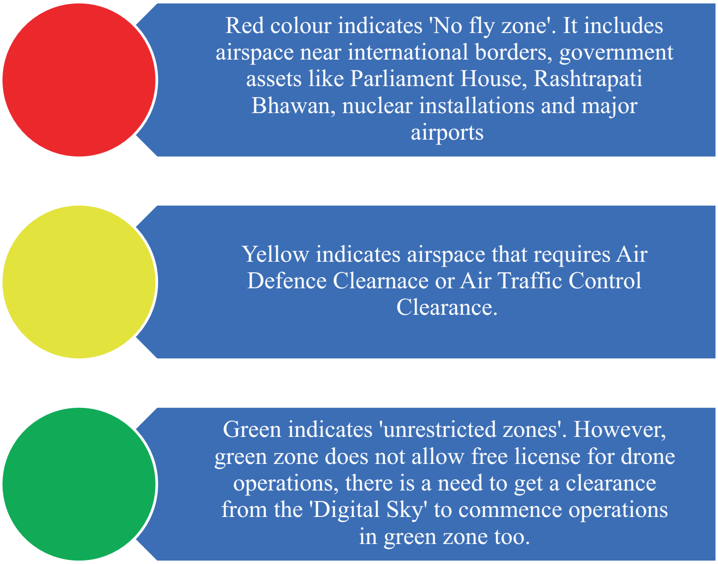

Fig. 11.2 Color categorization of Indian airspace for flying of drones. (Source: Author's compilation)

General of Civil Aviation (DGCA) and the Ministry of Defense. The stakeholders deploying UAVs under agri-insurance involve Mahalanobis National Crop Forecast Centre (MNCFC), Skymet, crop insurance companies, state agriculture departments, local administration, and farmers. The next section explains the value implications in society after introducing a new technology like civil UAV.

5 Implications of Values in Civil UAV Deployment

Values refer to what a person or a group of people consider necessary in life (Friedman et al., 2006). In all the aspects of constructing life, values are present (Maksimainen, 2011). "Value" is normative and is associated with what is "good" or "desirable (I. van de Poel, 2020)." Values can be analyzed from normative and socio-empirical approaches (Ruggiu, 2019, 2020). The normative approach focuses on norms and standards, whereas the socio-empirical approach focuses on social, cultural, and technological contexts (Ruggiu, 2020).

Understanding societal culture and values is essential for understanding and practicing RI (Setiawan et al., 2019). Values are indicators (Zahinos et al., 2013) that philosophize the technological and innovation approach (J. Gonzalez, 2015b). The existing research highlights that technology is value-laden (Flanagan et al., 2008; J Gonzalez, 2015b; Klenk, 2020; van de Poel, 2020). The deployment and development of technology undermine or promote specific values (van den Hoven, 2013; Klenk, 2020). Van de Poel and Royakkers (2011) defines values as "lasting convictions or matter that people feel should be strived for in general and not just for themselves to be able to lead a good life or realize a good society." However, the most inclusive definition of values that focus on action and means is provided by Kluckhohn (1951): "A value is a conception, explicit or implicit, distinctive of an individual or characteristic of a group, of the desirable, which influences the selection from available modes, means, and ends of action." Values change to occur with the interaction of users and stakeholders, along with societal development and technological interjection (Friedman et al., 2006).

New technologies like civil UAVs promote specific values; if not included efficiently in implementing the technology, they can herald controversies or failure (van de Kaa et al., 2020). Technology like civil UAV is not value-neutral (J. van den Hoven, 2013; Winner, 2001); instead, there are embedded values within it (Fleischmann & Wallace, 2006). Civilian UAV adds value to agriculture practices through its various applications and features. Agriculture UAVs are used in two main areas: surveillance (aerial imaging, remote sensing) of crops and soil and delivery or aerial applications of fertilizers and pesticides over agricultural lands (Efron, 2015). Drones equipped with near-infrared camera sensors allow the drone to see the light spectrum that plants use to absorb light for photosynthesis. Using the normalized difference vegetation index (NDVI), farmers can understand plant health (Margaritoff, 2018). Software analysis and interpretation of gathered data can be used to change values to reflect the specific crop type and the crop's stage of life. In addition to crop health, agriculture UAVs can create detailed GPS maps of the crop field area, allowing farmers to plan where crops are being planted to maximize land, water, and fertilizer usage.

Moreover, to make the technology sustainable in Indian agriculture, which is a contentious blend of various endogenous and exogenous values (Gonzalez, 2015a), adhering to these values where the civil UAV is deployed is essential for responsible innovation. Values like safety, security, privacy, affordability, transparency, trust, autonomy, accountability, and reliability should be given importance in deploying new and emerging technology like civil UAVs. Values implicated in society through the deployment of civil UAV in Indian agriculture insurance are as follows:

- *Safety:* Safety means the absence of risk and danger (I. van de Poel & Robaey, 2017). For a responsible deployment of civil UAVs in agriculture, avoiding risk, danger, and accidents is a crucial factor. Technology like UAV should be safe for society (people), the environment (birds, insects, and animals), and the economy (affordable) to make it sustainable. Safety is an external value, but it could be internalized through the formulation of standards and codes (J. Gonzalez, 2015b). Henceforth, providing proper training entrusted with specific rules and regulations to drone pilots can avoid accidents and damage to the drones and the losses to society, environment, and economy. The study found that drone is safe to operate, use, and deploy in Indian agriculture scenario—no threats to flora and fauna in neither of the states are detected where field surveys are conducted. The pilots of drone follow the prescribed safety guidelines prescribed by DGCA. Following safety rules makes drone operation conducive for society, people, and the economy.

- *Privacy:* Privacy means freedom from intrusion, surveillance, and control of information about oneself (Warnier et al., 2015). UAV is a technology that can collect data from a remote location without any human intervention. It can reach the rural community's privacy where the technology is deployed without their knowledge and permission. Drone breaching the privacy of the agriculture community is an ethical concern and can be unsustainable. Hence, adhering to privacy norms is essential for the sustainable deployment of the technology.
- The findings suggest that drone pilots operating in Indian agriculture adhere to International Civil Aviation Organization (ICAO) and DGCA's recommendations. The height of operation, visual line of sight (VLOS), and no-fly zones are strictly followed while flying a civil UAV in the sky. Following these measures promotes responsible and intrusion-free deploying of drones.
- *Transparency*: The data gathered by the UAVs are timely and transparent. The technology allows open communication (Hulstijn & Burgemeestre, 2014). UAV ingrained with the value of transparency is an essential dimension of legitimacy because it enhances public scrutiny and visibility in complex environments (Devaney, 2016). The value of transparency in civil UAV is reflected by their easy availability of gathered information, accessibility, and support to the user's decision-making process (Turilli & Floridi, 2009). The existing studies (Chamuah & Singh, 2020b; Honkavaara et al., 2013; Yamazaki et al., 2017) reveal that data supplied by drones are timely, accurate, and reliable. There is no scope for duplication or fabrication of information provided by civil UAVs.
- The high-resolution data provided by the drone can be acquired and processed in a few hours depending on the scale of operation, which further augments the quick settlement of claims of insured farmers. The transparency of the data supplied by drones from Indian agriculture promotes trust between farmers and insurance agencies. The technology is thus proving to be a boon for crop insurance in India.
- *Trust:* Trust is a kind of human reliance that is voluntary and willing carried out under the conditions of uncertainty and vulnerability (Nickel, 2015). The easy accessibility and transparency of information provided by the civil UAV help in a peaceful settlement of claims. The availability of required information in claim settlement helps build trust between the farmers and the insurance companies in India.
- The various features endowed in drone make it free of threats, intrusions, and hazards to society, economy, and the environment (Margaritoff, 2018; Peter V Blyenburgh, 1999). The risk-free operation, deployment, acquiring, and processing of drones' data make it a responsible technology for agri-insurance in India.
- *Autonomy:* The condition or quality of self-governing is called autonomy (Gonzales & Harting, 2014). Civil UAV is an autonomous system mounted with sensors, GPS, camera, video converter, and wireless router (Xiang & Tian, 2011). However, the technology equipped with various devices should not breach the farmers' autonomy by breaching their privacy and security.

- The study found that apart from being an autonomous technology, drones promote the autonomy of the pilot as well. The images can be captured at the desired time of the day without any environmental hindrance (Honkavaara et al., 2013; Raj et al., 2019). Additionally, images can be taken from different angles, which helps get architectural information of canopies (Raj et al., 2019).
- *Accountability* ensures answerability for undesirable actions or duties (Hulstijn & Burgemeestre, 2014; Mishra & Singh, 2018). When a new technology is deployed, various issues like adaptability and accessibility to the local conditions make the technology accountable. The information provided by technology should be traceable (Hulstijn & Burgemeestre, 2014). An autonomous vehicle like a UAV can be called accountable if it can display which regulatory rules apply to which transaction and produce a corresponding audit trail (Chamuah & Singh, 2021; Hulstijn & Burgemeestre, 2014). Values like operability, accessibility, and efficiency should be embedded during the designing process of the technology to make it accountable to the actors who deploy it.
- The transparency of data, the autonomy of operation, the absence of intrusions, building of trust, environmental friendliness, and societal desirability make the technology accountable. Furthermore, accountability is also promoted via effective governance of the technology (Devaney, 2016).

Civilian UAV or drone, or any other technology, embodies a given value in virtue of being designed to contribute to that value (Klenk, 2020; I. van de Poel, 2018). However, the technology's intentional history (intention behind designing) determines the embedded value (Klenk, 2020). Thus, upholding and adhering to these values are essential in the responsible deployment of civil UAVs. The culture-specific values also entwine the social fabric of a democratic country like India. Henceforth, it is essential to promote moral and socially responsible technological innovations by incorporating moral and social values during the design processes (V. D. Hoven et al., 2015). The idea of integrating moral and societal values in technological developments is also a part of the technological assessments (TA) process (Grunwald, 2011, 2014). The next section discusses the main findings of the study.

6 Discussion of the Findings

Civil UAV has ample scope to percolate in Indian agriculture, especially in crop insurance, provided it adheres to the culture-specific values of the society. The technology should also withstand the objectives of sustainability (social, economic, and environmental) (Blok & Lemmens, 2015; Setiawan & Singh, 2015; Stilgoe et al., 2013). The various actors and stakeholders governing the technology should maintain conducive coordination and collaboration with the local administration and farmers for a responsible deployment. Crop insurance companies should seek the UIN from DGCA to deploy drones in all the agriculture states in India. From the literature survey, it is evident that civil UAV is not yet fully deployed in PMFBY. The policy for drone regulations in India is still evolving (Chamuah & Singh, 2021; Ministry of Civil Aviation, 2021); the insurance companies are yet to acquire the UIN to fly in agriculture.

The study found that drones deployed under crop insurance schemes are making an impact on crop monitoring, surveillance, and quick settlement of claims. Farmers are also happy and satisfied with the current tools, which are not easily fabricated, and they get the deserving compensation in less time.

The study highlights that drone deployment in India involves stakeholders from the Ministry of Civil Aviation; Ministry of Defense; Skymet, a private weather forecast and monitoring company; academics from universities and research organizations; officials from DGCA and Mahalanobis National Crop Forecast Centre (MNCFC); state agriculture department; local administration; farmers; and crop insurance companies. There is a communication network among the stakeholders guided by some institutions before flying over the agriculture field. Henceforth, there is a responsible deployment of civil UAVs in Indian agri-insurance involving all the stakeholders from academia, industry, civil society, and policy (J. van den Hoven, 2013; Popa et al., 2020; Stilgoe et al., 2013). The next section on the conclusion provides the concluding remark of the study.

7 Conclusion

The participation of all the stakeholders of civil UAV innovations in Indian agri-insurance promotes accountability while adhering to the culture-specific values of Indian society. The accountability of the stakeholders ensures responsibility in new technology deployment further promoting sustainability (social, economic, and environmental). The RI approach, adopted as a theoretical framework, intertwined the study in the desired direction. The evolving drone regulations in India are well captured from existing literature from government websites and journals. The governance structure of civil UAVs consists of a diversity of actors from government, academia, companies, industries, and civil society. However, the study found that adhering to prescribed regulations and guidelines involving a multiplicity of actors endorses responsible governance and civil UAVs deployment in Indian agri-insurance.

Furthermore, the study found that Indian agriculture is affected by multiple factors, including flood, drought, pest, and other weather anomalies. Withstanding such weather vagaries is difficult in a diverse democracy like India enveloped by various agroclimatic zones. Henceforth, crop insurance schemes like PMFBY are a rescue cohort for otherwise downtrodden farmers. The research highlights that infusion of technology like civil UAVs in agri-insurance ensures the quick settlement of claims, promotes transparency in data collection, and builds trust among the agri-insurance companies and farmers. However, deploying new and emerging technology demands obeying the sociocultural norms of the society. There are embedded values in a technology, which should function in coherence with the overall values in the society.

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Chapter 12
COVID-19: The Urgency to Expand Sustainable Nutrition Solutions

Anamika Yadav

Abstract Nutrition is a multidimensional and complex issue. Several sectors are implicated in nutrition, by far the most obvious ones being the health sector and the food sector. This interlinking of nutrition into multiple sectors has given rise to a new area of multidisciplinary study that combines insights from agriculture, nutrition, economics, and social sciences. The field is still emerging, and the major research focus has been on specific aspects of agri-food system change in various nations. Even though sustainability has been a buzzword for some time now, researchers can argue that some have abused the word for their vested interest; the role of sustainable scientific interventions to address the triple burden of malnutrition cannot be neglected. Yet, the sustainable potential of nutraceuticals in combating nutrition has not been studied much. In this review, the researcher attempts to understand nutraceuticals and how they can contribute to expanding sustainable nutrition solutions, especially in the aftermath of the COVID pandemic.

Keywords Nutrition · Malnutrition · COVID-19

1 Introduction

In late December 2019, the Huanan Seafood Wholesale Market personnel in Wuhan, Hubei, China, experienced an outbreak of perplexing pneumonia characterised by fever, dry hack, lethargy, exhaustion, and occasional gastrointestinal signs (Huang & Wang, 2020). The disease quickly spread throughout China's provinces and cities, soon spreading to other countries. The outbreak culprit was later discovered as a new beta-coronavirus, which was dubbed SARS-CoV-2 (severe acute respiratory syndrome coronavirus-2) (Wu, Chen, & Chan, 2020). The World Health Organization

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(WHO) declared the rapidly spreading disease a global pandemic on March 11, 2020 and ordered countries to coordinate their preparedness and response efforts in accordance with the global strategic preparedness and response plan (WHO, 2020a). The World Health Organization's "strategic readiness and response plan" specifies the health precautions that all countries must take to prepare for and respond to the pandemic. We can help all national and international partners in developing national and regional operational strategies by putting everything we know about this virus so far into a holistic plan (Serpil Aday, 2020).

According to the WHO, a coronavirus-caused pandemic has never been documented previously, and this is the first coronavirus outbreak (WHO, 2020b). SARS-CoV-2 was found in early January 2020, and on the 11th and 12th of the month, its genetic sequence was made public. SARS-entire CoV-2's genetic sequence from early human cases and the genomes of many other viruses discovered from human cases in China and around the world after then show that SARS-CoV-2 has an ecological genesis in bat populations. According to all data, the virus is of natural animal origin, not man-made or developed (WHO, 2020b). Regardless, we now know how the pandemic began, but we have no idea how it will finish. Aside from the more obvious economic consequences, there is a slew of other difficulties that are less visible at the moment but have major implications for the future. According to the World Health Organization, the present pandemic is not only a public health issue but also a disaster affecting all sectors. One of them is the unsettling disclosures regarding the shortcomings of the world's food systems. COVID-19 provided numerous unanticipated obstacles to the food chain by introducing unanticipated stress.

2 COVID-19 and Nutrition Disruption

Lives and livelihoods are being impacted on a never-before-seen scale due to COVID-19 and its mitigation response. Existing nutrition issues in low- and middle-income nations (LMICs) have been worsened by global economic and food system crises and pandemic-related disruptions. Frontline surveys and economic simulations show that in developing nations, pandemic-related job loss and economic distress are wreaking havoc on existing poor and vulnerable people while altering the global poverty picture by introducing millions of "new poor." COVID-19 is expected to push more than 100 million people into extreme poverty by 2020 and up to 150 million by 2021, according to current predictions (World Bank, 2020). According to the estimates, the current crisis would affect practically all countries at least until 2030. As a result, lowering the global absolute poverty rate to less than 3% by 2030, a goal that was already in jeopardy prior to the crisis, is now more challenging than ever (World Bank, 2020). In 2019, 690 million people, or 8.9% of the global population, were hungry, increasing ten million people in a year and about 60 million in 5 years. Nearly 2 billion people were food insecure, meaning they didn't have consistent access to safe, nutritious food in large enough quantities, and 3 billion couldn't maintain a healthy diet. In addition, 47 million children under the age of 5 were malnourished, 144 million were stunted, 38 million were overweight, and 340 million were deficient in micronutrients (Carducci, 2021; FAO, 2020). COVID-19 and the resulting economic slowdown are expected to result in an additional 9.3 million wasted children, 2.6 million stunted children, and 168,000 child fatalities in low- and middle-income countries in 2022 unless suitable actions are adopted (Carducci, 2021). In all likelihood, the Sustainable Development Goals' zero hunger target will not be met by 2030; in fact, the number of hungry people and, as a result, the number of malnourished people will only rise (FAO, 2020). In addition, unsustainable production and consumption habits have already put the planet, the ecosystem, and human health under strain. Due to low food quality, chemical-intensive agriculture techniques have led to land degradation, natural resource depletion, biodiversity loss, nutritional loss, and a rise in diseases. As a result of the environmental consequences and the ongoing epidemic, finding sustainable and cheap nutrition solutions is crucial. And to do so, a long-term strategy is required, ranging from more sustainable food system practices to innovative scientific and technological solutions to the persistent problem of malnutrition and overnutrition.

3 Juxtaposing Nutrition and Sustainability

At the 2012 Rio+20 Conference on Sustainable Development, world leaders reaffirmed that everyone has the right to safe and nutritious food and the right to enough food and the fundamental right to be free of hunger (Nations, 2012). While SDG-2 explicitly addresses food by aiming to "end hunger, achieve food security and improved nutrition, and promote sustainable agriculture," the importance of nutrition in development can be seen in the SDGs— where improving nutrition extends beyond SDG2 and is linked to all other SDGs—and has the potential to play a significant role in achieving sustainable development (nutrition and the SDGs). Food has been the driving force behind public health, nutrition, and environmental issues for decades, but there are still a lot of territories to cover. Although nutrition is a multifaceted subject, it is inextricably linked to food and health. As a result, while attempting to confront the problem of nutrition, the clearest links between food systems and the health system emerge.

"All the elements [...] and activities that relate to the production, processing, distribution, preparation, and consumption of food, as well as the output of these activities are defined as" (HLPE, 2014). The diets that individuals may obtain as a result of the food system and the incomes of those who participate in the food system and the food system's environmental repercussions are all important outcomes. Variables ranging from the biophysical and technical to the political and sociocultural influence these varied and dynamic systems (HLPE, 2020). There is a risk of food system disruption whenever these dynamics are interrupted. As we all know, "sustainability" is a tough term to define because it may mean a variety of things depending on the situation, but the concept is far more than a trendy buzzword. In 1987, the United Nations Brundtland Commission on Sustainable Development produced the most often quoted definition: "Sustainable development [meets] the requirements of the present without jeopardising future generations' ability to satisfy their own needs." The first step in understanding a sustainable diet is to assess the agricultural, environmental, social-cultural, and economic causes and the nutritional content and implications of the food consumed. Nonetheless, sustainability encompasses the environment, economics, health, nutrition, and other linked concerns. This interconnectedness is reflected in the FAO's concept of sustainable diets:

> Sustainable Diets are those diets with low environmental impacts that contribute to food and nutrition security and to healthy life for present and future generations. Sustainable diets are protective and respectful of biodiversity and ecosystems, culturally acceptable, accessible, economically fair and affordable, nutritionally adequate, safe and healthy while optimizing natural and human resources.

Sustainable agri-food chains have been widely addressed in the scientific literature and the general public in recent years (Von Koerber, 2017). However, discussions about sustainability are frequently limited to ecological issues. In reality, sustainability encompasses a wide range of factors, including economic and social ones (according to the UN Sustainable Development Goals). Sustainability, according to Sachs, is the integration of three elements: environmental, social, and economical. Sustainable development entails more than just reaching a good level of life and environmental balance. "Sustainable nutrition" encompasses not only environmental, economic, and social dimensions but also ethical dimensions in which life is healthy for current and future generations, biological diversity and ecosystems are protected, culture is accepted, economic equity and affordability are met, nutrition is adequate, health is safe, and natural resources are optimised. In light of such varied and intricate definitions, a number of approaches based on the definition of various "sustainable diets" and their functions in food systems have been proposed.

4 Advances in Science to Tackle Nutrition and Issue of Sustainability

The importance of nutrition cannot be overstated. It is common knowledge that the food system, as the primary source of human sustenance, has a significant impact on environmental health. Seventy percent of all water drained from nature, 60% of biodiversity loss, and up to one-third of all anthropogenic greenhouse gas emissions are attributed to food systems. It is ironic that we have contributed to climate change by growing food, which is the primary source of human nutrition and has also jeopardised food security. However, over 2 billion people worldwide suffer from hidden hunger or micronutrient deficiencies as a result of poor eating (FAO, 2013). The issue of inadequate diet and malnutrition is becoming more serious as the world's population grows and lifestyle diseases become more prevalent. Hunger or malnutrition that goes unnoticed can have deadly consequences. It has the potential to induce mental illness, decreased productivity, and even death. Malnutrition is caused by three factors: undernutrition, overnutrition, and micronutrient deficiencies (Labadarios, 2005). Over 800 million people throughout the world are hungry, 2 billion are malnourished, and 2 billion are overweight or obese. There are various types of malnutrition, but the distinctions between them aren't always evident; a lack of food doesn't always cause malnutrition. As a result, health is not solely based on quantity; food quality is also an important factor in global health and nutrition. This triple burden causes delays in physical and mental development and loss of productivity, susceptibility to infectious and chronic illnesses, and early death (Lim, 2012). To combat this, improved food policies and targeted nutrition interventions are needed to combat the many kinds of malnutrition. The inefficiency of the PDS system, as well as glaring issues of malnutrition among mothers and children, combined with an increase in the incidence of lifestyle—diet style disease—increased life expectancy, increased consumer awareness, the impacts of climate change on agriculture, and a rapid increase in the middle and upper classes, necessitates a shift in focus from traditional diet habits to more scientific and innovative diet solutions. The nutritious supplement, which was privately made and marketed, became a cornerstone of the international development agenda. International development agencies like UNICEF and the World Bank had moved their focus from hunger as a result of poverty and famine to "hidden hunger" by the late 1990s. The emphasis was now on food quality and quantity, with the attributes of meals being tracked down to the molecular level. Since 1990, the need for a comprehensive diet for the treatment of underweight patients has prompted the development of novel formulations to meet the demands for a high nutritional content food that is easy to prepare and store while posing a low risk of contamination or modification (Guimon, 2012).

Nutraceuticals are a new product category born out of a growing understanding of the relationship between nutrition and health. The words "nutrition" and "pharmaceutics" combine to generate the term "nutraceutical." The term refers to herbal extracts, food supplements (nutrients), specific diets, and refined carbs such as cereals, soups, and drinks utilised as medicine and sustenance. In 1989, DeFelice coined the term nutraceuticals, which he later defined as "any item that may be considered a food or part of a food that delivers medical or health advantages, including disease prevention and treatment." (Fig. 12.1)

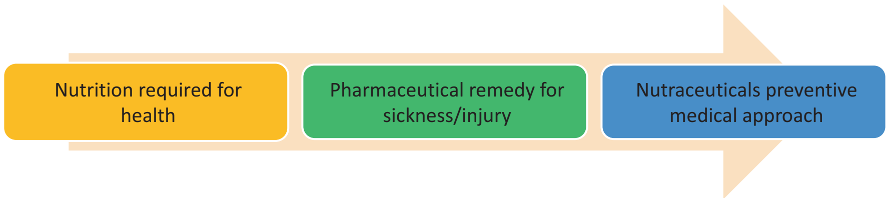

Fig. 12.1 Role of food, pharmaceuticals and nutraceuticals in human health. (Source: compiled by the author based on a literature review)

Several different meanings have followed since DeFelice first coined the term nutraceuticals. Palthur et al. (2010, p25) looked at 25 alternative definitions, extracted the most important ideas, and proposed a single working definition:

> A nutraceutical is a food or a part of a food for oral administration with demonstrated safety and health benefits beyond the basic nutritional functions to supplement the diet, presented in a non-food matrix or nonconventional food formats, in such a quantity that exceeds those that could be obtained from normal foods and with such frequency as required to realize such properties, and is labelled as a 'nutraceutical'.

A nutraceutical is a supplement that has a physiological benefit or provides protection from chronic and lifestyle disorders (Bhowmik et al., 2013; Baldi et al., 2013). As opposed to medications, nutraceuticals are substances that aren't always protected by patents. Pharmaceutical and nutraceutical substances may be used to treat or lower the illness's risk, but the government approves only pharmaceutical compounds. Nutraceuticals show a great promise for developing countries like India since they may be used for both battling malnutrition and as medications and preventive medicines; they also appear appealing because they are readily available without a prescription (Dharti et al., 2010) (Fig. 12.2).

Fish oil capsules providing omega-3 fatty acids, antioxidant capsules, and probiotic capsules to strengthen the immune system are just a few examples of nutraceutical goods. Nutraceuticals can give vital components for a healthy diet by delivering these nutrients. They can add to a better life by supplementing the diet with essential nutrients in the event of illness or disease prevention (Dharti et al., 2010). For a long time, food's therapeutic advantages have been addressed in Ayurveda, an Indian health science. According to historical documents, food's medical properties have been studied for thousands of years. Nutraceuticals can help to regulate and prevent certain diseases in this situation. The efficacy of nutraceuticals in treating and preventing a variety of diseases has been scientifically verified and confirmed by several study publications (Rec, 2007). Nutraceuticals are becoming increasingly popular, which is understandable (Pandey et al., 2010). Many botanical and herbal extracts have also been created as nutraceuticals, such as ginseng, garlic oil, and so on. Nutraceuticals are commonly utilised in nutrient premixes or nutrition systems in the food and pharmaceutical industries (Tables 12.1 and 12.2).

5 Nutraceuticals and Sustainable Nutrition

The production of plant waste from the agro-food industry has increased at an exponential rate during the last several decades. The situation is critical around the world. Wastes and by-products from facilities can be used to create high-value compounds, opening up new prospects for industrial growth as well as waste management in the process.

Research and development of novel functional foods and health products based on low-cost raw materials are becoming increasingly important in agribusiness, the nutraceutical industry, cosmetics, and medicines, among other industries. Humanity

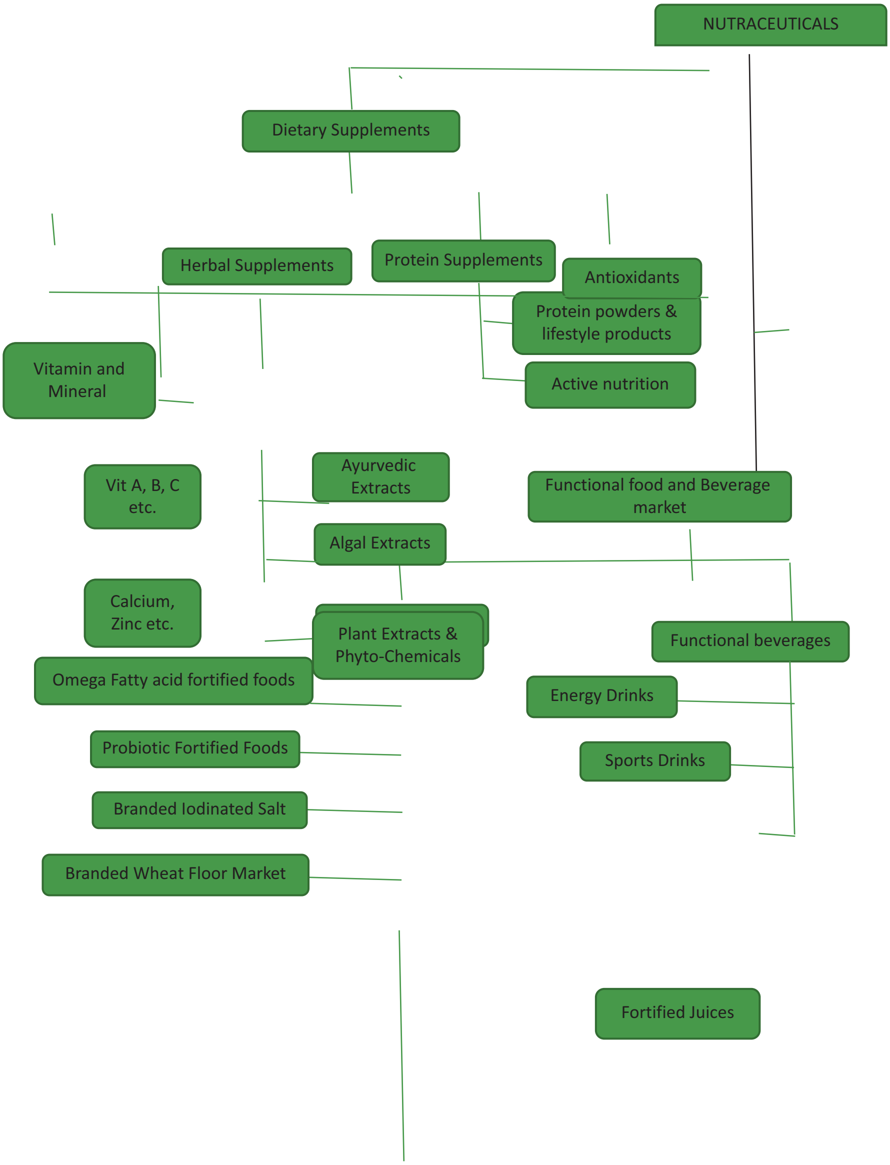

Fig. 12.2 Classification of nutraceuticals. (Source: based on literature)

desperately needs technical innovation to reduce biogas usage and environmental concerns while also recovering additional value from waste items and recycling them. Furthermore, from an industrial aspect, the usage of food waste for the manufacturing of nutraceuticals can be both economically efficient in the production stage and ecologically friendly in the disposal stage. The commercial exploitation of microalgae has been advocated in addition to gathering them from natural

Table 12.1 List of major nutrients and their health benefits

Nutrients	Benefits to health
Vitamin A	Antioxidants essential for growth and in the treatment of certain skin disorders
Vitamin E	The antioxidant helps form blood cells, muscles, and lung and nerve tissue and boosts the immune system
Vitamin K	Essential for blood clotting
Vitamin C	Antioxidants for healthy bones, gums, teeth, and skin in wound healing prevent the common cold and attenuate its symptoms
Vitamin B1	It helps to convert food into energy, which is essential in neurologic functions
Vitamin B2	Helps in energy production and other chemical processes in the body and helps maintain healthy eyes, skin, and nerve function
Vitamin B3	It helps to convert food into energy and maintain proper brain function
Vitamin B6	Helpful in the production of essential proteins and converting protein into the energy
Vitamin B12	It helps in the production of cells' genetic material; aids in the formation of red blood cells (RBCs), brain functions, and synthesis of amino acids; and helps in the metabolism of biomolecules
Folic acid	Produce the genetic materials of cells in pregnancy to prevent birth defects, and RBC formation protects against heart disease
Vitamin C	It acts as an antioxidant for the bones and teeth and helps maintain bone strength, which is important in nerve, muscle, and glandular functions
Pantothenic acid	Helps in the synthesis of cholesterol, acetylcholine steroids, and fatty acids
Biotin	Maintains several metabolic functions
Calcium	It helps in strengthening bones and teeth, nerve conduction, and the functionality of muscle and glands
Iron	Helps in energy production, carrying oxygen to tissues
Zinc	Aids in cell reproduction, growth and development in children, wound healing, sperm production, and testosterone production
Magnesium	Aids in nerve transmission, muscular function, bone development, and premenstrual syndrome prevention
Phosphorous	Building robust bones and teeth, cell genetic material synthesis, energy formation and storage
Iodine	Regulates thyroid gland functioning

Source: Dureja et al. (2003), Chauhan et al. (2013)

habitats. Several methods and approaches for mass-controlled microalgae production (e.g. open ponds, specialised photobioreactors) have been presented. The United Nations World Food Conference in 1974 declared Spirulina to be the optimal food for the next years, and this was the first time this had been done. According to the World Health Organization (WHO), Spirulina is a desirable diet for various reasons, including its high iron and protein content and its ability to be prescribed to youngsters without posing a health risk (Geneva, Switzerland, June 8th, 1993). Chlorella and Spirulina are now available in health food stores all over the world and have gained international recognition as some of the most nutritious foods available. During the United Nations General Assembly's 65th session (Second Committee, Agenda item 52), the IIMSAM (International Institution for the Use of

Table 12.2 Common herbs and their therapeutic relevance

Herbals (botanical source)	Therapeutic activity
Aloe vera gel *(Aloe vera* L. N.L.Burm.)	Dilates capillaries, anti-inflammatory, emollient, and wound healing properties
Ephedra (*Ephedra sinica* Stapf.)	Bronchodilator, vasoconstrictor, reduces bronchial oedema
Garlic (*Allium sativum* L.)	Antibacterial, antifungal, antithrombotic, hypotensive, anti-inflammatory
Liquorice (*Glycyrrhiza glabra* L.)	Expectorant, secretolytic, treatment of peptic ulcer
Ginger (*Zingiber officinale* Rosc.)	Carminative, antiemetic, cholagogue, positive inotropic

Source: Kumar Chellappan et al. (2012)

Microalgae Spirulina Against Malnutrition) spearheaded a revised draught resolution on the "use of Spirulina to combat hunger and malnutrition."

Nutraceuticals derived from fish are yet another example of environmentally friendly nutrition solutions. During the last few years, marine sources have risen to prominence in the fields of nutrition and health, particularly for humans (Alshammari, 2019). In addition to improving health and longevity, slowing the aging process, avoiding acute and chronic diseases, and supporting the basic structures and functions of the body, fish-derived nutrition can be beneficial in a variety of ways (Ashraf et al., 2020). Long-chain polyunsaturated fatty acids (EPA and DHA), omega-3 polyunsaturated fatty acids, peptides, protein hydrolysates, amino acids, minerals, vitamins, gelatin, collagen, fish oil, fishbone, and fat-soluble vitamins make fish an excellent source of nutraceuticals (Ashraf et al., 2020), because many fish by-products are either discarded or used for low-value items despite the fact that the proteins contained in them are the same as those present in fish muscles (Muzaifa, Safriani, & Zakaria, 2012). As a general rule, fisheries waste refers to species of fish that are either of little or no commercial significance or fish that are taken in small quantities and have little commercial worth. Fish waste from the fishing industry is wasted in large quantities, causing significant environmental damage and the loss of key bioactive compounds found in the fish waste (Anais et al., 2013). Aside from that, fish companies discard around half of all fish body parts, including the head, fins, skin, and viscera, because they are deemed trash. It is estimated that approximately 5.2 million tonnes of discards are created every year in the European Union alone (Caruso, 2015). Phoenix dactylifera (L.) is one of the world's oldest and most nutritious fruits, both in terms of nutrients and historical significance. Its production and consumption yields have increased significantly in recent years, and it accounts for around 10–15% of the whole fruit manufacturing industry's total production and consumption yield. Several research has looked into the chemical composition and profile of phytochemicals that have been shown to exhibit in vitro bioactivities, and the results have been promising. A number of functional foods and beverages using date seeds have also been studied in recent years. They have the potential to play a significant role in encouraging the sustainable use of agricultural products through the utilisation of waste by-products and other by-products. The powdered date seeds have been examined for use in a variety of food recipes as a low-cost source of fibres and antioxidants that are high in minerals and nutrients (Salama et al., 2019). According to the researchers, the anti-inflammatory properties of date fruits can be linked to their high content of unsaturated fatty acids, antioxidant chemicals (vitamins E and C), and phenolic compounds (Rahmani & Aly, 2014).

Furthermore, dates have been shown to lower leg oedema and plasma fibrinogen levels (Mohamed & Al-Okbi, 2004). Additionally, date seeds have a significant amount of fibre, antioxidants, and phenolic compounds, and they are also heavy in fat and protein, making them potent anti-inflammatory food sources (Al-Farsi & Lee, 2008). In addition to promoting industrial expansion through the use of low-cost raw materials, residuals or by-products-based nutraceuticals can also be used as an innovative waste management and nutrition strategy for long-term sustainability.

6 Future Prospective

Restoration of natural ecosystems is necessary to secure a truly ecologically diverse future. Pesticides, fertilisers, and monocultures are used less frequently in less chemically intensive farming approaches. The next step in this path is to develop nutrition solutions from food waste utilising cutting-edge research and technology. Nutrition that is environmentally responsible, socioeconomically sound, and provides consumers with nutritionally adequate, safe, healthy, and affordable solutions for the current and future generations while making the most of available natural and human resources is what sustainable nutrition is all about – and nutraceuticals, particularly those derived from food waste, are an excellent fit for this requirement. Nutraceuticals have the potential to present themselves as a new paradigm in medicine, countering watchful medicine with proactive medicine, focusing on prevention, and applying nutraceuticals in conjunction with lifestyle changes and appropriate nutritional consumption, among other things. There is growing interest in alternative and more “natural” methods of pharmacologic treatment prevention for these and other reasons, as well as for better long-term health management because drugs are often perceived in the public imagination as a source of potential risk rather than a cure (Maddi et al., 2007). In any case, consideration should be given to potential danger factors associated with the use of vegetal matrixes, such as the safety of the starting material, the absence of allergenic mixtures, the truancy of toxicity, the nonappearance of exogenous and endogenous impurities, the conceivable presence of harmful auxiliary metabolites, and additionally environmental contaminations that can pose a health hazard to humans. Overall, the situation of world nutrition is in very bad way. Furthermore, sustainable nutrition is a complicated problem in which the food production system and consumer patterns play important roles. In order to build a healthy and sustainable feeding system, there is a pressing need for international cooperation.

7 Conclusion

Throughout history, nutrition has played an important role in our daily lives, involving activities such as gathering, hunting, farming, and cooking. However, eating behaviours as a driver of agricultural and food systems are frequently overlooked in study and policy (Guyomard, 2011). Despite the magnitude of the environmental crises that we are currently confronting, there is still a lot of misunderstanding and disinformation. The expansion of the economy encourages the use of non-renewable resources in an unsustainable manner. For this reason, it is critical to implement policies that boost biodiversity, limit carbon dioxide emissions into the atmosphere, and reduce oceanic acidification. Despite the fact that it has raised the living standards of billions of people, globalisation is causing serious environmental challenges that are contributing to the steady depletion of natural resources. Those who provide food services but do not follow sustainable methods can significantly negatively impact the environment due to waste generation, incorrect product and packaging disposal, the use of chemicals, and the usage of huge amounts of water during the process of preparing meals. Globally, there is increasing interest in and knowledge of sustainable meal production techniques, owing to the possibility of natural resource scarcity in the future. Food consumption is influenced by a variety of factors, including availability, accessibility, and selection. The following variables may also have an impact on these variables: geography, demography, disposable income, socioeconomic status, urbanisation, globalisation, religion, culture, marketing, and consumer attitudes. As research has progressed, it has become clear that diets can have negative consequences for the environment as well as society, as well as public health and nutrition (O'Kane, 2012). As a result, effective food policy and focused nutrition interventions are required to reduce the many forms of malnutrition present. Finding long-term and cheap nutrition solutions becomes increasingly important in view of the data and arguments presented above and the ongoing pandemic. It will take a long time to achieve this, beginning with more sustainable food production practises and progressing to the development of new scientific and technological solutions to the enduring problems of hunger and overnutrition, among other things.

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Chapter 13
Environmental Consciousness and Sustainable Development Goal with Special Reference to Public Transportation in India: A Review

Tuhin Kanti Ray

Abstract Sustainable development has been a key issue from the very beginning of Earth Summit of 1992, held at Rio de Janeiro, Brazil. Environmental consciousness is the background concept behind it. Sustainability is one of the overbearing approaches of environmental stability. The General Assembly (held at New York) on 2015 gave an ultimate form to the sustainable development goal (SDG) which has to be attained by the year 2030. The main objective of this chapter is to determine how to attain the sustainable development goal in the public transportation sector of India. Critical analysis of the National Urban Transport Policy and evaluation of the adopted or implemented measures have been considered for the attainment of the said objective. Moreover, this chapter incorporates a case study of Kolkata as a megacity of India. It is necessary for a better understanding of the local or regional level situations of the country in this regard. This study has been mainly concentrated on the public transportation, though at times para-transit modes as well as personalised transportation have been mentioned since they are very much associated with the public transportation system. In conclusion it is found that the journey towards sustainability has started with an appropriate strategy, but there are few hindrances. The big question is how to overcome these hindrances, and further after attainment of the goals, maintaining of its continuity is another challenge.

1 Introduction

Environment, the term of utmost importance of this twenty-first century so far earth is concerned as the habitat of human beings. There are more than hundreds of definitions of this term and a good number of approaches to illustrate it. Sustainable development is one of those approaches which are enormously relevant at present

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date and situation. In its simplest form 'consciousness' is the awareness of inner or outside existence of any object. It is the perception of individuals towards its surroundings. Therefore, environmental consciousness is the awareness or perception of individuals towards their surroundings. It is quite obvious that environmental consciousness is a multidimensional issue as environment itself is a multidimensional concept. Contemporary environmental researches have given the stress on the three structural components of environmental consciousness (Kluckhohn, 1962). These are cognitive components (ecological knowledge), affective components (personal emotions and evaluative attitude) and active components (instructions on the environmental actions) (Shedlovska, 2013).

Sustainable development goal (SDG) (www. undp. org) is the ultimate outcome of environmental consciousness. This goal is aiming to achieve a better as well as more maintainable future for all. Historical perspectives of SDG may be incorporated here because it is related with the progress and achievements of the goals. The journey was initiated long back ago with the Earth Summit of 1992 (United Nation, 1992) which is known as Rio conference. Next remarkable milestone of this journey was Johannesburg Declaration of 2002. It was the world summit of sustainable development. In the year 2013, the General Assembly set up to develop a proposal on SDG. In 2015, the General Assembly (held at New York) began the process of negotiation among the member countries to give an ultimate form to the SDG which has to be attained by the year 2030 (United Nation, 2015). They addressed the critical issues related to holistic environment. There are 17 goals to achieve. Among them, this chapter is concerned about affordable and clean energy in infrastructural sector with special reference to public transport (goal numbers 3, 7 and 9, 11, 12). Goal number 3 is achieving good health, seven is addressing the issues related with clean energy and nine is emphasising on green infrastructure. Whereas goal number 11 stands for inclusive, safe and sustainable cities and human settlements. Parallel to it goal number 12 ensures sustainable consumptions as well as production patterns. All of these are focusing on the sustainability of transportation system.

Before going to the technical part of this chapter, establishing the relationship between sustainable development goal and sustainability of the public transportation system should be explained. Each of the goal contains a subcomponent which relates to the development of sustainable goals in public transport sector, for example, clause (3) is on confirming healthy lives and promoting well-being for all, and its subcomponent (3. 6) is aiming to reduce the number of fatalities and injuries from road traffic accidents. Similarly clause (7. 3) targets to ensure the global rate of improvement in energy efficiency by 2030. Subcomponent (9. 1) of goal 9 and (11. 2) of goal number 11 focus on affordable and equitable access of transport infrastructure for all and providing safe and sustainable transportation for all by the improvement of road safety, respectively. Lastly, economic and rational uses of fossil fuels to reduce its environmental impact have been emphasised on subcomponent (12. c) (Table 13. 1) (United Nation, 2015).

Besides these direct targets there are some indirect targets of the SDG related with transportation which together with the direct goals ensure smooth running and management of sustainable transport in the country.

Table 13. 1 Relation between sustainable development goal and public transportation

Targets	Goals	Description
Direct	3	Confirming healthy lives and promoting well-being for all
	3. 6	To reduce the number of fatalities and injuries from road traffic accidents
	7	To ensure the affordable, reliable and sustainable energy resources for all
	7. 3	Global rate of improvement in energy efficiency by 2030
	9	Development of reliable, resilient and sustainable infrastructure to support economic development and human well-being
	9. 1	Development of reliable, resilient and sustainable infrastructure to support economic development and human well-being
	11	Inclusive, safe and sustainable cities and human settlements
	11. 2	Target of providing safe and sustainable transportation for all by the improvement of road safety
	12	Ensures sustainable consumptions as well as production patterns
	12c	Economic and rational uses of fossil fuels to reduce its environmental impact
Indirect	2. 3	Agricultural productivity
	3. 9	Air pollution
	6. 1	Safe drinking water
	11. 6	Sustainable cities
	12. 3	Food loss and waste
	13. 1	Climate change adaptation
	13. 2	Climate change mitigation

Source: *SDG,* United Nation (2015)

Why sustainable transportation? This is an important question. For the achievement of sustainable development goals, a holistic viewpoint is required that aggregates the several sectors of human habitat and environment. Public transportation is a complex space where all the sphere of physical interactions converges. Sustainable transportation fulfils the demand of social development, environmental development (including climate) and economic growth.

A next important question is why India has been chosen for the study. Answer is hidden in the situation of public transportation system, especially in the condition of urban transportation. The deteriorating condition of most of the metropolitan and megacities of India in respect of public transportation system is really a matter of concern. Here enumeration of the problems of public transportation is desirable for the searching of answer of the above-mentioned question. In Indian megacities excessive growth of population leads to crisis of land that encourages decentralisation of urban spaces, and it is the foremost reason of commutation towards city core. This is one of the major factors of increasing travel demand. As public transportations are not that adequate in terms of quality and quantity, therefore dependency on personalised vehicles has accelerated to an unprecedented level. Pressure of vehicles is very high in terms of road space and total road length. Vehicular density as well as diversity both of them is very high. Overcrowding on road space not only creates traffic hazards like excessive traffic jam or road traffic accident, but it also

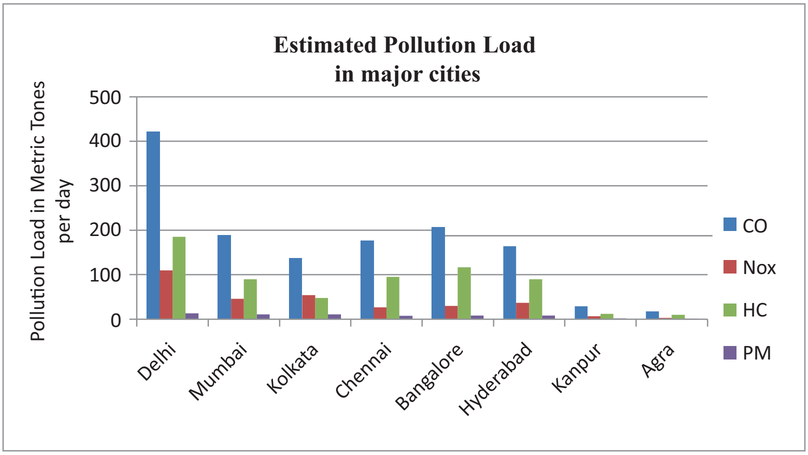

Fig. 13. 1 Estimated pollution load in major cities of India. (Source: Central Pollution Control Board, status of the vehicular pollution control programme in India (2010))

makes tremendous vehicular pollution (Khandar & Sharda, 2014). Figure 13. 1 represents estimated pollution load in megacities and two selected metro cities of India.

For a better understanding, the condition of traffic load in the same cities has been represented in Fig. 13. 2. It is observed that total estimated pollution load is more or less proportionate with the traffic load of the respective cities and it is quite obvious. It is evident from these two figures that the percentage of two wheelers and CNG vehicles are higher than the emission rate and the level of vehicular pollution is also low. Now it is clear why India has been chosen for this study.

2 Background

The main discourse of this chapter is how to achieve sustainable public transportation in India. So before discussing the sustainable solution for public transportation, discussion of the present situation of public transportation in India is essential. Public transportation is a form of travel constituted to cater local traveller along certain specific and well designated routes. It continues as a much well-organised and useful system of getting people from one place to another within a region. Suburban railway is an important component of Indian public transportation system. As it is operated mainly by government and there is some nodal authority for controlling this system, therefore a comprehensive and well-prepared data set is available for railway. Bus system is the second most important part of Indian public transportation. But there is no uniformity regarding the operation of buses and their system of service all over India. Entire bus system differs from city to city. In the absence of complete national level data on supply of bus service, we have to depend on the city wise fragmented statistics of bus fleet. It reveals a considerable growth.

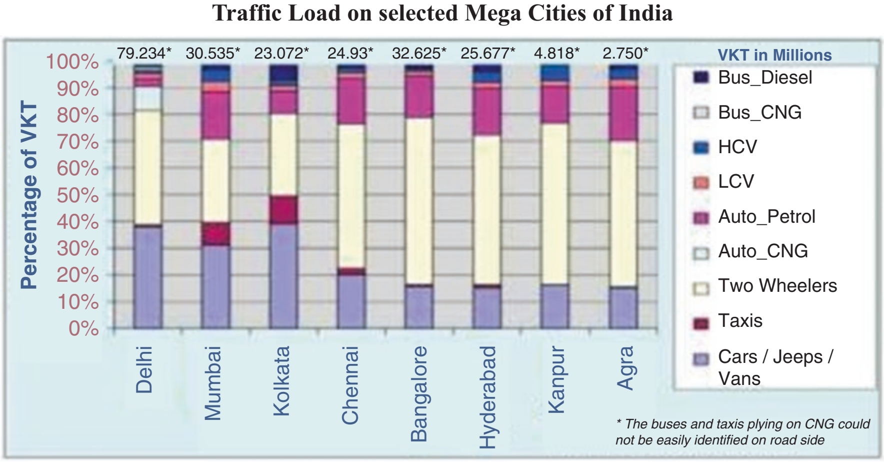

Fig. 13. 2 Traffic load on selected megacities of India

For example, in Mumbai, between 1990 and 2000, the increase of fleet was 86%; same was 54% in the city of Chennai. In case of Delhi, the number of public bus fleet truly fell, while the number of private buses increased by almost two times, yielding a net 28% increase (Association of State Road Transport Undertakings, 2002).

Bus services are responsible for 90% of public transportation in Indian cities. Certainly, majority of the Indian cities have to depend on a combination of buses, auto and cycle rickshaws and taxis as suburban railway systems are not present in all cities. In most of the cities, rail conveys only 30% (on an average) of passengers. Mumbai is an exception in this regard. India's most extensive suburban rail network has developed in Mumbai. It is carrying almost 58% of total public transport passengers of this region. (Brihanmumbai Electric Supply and Transport, 2003; Indian Railways 2002). There is a significant correlation between the total population of the city and passengers supported by the public transport services. Cities with population between one and two million support almost 30% of its daily movements by public transport modes. For the cities with populations between two and five million, the share is 42%, and same is 63% for cities with more than five million population (Sreedharan, 2003). The higher the population growth, particularly in large cities, further the increase of future transport demands in public sector. Though, there is a variation of demand for public transportation among cities of the same size category. Comparative study of percentage share of public transportation in respect of total trip reveals that in Kolkata it is almost 80%, 60% in Mumbai and 42% in both Chennai and Delhi. As compared to Kolkata and Mumbai, Delhi and Chennai have lower density since they are more polycentric and more spread out than Kolkata and Mumbai. Lower road space is another factor for the overcrowding in public transportation. For example, in Kolkata only 7% of land area is used for transportation, while in Mumbai it is 11% and 21% in Delhi.

Mixed vehicular traffic is another characteristic feature of the public transportation in India. It is one of the factors of road traffic accident in urban areas. The variety of public transport services availed by the population for moving from one location to the other differs greatly. The problem enhances since in almost all the major cities of the country there exists an unprecedented mix of vehicles (both slow moving like cycle rickshaws or battery-operated rickshaws and fast-moving vehicles like bus, cars, etc.) within the same road space. This aggravates the problems of surface movement in any Indian cities. Furthermore, suburban rail services are available only in the cities of Mumbai, Kolkata and Chennai in an extensive way. Metro railway is also another important mass rapid transportation mode, but its services are also limited to certain cities in the country. Initially Kolkata had India's only underground metro system. After that, a far wider metro has been constructed in Delhi (Delhi Metro Rail Corporation, 2003). Chennai has a hybrid surface and elevated metro, designated as mass rapid transport system (Southern Railway, 2003).

Thus few of the various problems associated with the transport sector, particularly as regards to public transportation, have been highlighted in this section.

3 Analytical Discussion

One of the objectives of National Urban Transport Policy of India is to ensure sustainable access of transport to its growing number of residents within cities. Analysis of national transport policy will show a path in searching of sustainable solutions for the public transportation sector in India.

(i) *Integration of urban land use planning and transport planning* is required to reduce the intra city travel demand in a more scientific way. In India most of the cities are very old, and they have such a layout that does not fit with the present demand of road space. Development of new town or satellite town in the adjacent part of the existing city may be a solution of this problem. This kind of integrated planning is also required for the old part of the city. As per example transport planners have to depend on the existing land use planning at the time of construction of flyover or underpass or any elevated track for metro railway.

(ii) *Coordination between state and central government* is required in integrating urban land use planning and transport planning. State level urban development and planning bodies would be required to have in-house transport planners as well as representative from transport authorities in their managements for this state and central level coordination (National Urban Transport Policy, 2019).

(iii) *Equitable allocation of road space is another solution*. Much more space should be allocated to the public transportation than is allocated at present. Carrying capacity of a bus is minimum ten times than a personalised vehicle. But it takes only two times road space than whatever is occupied by a private car.

The planner should discourage the use of more personalised vehicles, and they should encourage the use of public vehicles like bus. Enhancement of the comfort level of journey in public vehicles like bus must be a strategy for the planner. Otherwise, people have a tendency to use personalised vehicles, specifically the people who can afford it. Equitable allocation of road space will not be possible without reducing the pressure of personalised vehicles on road. Same strategy will also help to reduce per capita emission from transport sector and decrease the ecological impacts of transportation sector.

(iv) *High-capacity building* is another priority area to make public transportation more sustainable. Quantity and quality both of them have been taken into consideration for high-capacity building. Therefore, increase of carrying capacity of different transport corridor with proper safety measures is required. Central government would encourage the cities with a population of more than one million for starting planning in this regard. There must be a futuristic approach to start planning for promoting high capacity.

(v) *Sustainable financing is another important area of thought*. Any kind of capacity building project needs huge amount of investment. Before investing in such a project, judgement of financial credibility in terms of future prospect of the project is very essential.

(vi) For *efficient promoting of investments*, 50% of the project cost should come from the central government (equity participation). There is a provision of viability gap funding (to the extent of 20% of total project cost) in the national transport policy that will come from the central government. There is another funding provision that may be generated from PPP model. An attractive investment environment will encourage such private investment. Encouragement should come from central government for the making of high-capacity public transport systems through the mechanism of special purpose vehicles (SPV).

(vii) *Making of separate corridor for the various mode of para-transit* is another way to sustainable the public transportation. It is very challenging for most of the Indian cities. With the deterioration of the service quality of public transportation, para-transit has become a substitute mode. Public transportation corridor being occupied by the para- transit becomes so unmanageable from the point of view of traffic movement. Separation of the right of way is a solution to avoid the situation arising from the mixed vehicular traffic.

(viii) For the *mobility enhancement of public transportation*, construction of separate cycle track and pedestrian path is another solution. It has been taken into consideration under the National Urban Renewal Mission (NURM). This strategy will enhance safety. Pedestrian corridor and pedestrian safety are two suitable measures for smooth running of public vehicles. Adopting of these two measures also ensures the traffic safety as well as well-being of the pedestrians.

(ix) *Use of cleaner technology* like CNG has been adopted for bus services in megacities like Delhi. Electric trolley buses are also being proposed in Delhi. Such green technologies need to be encouraged to reduce the level of pollution. By implementing such technologies, we can ensure more sustainable fuel consumption.

Analysis of National Urban Transport Policy of India shows a way out for a more sustainable public transportation. Few of these already have started and the rest of them are in the phase of recommendation. This policy gives a road map for low carbon and sustainable public transportation in India. Sustainable public transportation is a challenge for the Indian megacities. In this study, Kolkata has been selected as a case study. The implemented and adopted measures for sustainable public transportation in Kolkata will be discussed in the following paragraphs.

4 Sustainable Public Transportation in Kolkata

With a population of near about 4. 5 million and with a density of more than 24 thousand per sq. km. , spread over the left bank of River Hugli, Kolkata is the major urban centre and port city of entire eastern India. Being the busiest metropolis in India and the most important commercial, educational and business centre of eastern India, it has been experiencing a rapid growth of population since time immemorial that leads to the growth of motorised transportation system with a lack of sufficient road space due to unplanned colonial growth of the city. The total road length of the city is near about 1400 km which is only 7% of the total land area. The existing street network in Kolkata consists of arterial roads, sub-arterial roads and local streets. Most of the roads are narrow and their surface conditions are not well retained. Lane discipline of traffic seldom is properly maintained. In Kolkata, arterial intersections are closely spaced and there is a lack of proper design. Here vehicles of different size, shape and carrying capacity and speed share the same right of way. The non-attention of the lane concept and movement of different types of vehicles through a single lane is a very general phenomenon in this city. The road-based passenger and goods transport system of this city mainly consists of buses, minibuses, personalised cars, auto rickshaws, taxis, motorcycles, bicycles and hand-pulled rickshaws. In a number of corridors, tramcars also share the same carriageway along with other vehicles. Furthermore, multifaceted factors in the city such as characteristics of the pavement, road geometry, nature of traffic, pedestrian behaviour, vehicle design, drivers’ behaviour and environmental aspects are the foremost reason of improper traffic interactions that lead to a intricacy in traffic management.

Measures adopted for sustainable public transportation in Kolkata The problems generated from public transportation in Kolkata are more or less similar with other megacities of India. Obviously, there are some exceptional or different issues depending on local situations. Before going to the sustainable solutions, it would be better to point out the situation-specific problems of public transportation in Kolkata. It is already mentioned that in Kolkata the percentage of land used for transportation is lesser than the other megacities of India. It is a big situational disadvantage of the city in respect of its public transportation. High vehicular density and slow-moving vehicles with a prolonged duration of traffic congestion are the problematic issues generated from the shortage of road space. All these lead to a travel delay as well as monetary loss. There is a problem related road alignment as well, i. e. all the roads converge towards city centre, thus develops such an unmanageable condition in traffic, that transport needs immediate consideration. Urban morphology of Kolkata is the outcome of its colonial legacy, and undoubtedly there was lack of transport planning, whereby the streets do not follow a regular pattern, instead though integrated has developed haphazardly. Another issue is the peninsular location of the city like Mumbai. The city of Kolkata does not have the scope of further growth towards east or west. As a result, urban sprawling is happening towards north or southward. This makes difficulties in public transportation especially difficulties to connect the city core with its northern and southern suburban areas.

What would be the targets or objectives of the sustainable public transportation strategy may be fixed out from the above discussion. Few objectives are very common with the sustainable transportation plan of any other megacities of India. Reducing levels of vehicular pollution, traffic congestion, traffic accidents and total energy consumptions are such type of objectives. The rest of the targets have to be set from regional demand, like enhancement of metro connectivity, increasing the road space and introducing separate corridor for para mode of transit.

To delve into the solutions of these burgeoning problems of the city, certain issues may be highlighted. Thus, this section would discuss the measures that have already been adopted and whatever is in the phase of suggestion or recommendations.

(i) *Metro railway* is a good example of green transport in terms of types of energy used and environmental pollution. But in spite of this fact, it is not fully sustainable. If sustainability in respect of the ratio of total investment and total passengers that it supports is measured, then it is observed that there exists a huge gap. Another problem is related with the connectivity with two major railway stations (Howrah and Sealdah) of the city. East-west metro presently has started its service, but yet these two railway stations are not connected with the existing metro railway system. In fact, few of the metro railway stations are only connected by the para-transit mode.
(ii) *Flyovers, railway over bridge and expressways* (collectively known as elevated road ways) are another group of sustainable solutions to the public transportation. Any kind of overview about their success or failures will be a mere generalisation. In few places their construction was very appropriate decision, and they are providing very effective services. In contrast few of them are unable to solve the problem of traffic rather the situation in those places has remained unchanged, particularly because in these places after the construction of elevated road ways, travel demand has also enhanced further.
(iii) *Air condition buses* have already started to provide services in a good number of routes. This is a very good strategy to cater the service to the passengers of higher affordability. Enhancement of the service quality of public transportation is required for reducing the level of uses of personalised vehicles. But the supply side of this service is not sufficient as compare to the demand. Average

financial credibility of the passengers or commuters has increased enhancing the tendency of using personal car. It is reflected form the increasing uses of cab or rental car services.

(iv) *Uses of CNG or LPG* yet has not been popularised in this city. Very few auto rickshaws (one of the para mode of transit) run on CNG. But in public transportation sector (particularly for bus services), uses of low emission fuel are very much limited. But suburban railway, tram and metro railway run on electricity. It may be mentioned here that majorly vehicular pollution is generated from the buses and taxis (public transportation) and private cars (personalised vehicles). Combining electric mobility with the uses of CNG might be better solution for bus services. Electric bus service is one of the way to combat with the air and noise pollution as they do not consume fossil fuel and these are almost silent. In the year of 2018, the E-bus services was initiated by the West Bengal Housing Infrastructure Development Corporation Limited (WBHIDCO) within Rajarhat Newtown. But though it was quite popular among the commuters due to their high comfort level and lower level of pollution, yet these buses running on the streets were highly inadequate and could not meet the demand of passengers, who on the other hand had to depend frequently on other types of public transport modes in the city. In 2021, the situation has been changed little bit and at present there are 75 intra-city E-buses owned and run by West Bengal Transport Corporation (WBTC) in various routes of KMA, in collaboration with Coal India Limited. These electric buses are very much cost effective as the operating cost is very negligible in compare to the diesel engine A. C buses. A study (Basu R. et all) conducted on electric bus operation in Kolkata reveals the comparative cost effectivity of electric buses from the perspective of ownership and energy.

(v) *Sustainable financing* is required for bus services and metro railway services. Public- private participation model is a very popular concept. Here, first phase of metro railway was entirely financed by the central government. There was a percentage share of state in total funding for the construction of 'East-West metro railway'. For reorganising the funding system for bus services, private-public participation has been encouraged through JNNURM project.

(vi) *Encouraging the existing inland water transport* may be a significant solution for public transportation system in Kolkata. This kind of transportation will be free from congestion and traffic jam. By avoiding traffic jam inland ferry services reduce the cost of time loss and alongside it also improves air quality by reducing the carbon emission. Operating cost and fare rate is also not very high in comparison to the other modes of transportation that also ensures the financial sustainability of this type of inland water services (Dey, 2013) in Kolkata.

(vii) Initiation of cycle routes and services might be a good solution for green transportation in Kolkata. In Kolkata cycling used to be banned in 178 roads earlier. Presently it is applicable for the 62 arterial roads of the city (Chanda, 2021). In spite of it, on an average, Kolkata and its suburbs records 1. 68 million cyclist and 2. 5 million cycle trips per day. Cyclist are being considered as one of the factors of traffic fatality by Kolkata Police, it has been seen during 2008 and

2020 cyclist death have remained almost same and it was only 6 percent of total fatality (Kolkata Police, 2020). It indicates cycle is not one of those crucial factors responsible for road fatality and restriction on cycle should be encouraged with required restrictions. Several vehicular counting during peak traffic hours on city's road have revealed that the share of cycle is very insignificant in comparison to the other motorized vehicles (Chanda, 2021). During covid period, the primary initiative has been taken by the New Town Kolkata Development Authority from the year of 2020. Notification issued for mandatory free Bi-Cycle parking in residential complexes and Govt. offices. This project was based on participatory planning and feedback accumulation through multiple interactive sessions conducted with officials and residents of New Town for the identifications of citizen needs, major issues and implementation of feedback. Bi cycle services are very much environmentally as well as economically viable. Before issuing order, multiple interactive session conducted with the socio-economically poorer section those who commute to the city for their livelihood on a regular basis. This project has been supported by the various infrastructural development like development of cycle stand along the major corridor of new town and construction of safe cycle routes having Graded & At-grade tracks. These track are well equipped with the proper modal segregation, adequate lighting and safe intersections. Even during covid situations, workshops were conducted under govt. initiatives to train the people on using bicycles (New Town Kolkata Green Smart City, 2021).

5 Conclusion

Environmental consciousness is an integral part of sustainable development goal. This chapter tried to delve into the ways of implementing the sustainable solutions for the public transportation sector in India. Analytical discussions of the situation in India and the kind of measures that have been adopted for the country show a partial picture. Therefore, analytical study for the city of Kolkata has been taken into consideration as a case study. Strategies, whatever have been adopted or implemented, are relevant to achieve the sustainable development goal. It is quite obvious that national planning is done from an apex body, but for their implementation, regional level modification and changes are required depending on the local situation. Study of Kolkata would help us to understand the regionalisation of the planning objectives to attain the local level sustainability in public transportation. Actually, the basis of the regional level sustainable planning strategies is related with the national level as well as global level issues and strategies. Environmental consciousness is not a fragmented concept as environment itself is a holistic concept. Public transportation is a global issue with its burgeoning demand, but its degree of coping with the environment must be treated from local (base level) to global (apex) level. Sustainability in public transportation is a dream to achieve a clean and healthy life. The time limit is 2030. By the time India as a nation and

Kolkata as city will attempt to reach the mark which is technically known as sustainable development. After achieving this goal there would be another responsibility of maintaining this sustainable situation. That of course is a greater challenge.

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Chapter 14
Pandemic, Resilience and Sustainability: Agroecology and Local Food System as the Way Forward

Pushpa Singh

Abstract Amid the unprecedented crisis created by COVID-19, there has been a renewed interest in agroecology and the local food system as a long-term solution to such unforeseen adversity. The crisis exposed the fragility and systemic limitations of the contemporary patterns of food and farming defined by the global network of agricultural and food systems on which there is tremendous reliance. It is the highly centralised resource and capital-intensive nature of modern industrial agriculture that makes it more vulnerable in face of pandemic-like situation. As evident, highly restricted mobility, severely disrupted chains of transportation and distribution and labour shortage resulted in hindered accessibility to essential food, vegetables and dairy products for communities across the world. Though all sectors of economy have been adversely impacted, losses in agriculture have heightened the fleeting food security in the Global South. Contrary to this, agroecological systems, primarily followed by small holders practicing diverse cropping patterns and reaching consumers through local supply chains, appeared resilient vis-à-vis large farmers and big agriculture. Agroecological farming encompasses the diversity of food crops that does not only fulfil the calorie requirement as by food produced from industrial agriculture but also provides the essential nutritional security and palatability. As the food system is also embedded in cultural and local socio-economic systems, a re-localisation of food movement would make the food systems more just and secure. This chapter aims to foreground the agroecological perspective on food and farming that require revisiting our understanding as well as vision of agriculture and agrarian developments in light of COVID-19 to make it local, diverse, resilient and sustainable.

Keywords Agroecology · COVID-19 · Local food system · Resilience · Smallholders · Sustainability

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1 Introduction

The unprecedented crisis of COVID-19 that the world has been through has exposed the deep vulnerability, and vagaries of external input-intensive industrial models of agriculture and food systems have been exposed like never before. The imposition of nationwide lockdown that initially started for 21 days on 24 March 2020 was followed by many extensions and conditional relaxations. It caused disruption and immense hardship in all sectors of production and distribution. Like other sectors, agriculture has been adversely impacted due to a range of factors. Panic-stricken farm workers began exodus to their native place as most of them happened to be migrants from other states, creating a severe labour shortage. Due to highly restricted mobility, the farm machineries and other associated requirements became inaccessible and unavailable. Along with the chains of production, the chains of distribution also got hampered. Though the precariousness of farming conditions in India is well known, the pandemic severely impacted the production and magnified the food and nutritional insecurity, especially for the poor and vulnerable. It is believed that the modern industrialised agriculture, due its overreliance on external inputs and overtly centralised and homogenised structure of production and distribution, is highly fragile to the pandemic-like situation. Conventional farming is capital and input-intensive; with huge carbon footprints, it is not only unsustainable in the longer run but is also embedded in the matrix of deep inequity and injustices. In a way, COVID-19 pandemic has arisen from the folds of our contemporary food system. Since the green revolution, commercial agriculture has been aggressively expanding by clearing the forests. As a result, there has been increasing interspecies proximity between human and wildlife leading to a spate of infectious diseases like HIV/AIDS, SARS, Ebola and Nipah since the 1940s and COVID-19 in recent times. Likewise, many lethal zoonotic diseases are transmitted across species due to intensive livestock farming, particularly pig farming, due to their confined rearing and genetic homogeneity (GRAIN, 2020). Coronavirus is also believed to have infected humans because of shrinking interspecies distance and from loss of bat habitat.

Whereas big agriculture faced immense challenges, small holders with diverse cropping patterns and local supply chains functioned relatively well because of its utilisation of family labour and on-farm inputs. Agroecological farming practices display complex adaptive systems by using community-supported agriculture operations (CSAs), backyard food production, multiple cropping and native seeds (Jardhary; Worstell, 2020). Hence, they appear resilient vis-à-vis medium and large farmers due to their least dependence on external sources. In fact, diversified farming systems and mobilisations around food sovereignty are fast emerging as a countermovement to the monopoly of industrial agriculture (Holt-Giménez & Altieri, 2013). Diversified farming systems deploy agroecological principles and whole system approach. By utilising the synergies of the biological processes, natural resources and indigenous knowledge, they reduce not only the cost but also the negative externalities of the system. Most of such farming practices are engaged in local production and have localised chain of distribution. Unlike the industrialised monocultures based on a very long chain of transportation involving wastage and loss of nutrition of the edibles, the agroecological models work on 'grow locally, consume locally' rule. The disruption created by the COVID-19 establishes beyond doubt that the resilience of the food system should be one of the most crucial parameters to assess the degree of success and desirability of any agricultural system. Resilience denotes the capacity of a system to recuperate from crises such as adverse shocks arising from natural calamities, wars and conflicts, epidemics and such other challenges while maintaining its function and identity. It reduces the risk and vulnerability and provides stability to the system. Therefore, it is pertinent to engage with critical analysis of the dominant agricultural framework and the existing alternatives to generate a wider perspective for overall resilience of the society.

This chapter is structured into three parts. The first part analyses agricultural modernisation to explore if the fragility of the agricultural sector is interlinked with its very process of development. The second part will highlight issues of human health and sustainability arising out of the environmental trade-off in the green revolution, and the third part will explore the sustainable and resilient alternative farming systems practiced in India, and the last part concludes the arguments.

2 The Discourse of Agricultural Modernism in India: A Critical Inquiry

To understand the problem of contemporary food and farming systems, it is mandated to visit the process of agricultural modernisation from a historical perspective. As discussed above, the centralising and homogenizing approach has been endemic to the planning and conceptualisation of the process of agricultural modernisation in India. The agricultural narrative of colonial and post-colonial India remains deeply entrenched in the ideas of productivism (Singh, 2021a). This vision of agricultural development is guided by food insufficiency, and increasing production is seen as the only solution while not paying equal attention to the other variables that may be shaping the food problem (Raina, 2015). Given the legacy of recurrent famines and rampant poverty, it was imperative for the newly independent Indian state to focus completely on increasing food production (Gupta, 1998). However, this was an uphill task. When India was struggling with food insufficiency, agriculture was doing extraordinarily well globally in the post-Second World War period due to scientific advancement and technological innovations. Especially, some of the advanced industrial countries like the United State (US) were performing exceptionally well on farm production. India was highly impressed by exceptional performance of America's agricultural development based on Tennessee Valley Authority (TVA) model and was eager to emulate it.[1] Driven by a mixed feeling of

[1] TVA was created in 1933 in United States as a state enterprise to bolster economic development of the country by providing managing flood control, fertiliser manufacturing, electricity generation, etc. that together boosted the agriculture and economy. It became a model of development for rest of the world.

philanthropism, global dominance and averting the communist takeover of the Asian region, the United States along with some of its philanthropic organisations like the Ford Foundation and The Rockefeller Foundation was willing to extend these technologies to India and such other countries from the developing world (Perkins, 1997; Cullather, 2010). Besides, a larger objective of developing agriculture on the lines of pro-market capitalist development and countering communism in the countries of Asia and Africa guided allocation of substantial funds for technical aid and other assistance (Saha, 2013).

India got entangled in a relationship with the United States for the food imports and assistance in agricultural modernisation. In this way, modern industrial agriculture took off in India with the aid and assistance of the US government along with two eminent private foundations in the form of bilateral treaty known as the Indo-American Technical Agreement signed by the US government and the Government of India (GOI) in 1952 under the aegis of technical cooperation programme (TCP, 1950).[2] In the beginning, the GOI adopted a holistic rural development approach targeting the social and economic transformation of agrarian life and launched community development programme (CDP) in 1951.[3] Agricultural improvements were expected to be achieved by the use of improved seeds, fertilisers, irrigation and farming tools. Simultaneously, large-scale dams and irrigation projects like Hirakud project in Odisha, Mayurakshi project (West Bengal), Damodar Valley project (West Bengal) and many others were undertaken for construction of multipurpose dams for irrigation.

However, as CDP was taking very long to show the expected result, the GOI signed an agreement with The Rockefeller Foundation to accelerate the agricultural improvement on lines of the American land-grant universities. Under this agreement there were provisions for Indian scientists to be trained in the United States and US scientists being stationed in Indian agricultural universities for teaching and research (Borthakur & Singh, 2013). While these arrangements were worked out, the country was still food deficit and at the door of Pakistani incursions in western India in 1965. The government signed an agreement with the United States under Public Law-480 in 1956 and imported millions of tons of wheat to avert any crisis (Dreze, 1988). But this created an exigency resulting in immediate adoption of hybrid high-yielding varieties (HYVs) crops along with the improved seeds, fertilisers, irrigation and credits for the farmers to avail these under Intensive Agriculture Development Programme (IADP) 1961. In the beginning HYVs could not succeed well due to the problem of lodging on heavy application of fertiliser, which was

[2] The objective of this bilateral treaty was to provide assistance and extension of agricultural research and education. To facilitate this process, a joint fund was created to provide modern farm machineries and technicians. The success story of high production of corn and wheat in case of Mexico by America was projected by it as a solution to the undeveloped rural agrarian systems of the developing societies.

[3] Community development programme was a wide-ranging programme launched by the GOI targeting rural welfare that covered 55 projects related to agriculture, animal husbandry, rural housing, education and so on. It aimed at rural reconstruction.

addressed by developing an optimal wheat hybrid by M. S. Swaminathan in 1964. After this, there was no looking back. The agricultural research institutes in India multiplied these optimal hybrids and distributed them among farmers in the targeted regions with high irrigation availability. A comprehensive programme of incentives, capitalist investments and production around these seeds were developed with the state-funded agricultural infrastructure for their widespread diffusion. As a result, the country witnessed an enormous increase in the grain yield enabled by the new technology that provided the much required food security by the 1970s. This phenomenon of internationally supported agricultural transformation that became successful due to symbiotic synergy between industry, state and commodity markets is called the green revolution. Centralised structures of agricultural research and extension, government organisations and agencies were created to diffuse the green revolution. Enormous state support was granted in form of subsidies and supportive policies to this particular model of agriculture. Henceforth, agricultural development became synonymous with large-scale export-oriented mass production in India, functionalised through centralised framework of agriculture. Mass production and distribution became the key idea guiding agricultural scientists and policymakers, and in the process, other existing agroecological farming practices were completely ignored (Kumar, 2019). However, diverting all public resources to the promotion of conventional agriculture and the neglect of alternative farming practices made the whole system unsustainable in the longer run as discussed in the section below.

3 Implications for Sustainability, Food Security and Farmer's Autonomy

There is no denial of the fact that the green revolution resulted in more than doubling of food production in the developing world between 1960 and 1985 (Conway, 1997). However, the bountiful harvest came at a huge environmental cost, and very soon serious concerns about issues of sustainability and social equity were raised against this model of agricultural modernisation. The criticisms also highlight how it was less driven by humanitarian consideration but more by geopolitical interest to keep communism at bay in Asia (Perkins, 1997; Cullather, 2010; Harwood, 2019). The underlying objective of the green revolution was promotion of the use of commercial agricultural inputs among farmers to raise production (Patel, 2013). In due course of time, the excessive use of agrochemicals and high demand for irrigation resulted in irreversible environmental degradation. The pests became immune to the pesticides in the evolutionary treadmill, and in desperation more chemicals were put in the fields by the farmers. The balance between the prey pest and predator got disrupted leading to a surge in one kind of pest that attacks specific crops hindering their production (John & Babu, 2021). The indiscriminate use of pesticides has led to large-scale contamination of water, soil and air and, eventually, to spike in cancer cases and several health issues in the pockets where the green revolution was implemented on large scale. For instance, the water quality index (WQI) of 80 per cent of the samples from Malwa region of Punjab was found to be massively contaminated with nitrate magnesium, fluorine and phosphates due to agrochemicals and unfit for drinking as highlighted by the study published recently in the *Arabian Journal of Geosciences*.[4] These chemicals are making the children of this region vulnerable to a blood disorder disease methemoglobinemia, in which insufficient oxygen is delivered to cells (Kukreti, 2018). The agricultural run-off poses particular risks to women as they are more exposed due to their responsibility for fetching water and firewood in many regions (Agarwal, 1992) and also causes death of aquatic plants and animals. Women become vulnerable to a host of diseases like hypothyroidism caused by DDT, leukaemia and Parkinson's disease. Pesticide use has been causing more harm than good as it is sprayed mostly by the untrained farm labourers without proper instructions and precautions, pumping much higher doses than the permissible level (Behal, 2020).

The green revolution promoted large-scale monocultures of hybrid varieties of the selected crops like wheat and rice. The aggressive diffusion of hybrids resulted in gradual disappearance of indigenous varieties due to their non-cultivation, and in process, almost one lakh native crop varieties were lost (Prasad, 2016). Traditionally grown sustenance crops like millets, sorghum, pulses and oilseed crops were replaced by a handful of hybrids altering the food production and consumption practices of the country. Export-oriented monocultures of few crops decreased the local food security and the nutritional diversity of the food. Albeit the enhanced production, the increase was only in the calorific value of the food, whereas the nutritional value declined critically. The concentration in the production and food supply chains creates heavy dependence on a handful of foods. Despite the rich global biodiversity that offers 50,000 edible plants in the world, the green revolution technology-based monocultures have resulted in their eventual wiping out, leaving only three choices, rice, corn and wheat. The hybrids have a narrow genetic base, making them susceptible to pest attacks and other biotic and abiotic stress. This makes it prone to crop failures. Additionally, the intensive cropping system with repetition of crop cycles leaves very little or no window between the cycles, depleting the nutrient of the soil (Srivastava et al., 2020). The heavy metals from the inorganic fertilisers and pesticides like Cd (cadmium), Pb (lead) and As (arsenic) contaminate the soil, while the weedicide and herbicide upset the soil's pH balance (Sharma & Singhvi, 2017). The chemicals destroy the beneficial pathogens; the soil gradually loses its microbiome and ultimately its fertility. A study on soil in Haryana found the soil there to be highly deteriorated due to excessive salinity, water logging and soil erosion making it unfertile (Singh, 2000). This kind of soil damage and water depletion would directly create immense food insecurity in the future.

[4] For details, refer https://www.downtoearth.org.in/news/agriculture/80-groundwater-in-punjab-s-malwa-unfit-for-drinking-60951, accessed 20.11.21.

Apart from the environmental and health crisis resulting from the phenomenon, many critics view the green revolution as the most favourable tool to extend capitalism in the new economies (Cleaver, 1974; Akram-Lodhi, 2013). The agriculture was reorganised to fit within industrial capitalist conditions so that it can become another avenue for profiteering (Fitzgerald, 2003). This was achieved through integrating the industrial logic into agriculture with the help of expert knowledge and agricultural university centres, industrial-scale production of fertilisers and pesticides, mechanisation and export-destined monocultures (Flach, 2016). In fact, since the beginning, the design of the green revolution represented support to an entrepreneurial mode of production and aggressive commercialisation, catering to the world market rather than to local subsistence needs (Cleaver, 1974). Concerted efforts were made to mould agricultural production as a strictly business enterprise similar to industry, and The Rockefeller Foundation was designing this shift in India by the 1960s (Loomis, 1976). Massive external pressure made the Indian elite to legislate policies in sync with free-market capitalism (Varshney, 1998). By late 1970s and 1980s, rapid commercialisation and commodification of agriculture took place, which gradually intensified in the subsequent decades (Shiva, 2000; Patel, 2013). The monopolistic agricultural markets have disrupted the traditional markets based on farmer's informal seed system making the farmers dependent on the companies for their agricultural inputs. The seed, which is the foundation of our food system, is aggressively brought under private enclosure through intellectual property rights, patents and royalties imposed by the world trade regimes. Concerted efforts have transformed agriculture into an industrial pursuit aimed as profiteering, enabled by newer research, especially in the field of transgenics spearheaded by agribusiness. The new agricultural regime has grave implications for seed sovereignty for the farmers across the world.

The new model of agriculture resulted in acute market dependencies for farmers, posing serious concerns for issues of food security and farmer's autonomy. Since the seed-fertiliser revolution, there has been construction of a corporate food regime in the Global South leading to creation of monopolies and cartels of multinational agro-enterprises. Driven by the advantage of economies of scale and globalisation of the food chain, these agribusiness corporations have consolidated vertically and horizontally by taking over the entire market of agriculture (World Development report, 2008). These firms supply all the inputs on the production front such as seed, fertiliser and pesticide as well as on the distribution front through food processing, storage and retailing through supermarkets. They sell the agricultural inputs as a package, seed-fertiliser-pesticide which caters to the wealthier farmers and is way beyond the means of smallholders. The impacts of the new system, which has corporate agribusinesses at its centre, were unevenly distributed on different classes of farmers. It was often the well-connected, affluent and networked farmers sharing proximity with agricultural officers who could adopt this technology because of their access to knowledge and capital to invest in it. These farmers received greater returns and bought more lands in the countryside as they became more profitable, while the poor resourceless farmers were forced out of farming, further adding to the class divide among the farmers and severing issues of social inequity (Byres, 1981).

The harmful implications of the green revolution have been ignored as negative externalities, but they are still persisting. In hindsight, it became very clear that the high-input industrial model of agriculture, though was crucial in ensuring food security in the past, is not sustainable in the longer run. On the other hand, there have been alternative agricultural techniques and practices prevalent in all parts of the world that are sustainable due to its wise and frugal utilisation of the critical resources. Such practices offer the most viable solutions to the contemporary crisis in agriculture, discussed in the section below.

4 The Way Forward: Agroecology, Resilience and Local Food Systems

With the rapidly depleting non-renewable resources and biodiversity on one hand and the increasing monopoly of the corporate food regime on the other hand, the limits of conventional agriculture appear more pronounced today. The exigency created by climate change is exacerbating the adversity. Additionally, the crisis of COVID-19 has exposed the systemic weakness of globalised farming and food systems like never before due to the loss of livelihood, issues of access and availability, causing the greatest hardships to the most vulnerable communities (Singh, 2021a, b, c). The pandemic heightened the food insecurity due to unavailability, hindered access and affordability of the food. The failure of production and supply chain distribution owes to the very structure of our current food system, highlighting the limitation of overdependence on them. In light of these crises, there is a necessity to rethink our contemporary system of food and farming to adapt it with the changing needs and resource optimisation. Hence, the urgent need to search for alternatives based on balance between the production outputs, biodiversity conservation, nutritional diversity and livelihoods has become exigent. With this backdrop the world is witnessing the emergence of many food sovereignty movements and diverse farming practices embedded in agroecology in many regions. The alternative voices stress that while agricultural production needs to be sustained, it simultaneously needs to ensure the provision of various vital ecosystem services and resource conservation.

Agricultural production and distribution have become highly concentrated and centralised through global food supply chains since the seed-fertiliser revolution. The prohibited mobility due to COVID-19 disrupted the functioning of these globally integrated markets. Obstruction of the supply chain enfeebled the already fragile food security in various ways. India has 45.6 crore migrants because a considerable number of people migrate to cities in search of livelihoods and better job prospects (Census of India, 2001). Prohibited interstate movements imposed by the lockdown at the end of March 2020 due to COVID-19 created a panic and resulted in massive reverse migration, as the workers tried to return to their native places (Kapil, 2020). This reverse migration has been marked as the second largest mass migration in the history of India since the independence and partition in 1947

(Mukhra et al., 2020). The agriculture of some of the states like Punjab and Haryana is largely dependent on the in-migrants from states like Uttar Pradesh and Bihar primarily for agricultural works (Census of India, 2001). These workers take care of a variety of tasks like tilling, sowing, transplantation, pesticide and weedicide application according to needs of crops, packing and delivering fruits, vegetables and crops to specific destinations. Many migrant workers possess skilled farm and cultivation knowledge for the paddy cultivation, especially the labour-intensive backwards walking in the paddy fields, which makes them highly sought after by the farmers from Punjab and Haryana (Chaba, 2020). In the season of paddy transplantation and harvesting, many workers migrate temporarily to Punjab and Haryana to earn money that sustains them for some months. In 2020, however, all those migrating to states like Punjab, Haryana and Madhya Pradesh in the months of February and March got stranded in the lockdown and lost their livelihood due to complete shutdown. Once they managed to reach their native places, they did not return back to the cities due to looming uncertainties affecting farm operations. While this created widespread labour shortage in states dependent on migrant labourers like Punjab, fears of joblessness arose in rural hinterlands of the states with less resources.

Due to loss of income, vulnerable sections like migrant workers were immensely impacted by the withering food and nutritional security in the times of COVID-19. Food security has been defined as 'physical social and economic accessibility of all people at all times to sufficient, safe and nutritious food based on their dietary needs and food preferences' (FAO, 2003a, b). While food security remained a crucial concern for all, the vulnerable communities like women, children and migrants suffered more due to lack of safety nets and social, cultural and economic barriers. India has 90 per cent of the workforce engaged in the informal economy and without the safety in the pandemic; about 400 million workers had been at risk of falling deeper into poverty (ILO, 2020). In general, the food and nutritional security have significantly declined because of wider adoption of processed-packaged products and poor diet (State of Food Security and Nutrition in the World, 2020). This contagious disease is most likely to persist, and the effective solution lies in improving immunity through nutritious food. However, the food that we get from the industrial food systems are aimed at generating huge profits by reducing production time and costs while significantly increasing the volume of commodities produced. This production model is ignorant of the nutrition and health value of its product and is seen as responsible for the rising cases of obesity and other health disorders. There has been widespread food markets disruption and sharp rise in food prices. For example, some vegetable prices like that of tomatoes increased by 77–78% resulting in the reduction of daily food intake of migrant workers and poor people, altering their pattern of consumption (Cariappa et al., 2020). The consumption of poultry meat also steeply declined during this time in the country.

On the other hand, uncertainty imposed by the crises resulted in the interruptions of supply chain due to absence of employees from work, halting the progression of food from producers to buyers. This caused massive wastage of food products like milk and eggs, increase in intake of highly processed foods and collapse of markets ending livelihoods of millions of producers worldwide (Richardson, 2020). The absence of the workforce, illness and immobility reduced the capacity of firms, and food essentials like vegetable, milk and other edibles could not be transported from the production sites to the consumers. Gallons of milk were destroyed on the field by the dairy farmers due to restrictions. The failing of the health care and food supply chain became more noticeable in all the countries in the times of COVID-19 because of their overreliance on international sourcing of items, movements of food and medicine in extended supply chains (Nabhan, 2020).

All these adversities only prove the urgency to reform our food and farming system to make it resilient and sustainable. Contrary to the industrial production system that causes a range of economic, environmental and social problems, the agroecological production is resource-wise and utilises the synergies of biological systems along with the innovative soil management practices that increase crop biomass production. Agroecological agriculture is based on the mobilisation of the ecological functionalities of agricultural systems, the optimisation of natural processes and the frugal management of resources. It employs principles of intercropping, mixed cropping and mixed crop-livestock system and has been noted to improve soil organic carbon components naturally. Several sustainable ways of land use, like the agroecosystem, agroforestry, conservation agriculture and integrated soil and nutrient management systems that are carbon smart technologies, enhance the crop productivity and overall resilience of farming process (Van den Putte et al., 2010). However, resilience is a context-dependent multidimensional process and requires to be evaluated applying multiple tools that factor in the particularities of each agricultural system (Dwiartama, 2014). This implies that there cannot be generic models and universal measures to induce resilience; rather each food system has to evolve these conditions based on their geographical, ecological, social and cultural contexts (Babu & Blom, 2014). Ecologically based production systems encourage the grassroot approach instead of 'top-down' standardised technical operations. Hence, decentralised production and distribution systems would work more efficiently by working in consonance with the local dynamics. While decentralisation minimises the ecological effect by reducing the transportation and storage costs, it also provides adaptability in the supply chain and allows people to procure natural and fresh items (Barman et al., 2021). As reported by FAO, 'an unacceptably high proportion of food is lost along the food supply chain before it reaches the consumers, amounting to over 400 billion USD every year' (FAO, 2021). Decentralisation will lower the production costs and will enhance the efficiency by minimising the wastage.

The Global South displays a microcosm of traditional and subsistence farming that has not only been producing food sustainably but also saving biodiversity and natural resources (FAO & IFAD, 2019). India alone accounts for 23 per cent of the world's small farms growing local cultivars under mostly rain-fed conditions. By cultivating the landraces and heirloom varieties, these farmers serve as the greatest custodian of agrobiodiversity. A diversity of locally adapted native crops provides crop insurance against drought, pest, disease and other reasons of crop failures. On the other hand, modern varieties possess a very thin genetic base which makes them susceptible to all kinds of biotic and abiotic stress. The genetic variability of heirloom varieties makes them a crucial source for varietal improvement programmes in agricultural research and hence must be conserved in face of aggressive onslaught of hybrids and transgenics. The world has already lost 73 per cent of the genetic diversity of local animal breeds (FAO, 2021). Conserving diversity is vital as it will help farmers rear varieties adapted to local environments.

The popular prejudice against the small family farms projects them as unproductive and obsolete by only considering the yield of the crop. But this assessment is flawed as it does not factor in the hidden cost and the carbon footprint of the monocultures in the high-production models. On the contrary, the small farms can be counted as more productive than large farms if total output is considered rather than yield from a single crop (Altieri, 2009). Therefore, a new way of assessing the performances of production requires a different kind of logic of innovation. The small-scale agriculture applies the rationale of eco-efficiency and is operationalised by smallholders; a majority of them include women. They employ indigenous knowledge and develop new strategies and hands-on field innovations to tackle social, economic and environmental challenges. Contrary to the popular perception, small farmers by managing the resources efficiently can also generate profit per unit of output and enhance the overall profit despite lower production of each commodity (Rosset, 1999). A paradigm shift towards the intensification of smallholder-led agroecological productivity gains requires affirmative policies to support family farmers. It will also check the outmigration of farm workers to cities where they lead their life without sufficient health care and employment. One of the important aspects of sustainable food production is addressing the issue of gender gap in agriculture found across all countries but is more pronounced in the Global South. Gender gap denotes the absence of or unequal ownership or access to land and other resources crucial for farming. Without addressing the widespread discrimination faced by women in the agriculture, the food systems would not have gender equity and not be viable by excluding half of the world population. In addition to increasing overall agricultural production, closing the gender gap in agriculture would lead to improving health, nutrition and overall well-being of the women in the society.

5 Conclusion

This chapter strongly recommends the integration, upscaling and sustainable intensification of agroecological farming practices to minimise the risk and vulnerabilities arising due to pandemic-like unforeseen conditions. While industrial production can certainly present some economies of scale, it can also elevate the extent of risk. Now that crop and varietal diversification is increasingly acknowledged as a crucial adaptation strategy, financial and policy support appears exigent to mainstream such endeavours. Local food and farming systems build up the strategies of resilience intrinsic to their system with meagre local resources and indigenous knowledge. The new scientific technological innovations must intertwine the research with the local indigenous knowledge with the lab-oriented research with collaborative sharing between universities, research centres and the farmers. No doubt, productivity has to be enhanced to cater to the rising population, but it has to do so without reproducing the impasses and social, nutritional and environmental impacts of the green revolution's productivist models. The most important objective for the food systems remains the attainment of resilience and sustainability, which apparently lies in the agroecological decentralised local production system as discussed in this chapter.

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Chapter 15
Integrated Water Resources Management and Urban Sustainability

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Abstract Environmental reports have revealed that many issues interfere with rainfall occurrence and that impact the hydrological cycle. As urban population is tending to increase in the world, so are the risks of food, energy, and water security (FEW nexus) and natural disasters. Anthropic activities also interfere with water resources. Water issues have potential to raise conflicts, impact food and energy supplies, as well as ecosystems and human health, and lead to environmental degradation, with the potential to force the migration of large contingents. It is very important to have an effective integrated water resources management (IWRM) to reduce the risks and guarantee water for future generations. The main objective of this chapter is to present and discuss challenges and best practices of IWRM, such as the increase of green infrastructure, sanitation universal coverage, as well as to reveal major potential risks such as conflicts over water, hydric crisis, and natural disaster hazards. Materials and methods include narrative and systematic literature review using important data collections such as Web of Science and Scopus and other smaller but focused databases, including grey literature. Findings are organized in boxes revealing risks, challenges, and potential practices to be adopted in IWRM toward sustainable development to secure water availability and quality. This chapter also emphasizes targeted actions to enhance governance, preparedness, prevention, adaptation, mitigation, and response to water-related natural disasters, as well as to improve cities' resilience.

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1 Urban Sustainability and Water Concerns

Urban populations of the developing world are predicted to reach up to 64% by 2050 (Zhang, 2016), and structural changes are expected due to the many effects in both the natural and built environment (Jamal, 2003). Urbanization is recognized as a civilizing development that defines the human relationship with the environmental ecosystem. Currently, a large part of the world's population lives in urban areas, where different social, economic, and environmental aspects interact and affect human societies. The urbanization process is considered one of the most prominent transformational processes in the world today, exerting a huge impact on the environment at all levels (individual, local, regional, and global). The implications of urbanization, both in terms of the use of natural resources and living conditions in urban areas, are varied and highly complex. The appropriation of water and its management in the urban space has been discussed as one of the crucial points for the development of sustainable governance mechanisms.

The water management in cities can go beyond their administrative and territorial limits and should be thought of considering their ecosystem (e.g., river basins, sub-basins, biomes, and regions) to facilitate the mapping of energy and material flows. The biophysical consequences of urbanization can be felt in different places. The urbanization of one region can directly affect the quality and availability of natural resources in another region. Cities are confronted with the trade-offs of urbanization, where negative and positive effects influence the environment, society, economic structure, and institutions. This influences the achievement (or not) of a sustainable agenda, a global challenge.

In urban water management, sustainability emerged as a concept that integrates aspects of the economy, society, and ecological thinking and has been widely applied to urban development. In this perspective, sustainability is a desirable state or set of ideal urban conditions that last over time. As well as the difficult task of defining sustainability in response to current urban thinking, so has the task of including sustainable development in this calculation. Since sustainable development has become the watchword in most international water discussions, various concepts and approaches have been developed and defended.

Sustainable development must be viable, equitable, and achievable (Tanguay et al., 2010). Even with a nonconsensual conceptual basis, we can see disjointed and nonintegrated advances in the different dimensions of sustainability, especially in aspects related to the environment. Interdimensional balance must be sought, recognizing the relevance of each theme inserted in each dimension. The literature does not reveal a universally accepted definition of sustainability, varying according to the researchers' field of knowledge. In the context of this chapter, we can define sustainable development as lasting development that meets human and ecological needs, improving people's quality of life. At the same time, natural resources must be managed with the aim of being sustained by the regenerative capacity of the urban ecosystem. Sustainable urban ecosystems are effective ecosystems, with little or zero waste generation, resilient, self-regulating, cooperative, and flexible (Dizdaroglu, 2015; Newman & Jennings, 2012).

In general, sustainable urban development seeks to achieve a balance between the growth of cities and the protection of the environment with a view to issues that are in the dimensions of sustainable development (population and health, wealth, culture and knowledge, laws, equity, governance, soil, atmosphere, water, wildlife, energy, recycling, urban transport, public services, etc.).

Urban sustainability can only be measured and achieved according to the specific objectives of each city or region. With the increasing number of sustainable cities, it is necessary to establish goals that allow us to perceive advances or setbacks toward sustainability. As cities adopt sustainability as their main goal, it becomes necessary to identify whether the actions taken by the public administration are allowing the system's sustainability levels to increase. In this case, water management is a crucial factor to guarantee the viability of a sustainable urbanization process.

Water is a critical natural resource for life on the planet and for carrying out productive activities around the world, and it is essential for the organic functions of living beings. It is also an irreplaceable element, non-expandable, irregular in its availability depending on the place and vulnerable to irresponsible uses. Water resources have been largely irresponsibly exploited in most parts of the world, putting strains on their quantity, availability, and quality and generating conflicts.

In the planning and management of water resources, conflicts arise when users and institutions disagree about the quantity and quality of water available for a particular purpose or productive activity. Many conflicts have become increasingly complex and need to be managed with the support of stakeholders, increasing public engagement and political management capacity. The resolution of many conflicts depends not only on water availability but also on sustainable urban planning and management. Sustainable urban development contains ten elements related to water concerns:

1. Democratic access to water and sanitation services (OHCHR, 2020).
2. Water treatment and recycling (Huxedurp et al., 2014).
3. Low energy consumption by green design technologies (Newton & Rogers, 2020).
4. Sustainable infrastructure and transport (Derrible, 2018; Jovičić et al., 2018).
5. Restoration and environmental protection (Asnake et al., 2021; Huang et al., 2020).
6. Waste management and climate changes (Rahmasary et al., 2019).
7. Green economies, including sustainable tax policies (Park & Page, 2017; Soto Rios et al., 2018).
8. Environmental justice (McDonald & Jones, 2018).

9. Preservation of natural and cultural heritage (Tengberg et al., 2012).
10. Environmental education and awareness (Suárez-Varela et al., 2016; Xiong et al., 2016).

Sustainable urban development balances water exploitation, including technological development and institutional capacity, to enhance the potential to meet society's aspirations, now and in the future. One of the main challenges of current society is to develop a sustainable water management structure that guarantees an adequate and quality supply and reduces the degradation of associated aquatic ecosystems. Likewise, the development of strategies and public policies for sustainable water management must include periodic reports, governance mechanisms, and sustainability assessment at various levels. These management tools facilitate the integration of relevant information about water and make it possible to understand the complexities and interactions of the ecological and human systems in the face of sustainable development.

Good management of water resources in urban spaces must characterize the level of sustainability of a current situation or anticipate the potential effects of action before its implementation. In this way, it is possible to anticipate undesirable future scenarios and support decision-making processes, playing an important role at the strategic and operational levels of water management.

Urban water security plays a central role in achieving good levels of sustainability in terms of protecting water resources, as it has a direct impact on sustainable urban development and other aspects associated with sustainability. The four dimensions of sustainability (economy, society, environment, and institution or governance) (Pires et al., 2017) provide guidance and intent for the transition of urban water management. The stages of urban water transitions are closely related to the dimensions of sustainability.

1.1 Urban Water Management Transitions

Transitions are nonlinear processes that span the entire society, with a central role for the bottom-up innovation processes, experimentation, learning, and networking. Public policies and public institutions are part of the structures of this framework, which implies its transformation. Sustainability transitions are conflicting and political, generating trade-offs and players resistant to change (European Environment Agency, 2019).

Transitions can generate unintended consequences in the fields of institutional, environmental, economic, and social sustainability. It is critical to continually assess the risks associated with transitions using anticipatory governance approaches. In water management, urban spaces play an important role in sustainability transitions because they are centers of innovation, providing learning opportunities and networks and offering the potential to achieve system-wide change at local levels.

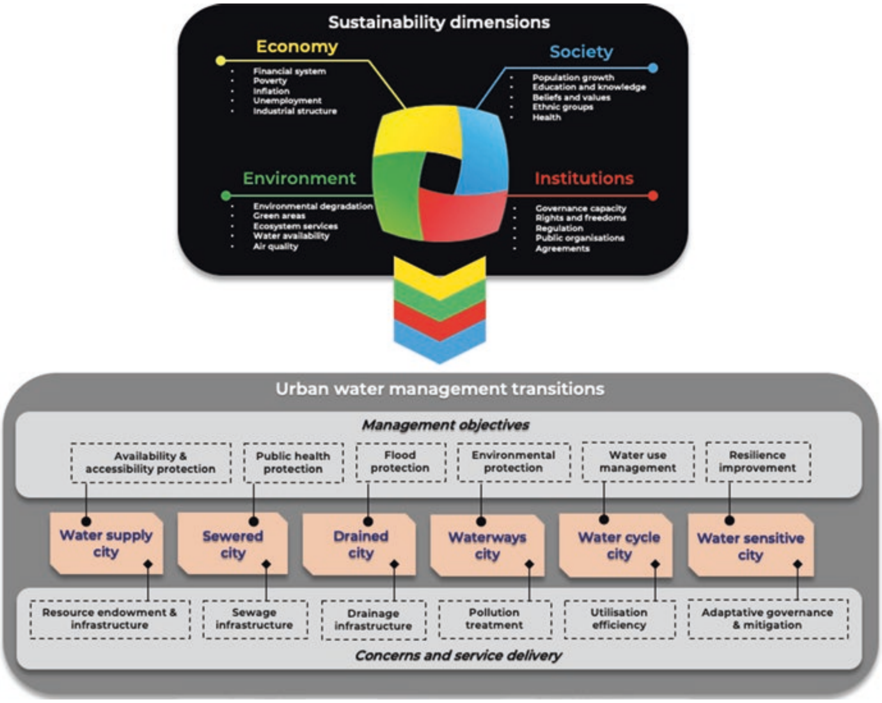

Fig. 15.1 Sustainability dimensions and urban management transitions

The guidelines and objectives of the practice of urban water management have changed over time, as a new market and economic development patterns, demands and social organizations, human behavior, values, and climate conditions have changed. Institutional aspects promoted transitions in urban water management in line with growing concerns about environmental issues. For the assessment of urban water management practices, six stages of management transition should be considered ((Brown et al., 2009; Daniell et al., 2015): (1) the city of water supply, (2) the city of sewer, (3) the drained city, (4) the city of waterways, (5) the city of the water cycle, and (6) the water-sensitive city. Figure 15.1 presents a framework addressing urban water management transitions and sustainability dimensions (Chang & Zhu, 2020):

1.2 Focusing on the Stages of Urban Management Transitions

The stages of urban management transitions may be disintegrated in different states, generating socioeconomic and environmental impacts in the short term. A priority scale must be adopted for each stage, as potential externalities must be taken into account for systemic and lasting change.

Water supply city commits to the availability and accessibility of water resources to meet a specific need. If the need is industrial, domestic, or agricultural, the quality and quantity requirements must be met. In the urban environment, several types of water supply projects can be developed, such as reservoirs, wells, or dams. Impoverished urban settlements are being deprived of their water right, with serious implications for their health and development.

Sewered city aims to build sufficient coverage of the sewage network to ensure public health, preventing waterborne diseases. Most urban dwellers in middle-income countries do not have sewage systems. In these countries, cities undergoing an accelerated urbanization process have difficulties in managing sewage waste, generating negative risks for human health and environmental health. Without proper management, sewage can be discharged into open waters or into waterways, vacant lots, and unsanitary dumping sites.

Drained city seeks to improve the effectiveness of drainage infrastructure to prevent flooding and environmental disasters. Drainage can be natural or artificial. Many urban areas have natural drainage, where vegetation and lakes and rivers are natural drainage tools. However, artificial drainage has been increasingly used in the urban environment.

Waterways city pays attention to improving the quality of water and the amenity of water bodies through the treatment and prevention of pollution. The control of pollutants in watercourses guarantees the life of animals, plants, and fish. Pollution also impairs the biological function of living beings and human uses for leisure and recreation.

Water-cycle city focuses on water use efficiency and closed-circuit water use. In urban areas, water cycle problems include pollution, waterways, floods, and depletion of soil moisture. In the urban context, the objective is to restore the natural rhythm of the water cycle, facilitating the infiltration and regeneration of groundwater. Evapotranspiration and district cooling must also be considered.

Water-sensitive city is related to the resilience of water-sensitive urban design, considering the damage caused by climatic actions and disasters. Water-sensitive cities need solutions that integrate urban structure, natural landscape, and adaptive management models.

2 IWRM and Sustainability Perspectives

2.1 Integrated Water Resources Management: Definitions and Perspectives

Integrated water resources management (IWRM) has been defined by the Global Water Partnership as a process that promotes the coordinated development and management of water, land, and related resources to maximize socioeconomic well-being with equity, without compromising the sustainability of fundamental ecosystems (Gain et al., 2017; Grigg, 2008; GWP, 2000).

A fundamental objective of IWRM is to coordinate and integrate different aspects and themes related to water as a means to achieve holistic water management and improve levels of sustainability of water resources (Jønch-Clausen & Fugl, 2001). The sustainability of water resources is a continuous process and not an end state, linking a better understanding of the needs of society and the environment, as well as the interactions between the uses and demands of both (Wallace et al., 2003).

In the current context, water management has approached the global set of goals with sustainable development based on Sustainable Development Goals (SDGs). However, a global agenda, based on a top-down approach, is hardly applied at more disaggregated levels. The challenge that must be faced is to meet the expectations of lower geographic levels – from the levels of communities and small regions, including watersheds and sub-basins to the highest levels, such as countries, nations, and borders. The formulation and maintenance of local IWRM policies play a critical role in the development and management of water resources. However, it is necessary to experiment locally and think nationally, to then glimpse an international scenario, considering the specificities of each territory.

Another relevant factor is social participation and stakeholder engagement. Water management must be directed toward governments (local, regional, national, global) and stakeholders (users, entrepreneurs, research centers, universities, NGOs, communities, among others) so that it is possible to include the expectations of each group. Social participation and stakeholder engagement facilitate the implementation of the IRWM through common actions and interests to operationalize IWRM and accelerate progress toward sustainable development. The practice of IWRM must be directed to the expectations of territorial agents, allowing the expected results to be delivered (Fig. 15.2).

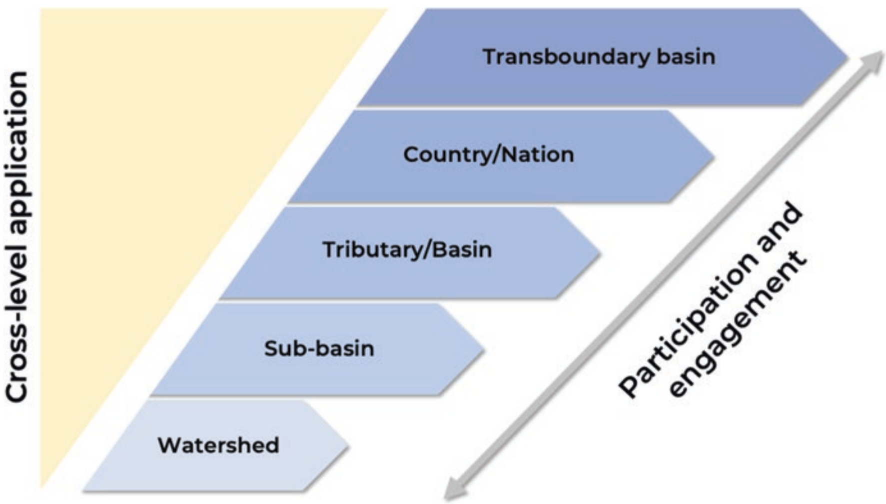

Fig. 15.2 Application level and participation and engagement for the integrated resources water management

IWRM has become one of the most discussed initiatives by governments at all levels. In this sense, the main challenge remains its effective implementation. The emerging need to understand that IWRM can provide sustainable water security has forced water professionals to become more accountable for their decisions and practices, especially toward the poorest areas. Another challenge related to the IRWM concept is found in the priority and political importance of water management, in which water must be seen in a broader context, considering the dimensions of sustainability as a transformational factor.

2.2 Adaptive Strategy to Operationalize IWRM

The operationalization of the IWRM must be adequate to the demands of the implementation of the strategic goals and objectives of the organizations, cities, regions, and countries/nations.

A successful adaptive strategy model can facilitate water management at all levels so that manageable changes can be established. IWRM processes must be reconciled with a practical approach to prediction and problem-solving. Those who have a leadership role need to facilitate changes in the development/maintenance and management of water resources in the implementation of management actions aimed at the participation and engagement of all actors (from public and private sectors). Operationalizing IWRM as an adaptive strategy for change combines four strategies (Smith & Clausen, 2015):

Policy and strategy Definition and implementation of policies and strategies, through negotiation between the main stakeholders and economic sectors, establishing priorities and goals for the development and management of water resources.

Problem-solving Applying pragmatic problem solutions that compromise established strategies, meeting stakeholder priorities at all levels (e.g., water utilities, water infrastructure, aquatic ecosystem preservation, and restoration). This provides new knowledge and can increase stakeholder engagement.

Operationalization Includes the operational mechanisms that are between establishing strategies and solving problems. This facilitates the negotiation and integration of the work of the stakeholders and economic sectors involved. It is guided by the strategic level, with a focus on execution.

Monitoring and control Monitoring progress (or regress) and achievement of goals and objectives, providing indicators and information with transparency, accountability, and reliability.

The IWRM agenda needs to align its strategies and operationalization with the holistic perspective of sustainability, establishing benchmarks, minimum standards, and trends. It will allow for the development of policies that increase the implementation ambitions, accelerating progress toward the transition to a sustainable urban management transition. It can speed up the water management process, in which players can help solve the problem, without them accumulating.

The adoption of sustainability goals and objectives should galvanize an adaptation and revitalization of a sustainable agenda, in which IWRM policies and practices can promote change in water management. The learning processes can help you understand what does and does not work at various levels and economic sectors, improving the quality of decisions and increasing the ability to manage the changes required by IWRM.

2.3 Principles of IWRM

In 1996, the Global Water Partnership (GWP) presented the guiding principles of the Dublin and Rio Declarations of 1992, which were agreed upon at the International Conference on Water and Environment. The Dublin Declaration with four principles on the water was also known as the Dublin-Rio principles. GWP has crafted these principles to reflect an international understanding of the "equitable and efficient management and sustainable use of water" (GWP, 2000):

Principle 1 Fresh water is a finite and vulnerable resource, essential to sustain life, development, and the environment: recognizes the interrelationship of the hydrological cycle with other ecosystems and natural resources. It considers mechanisms to ensure water sustainability, taking into account production and consumption costs. The integration of human systems – social, economic, and political – represents a major institutional challenge.

Principle 2 Is based on a participatory approach, involving different types of stakeholders, including users, policymakers, and planners at all levels: Participation requires that stakeholders at all levels of the social structure have an impact on decisions at different levels of water management. A participatory approach results in a social impact on decisions, seeking to reach a lasting consensus and consensual agreement. The type of participation will depend on the level of water resources management (local-global).

Principle 3 Ensuring that women play a central role in water supply, management, and safeguarding: Equal participation is related to women's right to express and negotiate their needs. Their right must be manifested through organizations that improve their participatory capacity.

Principle 4 Water must be recognized as an economic good, considering its uses and importance: to manage water by emphasizing efficient and equitable use, encouraging conservation and protection of water resources. Value and charges are two different things. Establish the use and value of water through regulatory or economic means.

These principles, together with the Plan of Action of Mar del Plata (United Nations, 1977), were the basis for the convening of Agenda 21 and the development of the IWRM at the global level. All subsequent initiatives (e.g., Millennium Goals and Sustainable Development Goals) bring the essence of these principles into their conceptual framework.

2.4 Principles for Sustainability: From the Principles of Bellagio to the BellagioSTAMP

In recognition of the real need to measure sustainability, as well as its associated risks and opportunities, in 1996 an international group of leading measurement professionals developed the Bellagio Principles intending to provide high-level guidance for measuring and evaluating progress toward sustainable development (Hardi & Zdan, 1997). The idea behind the Bellagio Principles was to follow a common assessment approach to help develop measurement systems as an integral part of how society, environment, and institutions work.

The original principles became widely known. To keep them up to date and reflect the changing context for measurement, a review meeting was organized, following a similar approach used to develop the original principles. The review meeting, involving internationally recognized measurement professionals, was held in 2009 in Italy, specifically in Bellagio (OECD, 2009).

The updated principles have been renamed Principles of Assessment and Measurement of Sustainability (BellagioSTAMP) and reformulated more succinctly, eliminating ambiguities and duplications found in the original set and also highlighting other points (Pintér et al., 2012). The new version has been reduced from ten to eight principles. BellagioSTAMP includes these principles:

1. *Guiding vision*: vision guided toward sustainable development within the biosphere's capacity to sustain human well-being for future generations. Two attributes contribute to vision development, participation and social engagement.
2. *Essential considerations*: consideration should be given to the underlying social, economic, and environmental system as well as their interactions, including issues related to governance; current and future trends; risks; drivers of change; and practical implications for the decision, including synergies and trade-offs.
3. *Adequate scope*: the scope of assessment includes an appropriate time horizon to capture the effects of current political decisions and human activities and an appropriate geographic level (ranging from local to global scales, depending on the issue at hand). The assessment space should be sufficient for impacts at higher levels (not just local impacts).
4. *Framework and indicators*: based on a conceptual framework that identifies theoretical and conceptual domains; measurement methodological approaches; comparative analysis of the measured values with their respective goals. In this principle the definition of targets is desirable.

5. *Transparency*: ensuring access to evaluation data, indicators, and information and explaining in detail the research sources, methodological choices, assumptions, and uncertainties that determine the results, sources of funding, and conflicts of interest. The principle of transparency should ensure public understanding of methods and results, and that results are reliable.
6. *Effective communications*: application of clear and simple language, using visual and graphical tools to help in the interpretation of the results. Make clear the data available in full detail.
7. *Broad participation*: public participation strengthens the legitimacy and relevance of sustainable development. Involvement in selecting indicators empowers communities and can ensure that they are heard.
8. *Continuity and capacity*: this principle requires repeated measurement, responsiveness to change, investment, and learning and continuous improvement. Long-term measurements are desirable to recognize trends using longer time series.

The principles presented above can also help the entire process of sustainable water management, including its development and communication and review of results. They are interrelated and must be applied as a complete set. They are intended to be used to initiate and improve the sustainability assessment activities of community groups, local, regional, and national governments, corporations, and international institutions.

2.5 Interrelationship Between IWRM Principles and BellagioSTAMP Principles

The sustainability of water resources at all levels continues to demand information data to fill gaps in the theoretical and practical scope. Water management has incorporated new issues, forcing the maintenance of existing approaches to adapt to present-day needs.

Water issues go beyond concerns related to pressure, impact, conservation, and preservation of the environment. Building an IWRM work agenda requires a complete approach, covering the interests and principles of sustainability. The ability to advance toward sustainable development is determined by the ability of people and institutions to apply and manage the principles of sustainability.

Figure 15.3 demonstrates a matrix of potential interrelationships between the IWRM principles and BellagioSTAMP Principles. It demonstrates possible links between different themes and can be used as a study and application guide.

The joint presentation of these principles favors their integrated analysis. There is no doubt that it is possible to make different connections and find connections by associating almost any principle. The interrelationships mentioned, however, are restricted to the most direct and obvious relationships. These are indications of a theoretical nature, derived only from a qualitative assessment. With this matrix, it is

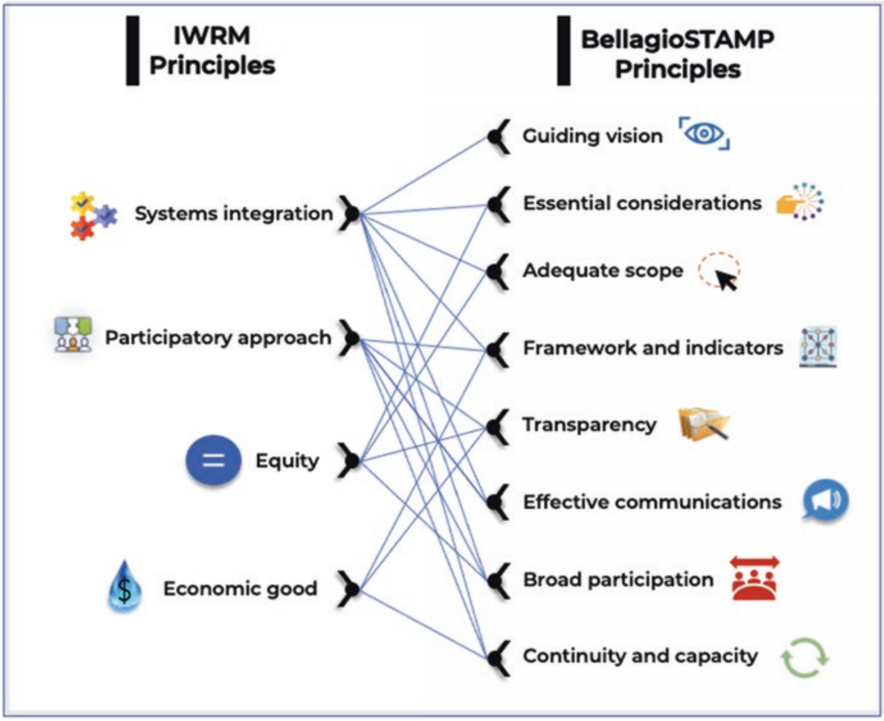

Fig. 15.3 Matrix of potential interrelationships between IWRM and BellagioSTAMP principles

expected a more systemic study and reflection, as well as suggesting new researches and elaboration of policies that integrate the dimensions of sustainable development.

3 Food-Energy-Water Nexus for the Global Sustainable Development

Due to the world economic and demographic growth, there is an increase for the demand of food, energy, and water (Zhang et al., 2019). Thus, the food-energy-water (FEW) nexus is an essential approach to allow the understanding of the inter-connected relations among these resources for the global sustainable development (Chang et al., 2016; Karabulut et al., 2016). However, the FEW nexus relies on a series of common elements (Bazilian et al. (2011), such as:the following

- Lack of quantitative or qualitative access to them.
- Rapid growth of global demand for limited resources.
- Implications regarding international trade and regulated markets.
- Regional variability in availability, supply, and demand.

- High influence from climate change and environment.
- Resource security risk.

The interaction between the nexus shows that if one of its elements is poorly managed, the security of the others will be compromised. In countries where the majority of the electricity is generated in hydroelectric plants (de Dias et al., 2018), if a water crisis occurs, the entire energy system is affected, increasing the economic and social risk. Likewise, food production and public water supply would also be compromised.

The concept definition of the FEW nexus is diverse. However, there is a special focus related to water, being in a central role of the nexus (Hoff, 2011), based on the fact that water is vital for the production and distribution of food and energy. Because of that, several studies prioritize primarily focus on calculating the water consumption for all the food and energy demands (Chang et al., 2016), particularly because it is a limited and sometimes a scarce resource for many inhabited areas (Boulomytis et al., 2021).

4 Water Relevance for the 2030 Agenda

Among the 17 Sustainable Development Goals (SDGs), SDG 6 is the one referring to water. It aims to guarantee water safety for all, based on the sustainable management of water resources, wastewater, and ecosystems. The SDG 6 comprises 8 targets and 11 indicators. The targets are related to the goals, while the indicators represent the metrics, which identify if the targets are accomplished (Ritchie et al., 2018). Both targets and indicators are detailed in Table 15.1.

Table 15.1 SDG 6 targets and indicators for the sustainable management of water resources

Target	Definition	Goal by 2030	SDG	
6.1	Safe and affordable drinking water	Achieve universal and equitable access to safe and affordable drinking water for all	Indicator	6.1.1
			Definition	Proportion of population located in the premises using safely managed drinking water services, free from contamination, and available when needed
6.2	End open defecation and provide access to sanitation and hygiene	Achieve access to adequate and equitable sanitation and hygiene for all and end open defecation, paying special attention to the needs of women and girls and those in vulnerable situations	Indicator	6.2.1
			Definition	Proportion of population using safely managed sanitation services and a hand-washing facility with soap and water

(continued)

Table 15.1 (continued)

Target	Definition	Goal by 2030	SDG	
6.3	Improve water quality, wastewater treatment, and safe reuse	Reduce pollution to improve water quality, eliminate dumping, and minimize the release of hazardous chemicals and materials, halving the proportion of untreated wastewater and substantially increasing recycling and safe reuse globally	Indicator	6.3.1
			Definition	Proportion of wastewater safely treated.
			Indicator	6.3.2
			Definition	Proportion of water bodies with good water quality
6.4	Increase water-use efficiency and ensure freshwater supplies	Increase water-use efficiency across all sectors and ensure sustainable withdrawals and supply of fresh water to address water scarcity and substantially reduce the number of people suffering from water scarcity	Indicator	6.4.1
			Definition	Change in water-use efficiency over time
			Indicator	6.4.2
			Definition	Level of water stress: freshwater withdrawal as a proportion of available freshwater resources
6.5	Implement integrated water resources management	Implement integrated water resources management at all levels, including through transboundary cooperation as appropriate	Indicator	6.5.1
			Definition	Degree of integrated water resources management implementation
			Indicator	6.5.2
			Definition	Proportion of transboundary basin area with an operational arrangement for water cooperation
6.6	Protect and restore water-related ecosystems	Protect and restore water-related ecosystems, including mountains, forests, wetlands, rivers, aquifers, and lakes	Indicator	6.6.1
			Definition	Change in the extent of water-related ecosystems over time
6.A	Expand water and sanitation support to developing countries	Expand international cooperation and capacity-building support to developing countries in water- and sanitation-related activities and programs, including water harvesting, desalination, water efficiency, wastewater treatment, recycling, and reuse technologies	Indicator	6.A.1
			Definition	Amount of water-and-sanitation-related official development assistance that is part of a government-coordinated spending plan and sanitation support
6.B	Support local engagement in water and sanitation management	Support and strengthen the participation of local communities in improving water and sanitation management	Indicator	6.B.1
			Definition	Proportion of local administrative units with established and operational policies and procedures for participation of local communities in water and sanitation management

Source: Adapted from Ritchie et al. (2018)

5 Mitigation and Adaptation to Natural Disasters

According to Zulaica and Vazquez (2021), although the conceptual discussion of risk is broad, two dimensions are commonly used to identify this principle, hazard, which refers to the probability of occurrence of a natural phenomenon or anthropogenic interference (Natenzon & Parkinson, 2020), and vulnerability, which refers to the social, economic, and cultural conditions that expose a population and make it prone to be affected and suffer from the hazard (Lavell, 1996).

However, all the environmental risks due to climate change and extreme events are variable from a place to another, based on the physical and geographical conditions, political agendas to face the mitigation and adaptation measures and respond to emerging urban problems (Zulaica & Vazquez, 2021).

It is well known that the inefficiency of IWRM has caused water contamination and flooding of many densely occupied regions. In coastal areas, there is an additional challenge due to the low-lying plains, shallow water tables, and tide variation, which affects the flow dispersion in the upstream areas. The Latin American and Caribbean region suffer from the incidence of tropical cyclones, floods, droughts, heat waves, increases in temperature and rainfall patterns, and rising sea levels, while 73% of the population lives in coastal areas (Zulaica & Vasquez, 2021). Thus, the geomorphological and ecological aspects make coastal areas more susceptible to extreme events and more vulnerable to natural disasters. The sustainable development of coastal areas is associated to the awareness of the local vulnerability to natural disasters, such as floods (Boulomytis et al., 2017).

The flooding risk will become more frequent in the following years (IPCC, 2021), and several needs have to be addressed for the IWRM, due to the impact on human life, environment, and economy (Mubeen et al., 2021). Tucci (2016) states that these impacts have to be controlled by the use of integrated structural and nonstructural measures to reduce substantial expenses for governments, businesses, and residents. Among the nonstructural measures are the public policies adopted in line with the guidelines of urban planning instruments, with the aim of mitigating the increase in surface runoff rates and maximizing the efficiency of drainage systems (Boulomytis et al., 2021).

Alternative urban drainage measures provide a balance between infiltration and runoff rates, increasing the possibility of rainwater retention at critical moments, such as rain gardens, green roofs, drainage permeable pavements, cisterns for rainwater collection, infiltration, and retention and detention basins. The synergy between structural and nonstructural measures improves the quality of life of the inhabitants and also the ecosystems of urbanized areas.

6 The Concept of Water Security

In 2013, the United Nations suggested that the definition of water security should be defined as:

> The ability of a population to safeguard sustainable access to adequate amounts of water of acceptable quality to sustain livelihoods, human well-being and social & economic development, to ensure protection from water pollution and water-related disasters, and to preserve ecosystems in a climate of peace and political stability.

This concept is quite comprehensive and is still under development, as it may include new aspects, since water is a vital and essential resource for all human activities. It is not naturally guaranteed in the same quantity and quality all the time, and this spatial-temporal variability explains the climate phenomena of droughts and floods that have always affected humanity.

Hoekstra et al. (2018) provided a good review of terminology changes over time, which may reflect the changes over the past 40 years. In the mid-1980s, it became evident that the solution for problems related to water could not be solved without a more holistic approach. They observed four different focuses used to define water security, well-being, equity, sustainability, and risk.

In general, studies treat water as a means of increasing economic welfare and social equity (Fig. 15.4). They believe this approach leads either to sustainability or to the reduction of water-related risks in a long term. Hoekstra et al. (2018) realized that many studies combine different degrees, extents, combinations, regional needs, and climate realities. That would be the reason for the large number of different approaches.

The focus on welfare aims at increasing urban quality of life through different paths, such as better use of the various functions and services of urban water

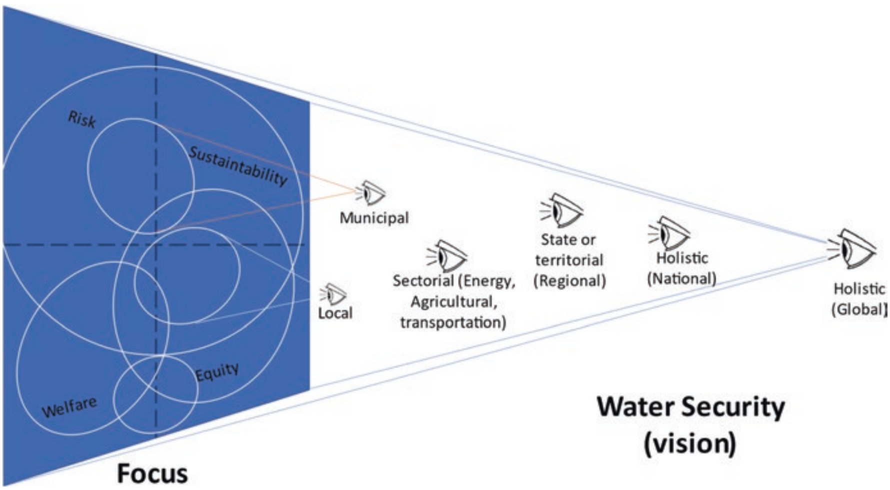

Fig. 15.4 Different scales and focuses about the concept of water security

systems and the reason to take care of an ideal system. This focus includes ecological and social values and risks, the essence of which boils down to increasing long-term welfare for all. It incorporates abstract and subjective values that are difficult to capture by economic terminology, such as aesthetic, cultural, and ecological values. Social inequality affects access to good-quality water, and the temporal dimension makes it difficult to measure water security and its contribution to welfare. The adequate inclusion of risks in welfare metrics is also recognized as being difficult to insert, as risks incorporate uncertainties that are difficult to quantify but are part of water insecurity.

The urban water security has a slightly different concept because problems become more specific and the focus changes. Its application changes according to the territorial size according to the scale dimension (e.g., metropolitan region, municipality, or a group of houses). Different scales induce a number of elements that are valid for urban water security but may not be valid to deal with a state, national, or continental scale.

When the welfare approach includes equity and sustainability, van Beek and Lincklaen Arriens (2014) call this set as the development focus on water security, which contrasts with the risk focus. In the broader development focus approach, the adoption of certain goals and combination of policies, reforms, and investments lead, over time, to improved water security.

The risk-based approach revolves around the fourth focus, related to risk management to reduce the vulnerability to hazards related to extreme events and natural disasters due to water-related infrastructure. According to van Beek and Lincklaen Arriens (2014), these two approaches are complementary and should be sought in a balanced and simultaneous way. The risk approach, according to Hoekstra et al. (2018), can be easily summarized as a cost-benefit analysis on a macroeconomic scale with a main focus on general welfare, under-dimensioning equity and sustainability issues, which are values that are difficult to quantify and in most cases incorporate risks and subjectivity.

Risk can be considered as a combination of danger, exposure, and vulnerability. For Veyret (2003), risk can be defined as the perception of the danger of a possible or potential crisis or catastrophe. There is no risk without a population or individual perceiving its individual or collective consequences. Perceived risks, in a way, measure the degree of perception and sophistication of a society. The domain of risks is based on three elements: precaution (possible through prior identification), prevention (due to prior characterization), and compensation (Zuffo & Zuffo, 2016).

The potential hazards might be natural (e.g., droughts and floods) or anthropogenic, where both can cause the deterioration of water quality. The perception and acceptance of any risk has its origins grounded in cultural and social factors. Exposure is always relatively higher in areas with higher population densities, but there are always some considerations to be made, because this exposure to risk is also associated with the socioeconomic development, adaptation, organization of the society, and urban infrastructure, which in good conditions may increase the resilience to disasters. Thus, a highly populated city, such as Tokyo in Japan, whose demographic density is around 64,000 inhabitants /km^2, is less subject to risk than the city of Port-au-Prince in Haiti, whose demographic density is around 27,400 inhabitants /km^2. That occurs because capacity to respond to possible disasters comparing the two cities is very different, as well as the financial resources.

(a) *The Impact of Water Security Against Society*

Efforts to ensure the use of ecologically sound and socially effective resources stand out as major problems on the twenty-first -century agenda. Population growth and the increase of water users have led to a reduction in the per capita availability of water and other essential resources. The reduction in water availability is also due to the continuous degradation of its quality. It represents one of the greatest tangible threats to the continuous production of various goods and services required by the modern society.

Water security cannot be compartmentalized only in the subsistence of population groups but also in the context of entire nations. This is the paradigm, as security is defined by the needs of individuals and not by the needs of states.

The relationship between the environment and society has been increasingly related to human security. The scarcity of good-quality water, as a crucial and relatively rare resource, can be defined in two ways: (1) physical scarcity, which is established by the atmospheric circulation in which high-pressure zones define dry regions and low-pressure zones define wetlands; and (2) economic scarcity, which is due to the lack of financial resources to enable the construction of adequate water infrastructure for the collection, treatment, and distribution of water.

Figure 15.5 shows the interconnection between the water security and other essential ones for the global sustainable development, based on perspectives from Boulomytis et al. (2021).

Fig. 15.5 Interconnection between the different kinds of security

The lack of water impacts food security, as it reduces agricultural productivity in the countryside caused by reduced rainfall during prolonged droughts. In drier periods, the food prices and supply are impacted. Animal meat production also suffers with the drought, because in addition to the need for food, they also consume a lot of water. Countless are the reports about the recurrent droughts in the northeastern Brazilian locality in which cattle die of hunger and thirst. The flow reduction in rivers causes an increase in the concentrations of pollutants and contaminants, which compromises the preservation of ecosystems and the community quality of life.

Water scarcity also affects the public supply, which guarantees our daily hygiene. In addition to reducing access to good-quality water, the decrease in water supply also affects our sewerage systems, which uses water as a vehicle transport for the sewage removal.

It also impacts the economy because of the reduction or even interruption of the industrial production. The same happens when the water levels from reservoirs are low, affecting the nautical activities and tourism industry. Then, it affects the economic activities, increasing the number of unemployed people, which can lead to famine and increase in violence.

(b) *Water Security for the Sustainable Development*

The consumption of cities is increasing year by year in countries where the population is growing or where the rural population continues to shrink as agricultural machinery reduces the need for large numbers of labor.

Several urban areas are unable to meet their own resource demands (e.g., water, energy, food) within their urban area. These areas need to be supplied by resources produced outside their geographical limits, outside the urban area, and often from very distant places. For instance, we can cite the electrical energy used in the city of São Paulo. About 65% of the electrical energy produced in Brazil comes from hydroelectric generation. The Brazilian system is interconnected, which means that the energy has free transit from north to south and from east to west of the country. In this context, it is possible that the energy consumed in São Paulo comes from different regions of the country. In the south region, the major hydroelectric plant is Itaipu, located in Parana River, on the border between Brazil and Paraguay. The energy from the north and midwest regions come from Belo Monte and Tucurui hydroelectric plants, respectively.

Food comes from all parts of the globe, as wheat can come from Argentina or Canada, medicine from India, oil from the East, among others. However, for their water supply, the sources must be closer, within the "reach of urban infrastructure," as defined by McDonald et al. (2014). This infrastructure can be decades of kilometers away but surrounding the metropolitan areas, because the further away the water is the higher it costs to bring it to the regions where it is needed. In this situation the cost of production is very important, and the networks of pipelines will grow as long as the cost of collection, transport, treatment, and distribution are lower than the cost of treatment and reuse of the water already used. Semiarid countries like Israel and Spain, where the availability of fresh water is scarce, are adopting more expensive solutions, such as the desalination of seawater and the direct reuse of wastewater treatment of domestic sewage. Direct reuse adds another risk to water security and health security, as any problems in the treatment process can bring negative consequences to the health of the population. Israel both desalinates water and makes use of water reuse for its agricultural fields. The implementation and maintenance costs are high, and the necessary labor is specialized and involves technology, but the country has financial and human resources to ensure its water security.

The metropolitan region of São Paulo cannot use water from desalination, despite being a few kilometers from the coastline, with access to the Atlantic Ocean; it is located at an average altitude of 750 m, which would make it economically unfeasible to pump significant flows to supply the great metropolis. The infrastructure required, both for implementation and for operation and maintenance, would not be economically feasible because it would also require very powerful motor pumps and extremely high energy consumption, both for desalination and for pumping the water supply uphill.

As the water varies in space and time, its occurrence is not completely known, as well as its variability, not always occurring in regular intervals, but defined by the climate of a region. However, this fragile regularity can suffer sudden and unexpected variations, enabling weakly predictable intervals and causing excess water in some regions and shortages in others. These variations are not only seasonal but may occur for longer or shorter periods of time. It remains stable for several decades (decadal variations), with cyclical or quasi cyclical characteristics, which alternate between drier and wetter periods, in not very regular sequences over time.

Climate variations have always affected mankind, which has never been able to foresee abrupt climate variations. Because of that, we have suffered harmful consequences, such as hunger, wars, and epidemics, responsible for the migrations of entire populations, as the history of human civilization tells us.

Water security seeks to guarantee sustainable access to water in adequate quantities and of acceptable quality for existence, socioeconomic development, and human welfare, even in the most adverse periods, reducing our vulnerability to these events.

The human species has never been as populous as it is today and is still far from reaching a level of balance. Thus, population growth is one of the factors that threaten the balance between water supply and demand, especially in urban areas, and technology is an ally to increase the efficiency of water use by reducing waste.

Economic growth generates increased demand for water, and the efficiency of the different uses is still very low. Technology has been improving the efficiency of the various uses of water, especially in industry and agriculture.

However, it has not reached a large scale on the planet, which has very heterogeneous efficiency of use, leading to waste in some places and scarcity in others.

The lack of planning reduces coordinated institutional actions and investments in water and sanitation infrastructure, which are responsible for the water insecurity scenarios, especially in large metropolitan areas. Knowledge of past events enables us to understand the present and prepare for the future. The database of climatic, hydrological, environmental, and socioeconomic variables gives us the basis for the construction of solutions for future problems, which have always occurred in the past.

The next imminent water crisis will be a major challenge that will go far beyond policymakers and formal government agencies. The necessary solutions must come from society. Technical arrangements will remain necessary, but the social, institutional, and technological dimensions will be increasingly crucial.

Reversing this picture of water insecurity is possible by acting in traditional ways, with the implementation of water infrastructure and improved water resource management, but they are not sufficient. It is important to incorporate risk management measures in order to avoid having to deal with crises resulting from the lack of these measures. The proposition of actions aimed at increasing the resilience of a particular region or catchment will only be possible through the in-depth knowledge of vulnerability and exposure of the environment to events of different magnitudes.

In summary, what is sought in an ideal water security scenario is an infrastructure that is well planned, designed, implemented, and efficiently managed, which allows the balance between water supply and demand, even in critical and adverse situations, by reducing vulnerability to extreme climate events.

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Chapter 16
Corporate Social Responsibility and Roles of Developers for Sustainability in Companies

Anu Sharma, Moharana Choudhury, Sangita Agarwal, Ranjan Sharma, and Rajni Sharma

Abstract Corporate social responsibility (CSR) is the responsibility shared by the corporate sector toward society. This approach aims at fulfilling social and environmental obligations as a matter of responsibility toward society and the environment, respectively. It is a globally acknowledged private business based on the idea of self-regulation while generating revenue and making a profit. The whole concept revolves around contributing to the societal goals based on the philanthropic or charitable ideals supported by ethical values. Sustainability relies on resource consumption, keeping in mind the intra and inter-generations. The corporate sector, through the principle of CSR, ensures that they contribute their part in terms of finance, ideas, technology, etc., to achieve the sustainable development goals (SDGs) like sanitation, green cities, gender equality, education, eradication of poverty, hunger, illiteracy, and inequality put forth by the United Nations by 2030, popularly known as Agenda 2030. The framework of the chapter involves the evolution of the idea of CSR based on environmental ethics, the role of CSR in solving the problems since its inception, and how the business practices and work culture of the corporate world impact sustainability both positively and negatively.

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The chapter aims at bringing out the ideas of how sustainable business practices and stakeholders of CSR can contribute toward the improvement of the environment and bringing sustainability in the companies, followed by a conclusion.

Keywords Business practices · Corporate social responsibility (CSR) · Environment · Social Goals · Sustainable development goals (SDGs)

1 Introduction

As defined by the European Commission (2001), corporate social responsibility is the non-compulsive and free-willed amalgamation of environmental and social concerns into business transactions and interactions with stakeholders. Making sustainability data public encourages accountability, brings recognition and useful in managing risks, as well as inspires businesses to take advantage of new opportunities. In today's context, corporate social responsibility is a pillar of corporate sustainability. It might be defined as a company's reaction to sustainable development, characterized by plans and practices that address the world's most pressing concerns (Yevdokimova et al., 2019). Corporate supportability is a practice aiming at long partnership while executing the business system that focuses on the ethical, public, natural, and monetary components of carrying on with work. Corporate manageability depends on six standards, ecological efficiency, social growth, environmental and environmental sustainability, social sufficiency, and values of the environment (Dyllick & Hockerts, 2002). Corporate social responsibility is a liability concerning the effect of association on its surrounding environment. These environmental factors include business domain, ecology, and public relations. Sustainability is a skilled state of the association in the financial actuality, keeping in mind all the societal and monetary complications, environmental freedoms, and threats. Corporate sustainability describes that only business is not essential. While doing business, it is equally necessary that a corporate or organization considers the social issues. The focus should not only be making a profit. It should ensure the benefit of all.

The idea is one step toward a sustainable economy and against the popular notion that both the environment and economy cannot go hand in hand. The economist and corporate sector have to find ways so that one sector does not suffer because of the progress of another industry. The environment cannot be degraded for achieving higher economic growth and vice versa the growth cannot be stopped to keep the climate unaltered. A sustainable economy calls for environmentally compatible designs. At the World Conference on Environment and Development in 1987, Gro Harlem Brundtland, the Norway prime minister, coined the phrase "sustainable development" in its report known *Our Common Future* under Brundtland Commission. Ecological sustainability or sustainable development implies the utilization of resources for fulfilling the current generations' requirements and keeping in mind the needs of the future generations.

The impact of environmental changes is taken into account in sustainable development, and efforts are made to minimize that impact. Two key ideas underpin sustainable development. To begin, the carrying capacity of the environment is taken into account, as is the quality of the ozone layer and other natural resources such as forests, soil fertility, and healthy wetlands. This situation also indicates the existence of a sustainability threshold. Another idea is to strike a balance between the various facets of society, including economics, social issues, and the environment. There are similarities between the two ideologies in that they both focus on the existence of life and maintenance of resources. Sustainable development stands at the three pillars of community development, economic development, and environmental protection. Community development includes meeting basic human needs, such as food, shelter, clothing, healthcare, and education (providing clean air, safe water, and a quality environment). Sustainability in development is a critical characteristic that must be considered in all planning procedures because development is inherently linked to environmental degradation. The business sustainability model is depicted in Fig. 16.1.

The idea of incorporation of corporate social responsibility has come mainly from restoring the degrading environment. Due to the degradation of the environment, the reasons for degradation were explored. Out of many reasons, one of the most important was losing environmental ethics, which paved the way for the devastation of the planet. Therefore, ecological ethics came to the forefront. Corporate social responsibility has come into business practices as a part of social and environmental ethics. The corporate sector has been a significant stakeholder in environmental degradation. Until this was realized, the whole world, particularly the north

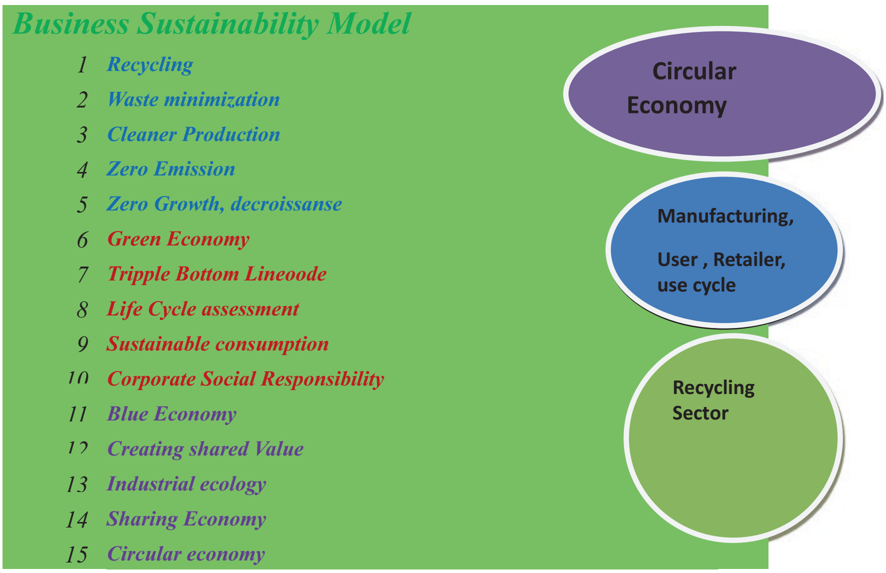


Fig. 16.1 Representation of business sustainability model

world, kept growing at the cost of environmental health. In the present century, when we face huge environmental issues, we realize that there is a need to revisit the idea of development. To tackle the situation and, of course, as a mark of responsibility, the corporate sector has come forward to contribute their part of the profit in solving the environmental issues and other social problems that occur due to poor environmental conditions. Such an approach has brought relief to the already pressing public institutions and overburdened exchequer. The introduction of extended producer responsibility is one such illustration that plays a vital role. Extended producer responsibility (EPR) is a concept where the producer shares the responsibility of collecting the product back once it is of no more use. It is a way of managing waste, especially electronic waste.

M. Scilly (an American writer and editor) has given the four types of CSR which are as follows:

- *Economic responsibility*: The first step to becoming a decent corporate citizen is to ensure that your company can make money. Profit is its primary concern. To put it another way, if a business owner wants to be in business for the long haul, they must generate revenue. The company will not meet its social commitments and will be forced to lay off its employees.
- *Legal responsibility*: Those responsibilities that have been imposed on it by the legislation According to the philosophy of corporate social responsibility, it is the most significant part of a company's operations after ensuring that it is profitable and that it complies with all applicable laws. Legal obligations encompass a wide range of laws which include environmental laws, labor laws, and in some instances even criminal laws.
- *Ethical responsibility*: A company is ethically responsible toward its employees, customers, and society in totality. Ethical responsibilities are to be followed by the company as owners of the company find it the correct decision. It is not mandatory for the company to do so due to any commitment but on the moral grounds. Such moral responsibilities include eco-friendliness and proper salaries to its employees.
- *Philanthropic/humanitarian responsibility*: A standard that goes above and beyond what the company deems acceptable. Involvement in community service programs, environmental stewardship, or philanthropic giving is all examples of what it means to give back to one's community.

Evolution of idea of corporate social responsibility The concept and concerns around corporate social responsibility have evolved considerably in the past few years. Several issues have arisen over the years which required the corporate world to behave more socially and responsibly (Welford & Frost, 2006; Engle, 2006), bringing the vision of corporate social responsibility. Conventionally it is not a management tool or a business tactic but a moral obligation (Gerard & Zwetsloot, 2003) and means of strengthening the understanding and guidance on social responsibility.

Several companies already existed well before the idea of corporate social responsibility came and was formally recognized. The idea is not new. It has been there for more than a century. Officially the term was coined in 1953 by Howard Bowen, an American economist, in his publication *Social Responsibilities of the Businessman*. He is being regarded as the father of corporate social responsibility. The concept of "social contract" was introduced in the United States in 1971 by the committee for economic development between the society and the business groups. This social contract idea brought to light the relevance of public approval for the companies to function and flourish. This concept also highlighted that there is an obligation of the corporate world to contribute to the needs of society. More and more organizations came into the picture. They started taking an interest in general conditions. Thus, the early CSR kept on evolving.

Hopkins (2003) maintained that CSR evolved through many years and took the form of an ethical and responsible track in the business world over time. Therefore, CSR is a way of forming higher living standards and maintaining the corporation's cost-effectiveness.

2 Efforts to Be Made by the Corporate Sector to Promote Sustainable Work Culture and Protecting Environment

There are various activities which can be implemented by the company into their operations under CSR; out of which some have been listed as follows:

- Implementation of policies that safeguard the environment aiming in bringing down the carbon footprints and increasing handprints. The need is to switch over to the usage of recyclable materials, habit of reusing things.
- Investments have to be in favor of society as well as environment.
- Labor policies need an improvement on the one hand, and adoption of fair trade is significant.
- Participation in charity work to feed the hungry, take care of their educational needs, etc.
- Voluntary work needs a push so that more and more businesses should come forward to participate in the process.

3 Formal Practices for Corporate Sustainability

There are some formal sustainable business practices which needs to be adopted under corporate sustainability such as the following:

- Awareness with regard to sustainability.
- Joining hands with stakeholders and promoting sense of responsibility.

- Water and electricity preservation.
- Supply chains management in sustainable way.
- Fostering reuse system.
- Management of chemicals.
- Buying energy-efficient items.
- Fostering sustainability work strategies.

4 How CSR Leads Sustainable Corporate Sector

Corporate social responsibility has served as a tool for citizens to hold businesses accountable for their actions since the 1950s. It is becoming increasingly relevant in the present times. The concept revolves around many things, including public work, product presents, and financial assurances, practices taking care of the environment and ecological balance, and many other creative and visionary means for large and small organizations to reward their networks.

While it is incontestable that most CSR efforts give an advantage to the public, it is favorable to organization, pioneers, and commercial specialists to evaluate what such endeavors mean for the firms that carry them out. Figure 16.2 shows the CSR policy report for 5 years (2014 to 2019) in Indian context (KPMG in India's analysis found on India, CSR reporting survey, 2019).

According to the report in 2019, a total number of 100 companies, 98 percent had their CSR in the public domain, which is easily available to individual outside the company. In 2019 two companies (PSU) do not have a CSR policy on hand in public domain, of which one is a new entrant to total 100 list and one has defaulted.

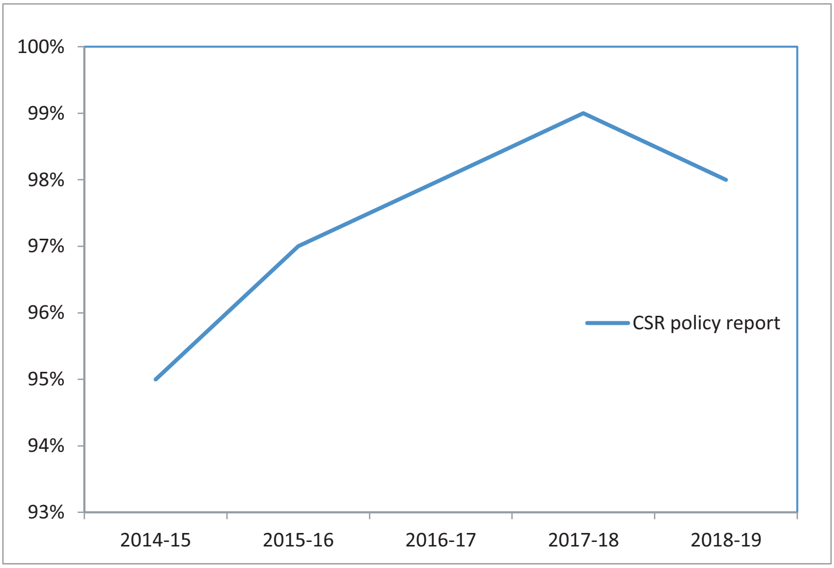


Fig. 16.2 CSR policy report in Indian context for 5 years

5 Total Disclosure on Region of Intervention in the CSR Policy

In the below table disclosing details with respect to the thematic areas of CSR intervention is mandated in the act. Out of the total number of 100 companies, 99 percent companies that have CSR policy obtainable in the public domain have revealed the details of the CSR intervention areas. In 2019 one company (PSU) has unable to provide these details for fifth time in a row as shown in Fig. 16.3 (KPMG in India's analysis found on India, CSR reporting survey, 2019).

6 Employee Volunteering for the Implementation of CSR Projects

As on the basis of CSR reporting survey 2019, in Fig. 16.4 (KPMG in India's analysis found on India, CSR reporting survey, 2019), out of the total number of 100 companies, only 59 percent companies have revealed the participation of employees as volunteers for the execution of CSR projects in the year 2018–2019. The distribution for "salary paid by the companies to regular CSR staff as well as to volunteers of the companies (in promotion to company's time/hour spent specially on CSR) can be separated into CSR projects' cost as part of the CSR expenditure," which was omitted vide General Circular No . 36/2014.

Five key ways in which commercial obligations contribute to the triple principle:

1. *Optimistic Media and Notoriety Structure*
   Prudent use of trade and commerce has the capability to yield impactful exposure for a cause quite swiftly and efficiently. Along with press and web-based

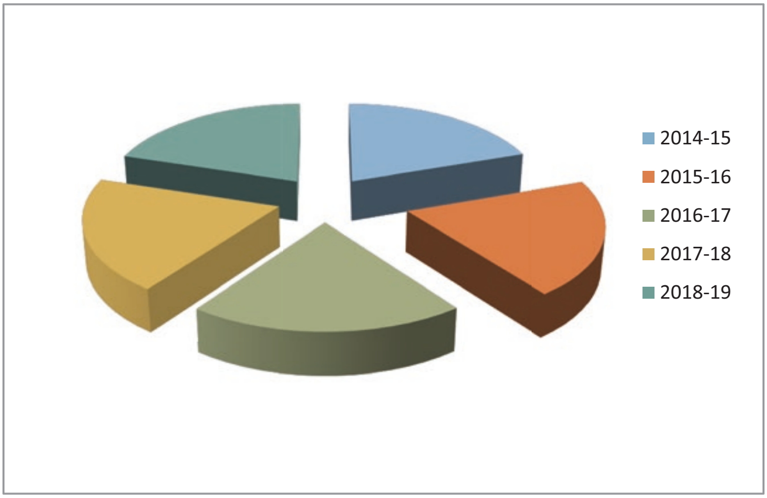


Fig. 16.3 Pie chart showing the total disclosure on region of intervention in CSR policy

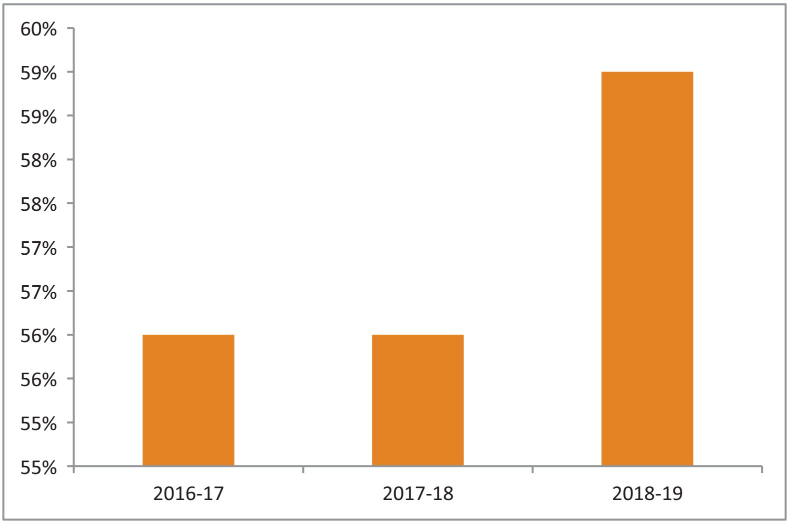


Fig. 16.4 Employees volunteering for the implementation of CSR report

media inclusion, several chief business grants consider corporate citizenship when selecting firms to perceive it. Associations that cannot take liability for business movements can gravely hurt their reputation. Annual Open Eye Grant recognizes organizations that exhibit helpless morality, cause environmental harm, and submit common freedom violations. While both good and negative evaluations were previously only discussed among industry professionals, the current context of internet media inclusion frequently places an association's moral standards directly in front of purchasers.

2. *Customer Advances and Appeals*
   With time the movements and campaigns regarding corporate responsibility have become widespread. With this, customers have been increasingly intent on approving firms that support causes they care about. As per Nielsen survey, most customers polled across 60 countries claimed they were willing to pay a higher price for goods provided by socially responsible firms. Corporate pioneers might gain from joining together with good causes important to their customers. As an illustration, an outside sports and entertainment business that contributes a portion of its profits to natural life and backwoods protection is not entirely compatible with its image. Still, it tackles a global problem that is extremely important to its customer base.
3. *Ability Fascination and Worker Maintenance*
   Customers are not the only people drawn to a company's commitment to work globally. When seeking positions, experts, particularly those seeking business, the executive's professionals, increasingly consider if an organization's basic ideas follow their ideas. Several organizations generally can cope up and cover up the issues related to time and money spent on administration with better profits resulting from high-level talent enrolment.

Corporate responsibility also plays an essential part in representational fulfillment and reliability criteria. It is an organization initiative that incorporates workers in deciding what is good to serve the cause and how to support them. While doing so, it gives representatives a better and more meaningful sense of engagement, another fundamental way corporate responsibility promotes more worker fulfillment is through group or large-scale assistance expeditions.

4. *More Grounded Customer and Local Area Relations*
   Generally, watching one organization performs philanthropic activity can inspire other organizations to engage similarly locally and globally. This allows keen partnerships to collaborate with other companies, including expected clients or colleagues, and develop significant ties while benefiting everyone.

   Organizations may essentially support and put together large stretches of administration that include entire networks. These events increase an organization's positive impact, but they also serve as fantastic opportunities to plan, interact with other specialists, and lay the groundwork for future collaborative projects. One approach that organization leaders can use is to compete with other organizations to see who can collect the most money or volunteer hours.
5. *Main Concern*
   None of the corporate world leaders would ever deny that the chief aim of a company is to generate revenue. While focusing on corporate responsibility which has some significant drawbacks, it can also have a beneficial net influence on a company's principal concern. All of the previously mentioned advantages, namely, brand building, client offers, capability upkeep, and extended connections, can help an organization's financial well-being. In any event, making sound decisions on one's own can be beneficial to a company's principal issue. For example, switching from paper to a wholly computerized system reduces an organization's environmental impact while lowering long-term management costs. Other similar options include substituting the traditional approach of lighting with ecologically viable illumination, consuming solar electricity, and working in an office possessing a green certificate.

Occasionally, a company's corporate soul and manageability efforts can ensure its long-term viability. For example, farming and fishing businesses that rely on regular resources can adopt more cost-effective strategies that do not devastate the environment or deplete marine life populations. This shift is beneficial to the environment, but it is also a huge undertaking that lays the groundwork for a business to function well for many years to come. Companies can succeed by advancing smoothly by adopting a broader perspective of serving all partners rather than just investors.

7 Similarities Between CSR and Corporate Sustainability

Both CSR and corporate sustainability are concerned with aiding businesses in operating in a way that allows them to be morally compelling while never harming others. CSR and corporate sustainability both help firms positively impact the people around them. These two concepts are inextricably linked. Corporate sustainability is critical for corporate social responsibility in general. Regardless, there are some significant differences between them.

8 Differences Between CSR and Corporate Sustainability

Points of Difference Between CSR and Sustainability.

1. Vision
   - CSR frequently looks into the situation where it thinks and tries to evaluate the contribution of an organization toward promoting the social good. It evaluates how meritoriously an organization has contributed for the welfare of the society.
   - Corporate sustainability also maintains that a procedure should be followed which has the tendency to look ahead and also make efforts as what should be done to meet the social obligations.
2. Target
   - The objectives of CSR drives are regularly assessment formers (e.g., media, pressure groups, and lawmakers).
   - Corporate sustainability takes a gander at the entire worth chain (i.e., everybody from end shoppers to partners).
3. Motivation
   - The inspiration and main thrust behind CSR drives is to secure an organization's notoriety.
   - For corporate manageability, the drive has more to do with setting out new open doors for developing business sectors.

Developing "environment-friendly goods" (EFP) is a positive step forward in this industry. Markets are overflowing with the outcome of day-to-day utilization due to industrialization and innovative development. As a result, competent and feasible management of available assets is required for overall sustainable growth. They could, in any case, be a source of danger to our health and harm to our existing situation. As a result, it is necessary to distinguish environmentally hazardous consumer goods from those less harmful or positively impact the environment, starting with the manufacturing process and continuing through packaging, distribution, usage, removal, and reusability or reuse.

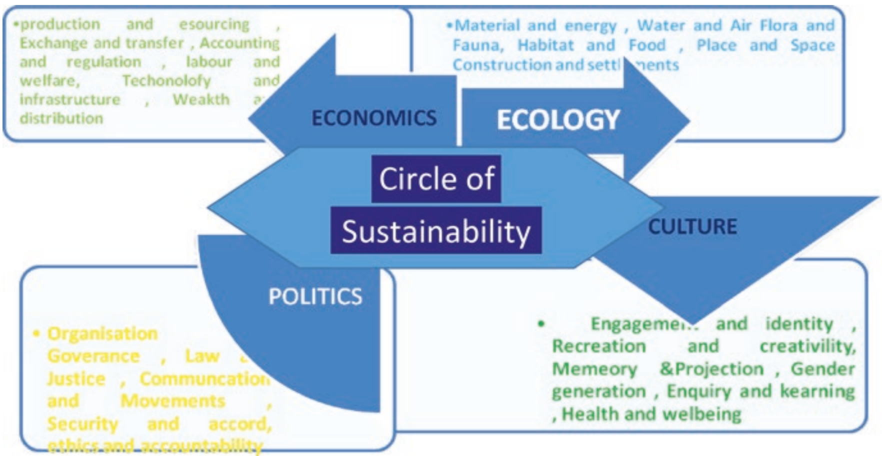
The growth of EFP is currently being highlighted all around the world. In India, the Agency of Indian Principles, the Service of Climate and Backwoods, and the Focal Contamination Control Board collaborate to promote EFPs. A scheme to mark Ecomark has also been in the works since 1990. Cleansers, plastics, papers, beauty care products, colors, frying oil, insecticides, medications, and other delectable items are remembered in the early stages.

9 Approaches for Sustainable Design

Designing buildings in a manner that exists in harmony with natural systems is also termed sustainable design. It is a philosophical concept used by various organizations and companies to achieve a brighter future for humanity by judicious use of resources. The term “sustainable design” relates to integrating an eco-friendly approach and natural resources in the part of the design. The designers play a pivotal role in problem-solving through innovation in services and products, hence help to replace outdated products with newer and sustainable ones that consume lower resources and generate less waste.

All the steps in developing any product should consider sustainability as a priority. The visual shape or the form should be designed so that it can help reduce the transport cost, fuel emissions, and usage. The flat packaging and self-assembly helped achieve the goals of sustainability and reduce the cost (Five Companies, Five Rules of Design (designorate.com). The usability and function of the product also indirectly affect sustainability as consumers can use the products with less waste and energy consumption. If the designers can make sustainable products at less or par cost to the non-sustainable products, the consumers would switch to sustainable ones and not depend on non-sustainable products. The materials used in the products also need to be easily recyclable and innovative, which would also help reduce cost. Final products should be able to last long or can be fully recycled to achieve zero waste.

10 Eco-Labelling



The eco-labels on goods and products help consumers to buy products which are eco-friendly. This label also encourages companies to manufacture green products by using resources that are extracted by sustainable processes. The eco-labels have been established to fulfill the following objectives:

(i) The main purpose is to protect the environment and create awareness among the consumers who are one of important pillars in economy of the nation.
(ii) The eco-labeling would encourage management of renewable and nonrenewable resources efficiently and effectively keeping in mind the needs of future generations.
(iii) The eco-labels would also encourage the protection of ecosystems and biodiversity as well as proper management of chemicals in preventing pollution.

In India, eco-label, which is known as Ecomark, is issued by Central Pollution Control Board (CPCB), which emphasizes clean and green production processes. *It is represented by an earthen pot or pitcher which is known as Ecomark. It is made up of soil. It is later on returned to the soil after it is used*. It involves no negative impact on the environment.

As was the practice earlier in any activities about development, environmental conscience was the least developed, leading to environmental degradation. Such an initiative would bring ecological awareness to the manufacturers and consumers. Sustainability should be a part of all processes in planning and implementation.

11 Business Practices, Work Culture, and Environment

Ethics in business, often known as corporate ethics, is the study of ethical principles, moral ideals, and ethical dilemmas in conducting business. Every facet of a company's operations is impacted by this principle, which affects both individuals and entire organizations. Both prescriptive and descriptive aspects can be found in corporate ethical behavior. The field essentially leads to policymaking and standard setting as a commercial activity and professional specialty. Descriptive approaches are used by many academics who are working to understand business behavior better. During the 1980s and 1990s, big corporations and academic institutions saw a significant increase in interest in business ethics. Non-economic considerations and profit-maximizing behavior have been the subjects of many corporate ethics questions. Corporate social responsibility and ethical codes, for example, are two terms commonly used to describe how a company feels about its commitment to non-economic ideals. Adam Smith, an eighteenth-century economist, said, "People of the same trade seldom meet together, even for merriment and diversion, but the conversation ends in a conspiracy against the public or some tactics to raise prices." Governments use laws and regulations to point business behavior in what they perceive to be beneficial directions. Ethics implicitly regulates areas and details of behavior that lie beyond governmental control. Figure 16.5 shows the circle of sustainability resting on the four pillars, namely, ecology, economics, politics, and culture.

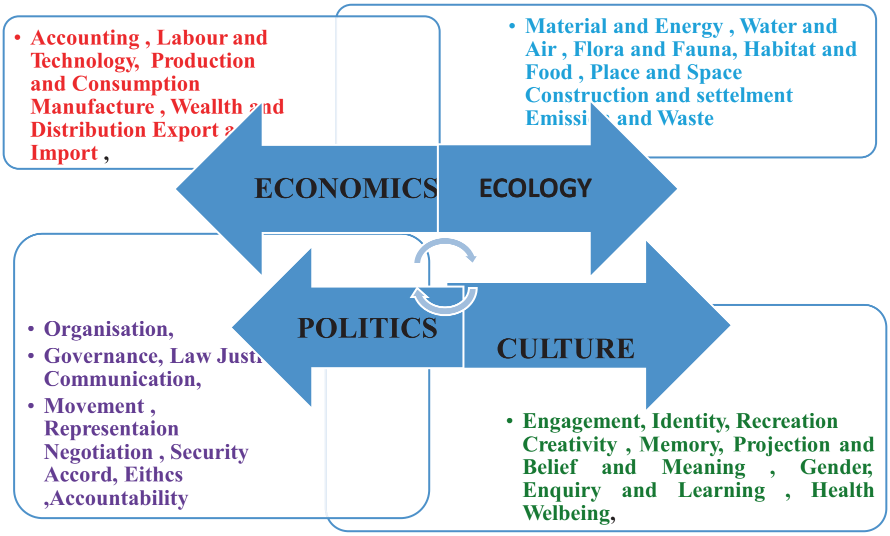


Fig. 16.5 The circle of sustainability

12 Overview

Business ethics reflects the philosophy of business, one of whose aims is to determine the fundamental purposes of a company. If a company's goal is to maximize shareholder returns, sacrificing profits to other concerns violates its fiduciary responsibility. Corporate entities are legally considered persons in the United States and most nations. The "corporate persons" are legally entitled to the rights and liabilities due to citizens as persons. *Economist Milton Friedman writes that corporate executive's responsibility generally will be to make as much money as possible while conforming to their basic rules of society, both those embodied in law and those displayed in ethical custom*. Milton Friedman also said, "The only entities who can have responsibilities are individuals." A business cannot have responsibilities. So the question is do corporate executives, provided they stay within the law, have responsibilities in their business activities other than to make as much money for their stockholders as possible? And my answer to that is, no, they do not. Ronald Duska (consultant on business ethics) reviews Friedman's argument as substantial rather than practical, implying corporate freedom, which would benefit the most in the longer term. Similarly, another business consultant Peter Drucker observed, "There is neither a separate ethics of business nor is one needed," implying that the standard of personal ethics covers all business situations.

According to the guiding principle of CSR, an ethical business must act ethically in its communities, even if it means sacrificing revenues or other important goals. Many developed countries, including the United States, regard corporations as people under the law. For example, they can own property, but their rights to free expression are limited, which may be effectively justified because they have their ethical obligations. As a company's fiduciary agent for its stockholders, its employees, customers, suppliers, and neighbors are at the heart of ethical considerations. Corporate social entrepreneurship, corporate governance, political contributions, and a few legal concerns, such as the moral concern about introducing a crime of corporate manslaughter, are all closely related.

1. *Human Resource Management*
   Personnel assets cover many activities, from enlistment selection and direction to execution inspection and preparation and advancement, current relationships and well-being, and security concerns. There is a wide range of viewpoints among business ethicists regarding morality in the workplace. There have been studies on human asset arrangements to determine whether or not libertarian working conditions and a sense of accomplishment are supported. There should be a clear distinction between fundamental freedoms and questionable liberties regarding issues such as business, security, and pay. A preference for young or elderly is sex/inappropriate conduct and race, religion, handicap, weight, and allure. Government policy toward social minorities is a standard method of combating segregation. Licensed innovation insurance and whistleblowing are just two of potential representatives' moral responsibilities to their bosses. Bosses should think about keeping their workplaces safe, which may entail moving to a new location or providing employees with adequate training or information about potential hazards. However, many of the more significant monetary issues that affect working environments and have a moral component are beyond the control of individual firms.
2. *Management Strategy*
   A "delicate" approach that sees employees as a source of innovative energy and members of the working environment navigators, a "hard" form unequivocally centered on control and hypothesis Z, which underpins the theory, culture, and agreement of the organization, is one of the techniques used by executives in organizations. According to a few studies, none of the above guarantees morality; economic success necessitates humane treatment and a happy workforce.
3. *Finance*
   In general, the study of finance can be classified as a branch of sociology. Humanism, finance, accounting, and bookkeeping are all included in the discipline's purview. Specialized difficulties, such as the combination of obligation and worth, profit strategy, the evaluation of alternative venture projects, choices, fates and trades, various subordinates, portfolio expansion, and many others, are addressed. It is frequently mistaken for a morally free discipline. In the wake of the 2008 financial crisis, pundits questioned the morality of those in charge of the United States and European monetary foundations and administrative agencies. For another reason, challenges in finance are frequently referred to be legal rather than moral ones.
4. *Finance Worldview*
   Aristotle said, "The end and motivation behind the polis is easy street." Adam Smith portrayed easy street as material products and academic and moral

strengths of character. In his *The Wealth of Nations*, Smith remarked, "All for ourselves, and nothing for other people, seems, in every age of the world, to have been the vile maxim of the masters of mankind." Neoliberal philosophy profoundly advanced money from its situation as a part of financial matters. Be that as it may, a part of business analysts impacted by the philosophy of neoliberalism deciphered the target of financial issues to be an augmentation of economic development through speed-up utilization and creation of labor and products.

5. *Trade Unions*

   Associations, for example, might exert pressure on employers to improve working conditions for their employees, but they can also jeopardize jobs by asking for excessive compensation and rigid work restrictions. Because of the potential moral repercussions of work decisions that favor a few specialists over others, unionized workplaces can withstand efforts to break up associations and strike.

6. *Sales and Marketing*

   As recently as the 1990s, showcasing emerged. Deontology, consequentialism logic, and relativism all contributed to the rise of advertising morality in proper or ethical morals. The standards, attitudes, and beliefs that advertisers (and promotion organizations) should adhere to are managed by advertising. Further, besides the recently revealed topic of expected disputes among benefits and varied concerns, promoting morality is also problematic. Concern for customer safety and independence, publicizing honesty, and decency in estimation and distribution are all examples of ethical marketing issues. Some of the examples are like advertising risky products or services straightforwardly about natural dangers and item fixings, such as hereditarily modified life forms that pose possible health issues, monetary dangers, and security threats. The standards to fantastic showcasing are set by promoting morals, with no regard for the product or the market being targeted. Remember that all showcasing choices and initiatives must be made with the needs of customers, suppliers, and coworkers in mind to be ethical and practical. Many businesses are concerned for the people and the environment in which they operate. They believe that they owe it to the people, places, and things within their practical grasp to fulfill their social obligations.

7. *Other Issues*

   Money and bookkeeping incorporate decency in exchanging works on conditions, monetary contracting, bargains rehearse, consultancy administrations, charge instalments, internal review, outside review, and chief pay. Creative accounting benefits the executives, deluding financial investigation, insider trading, protection misrepresentation, payoff/payoffs, and assistance instalments which are examples of specific corporation moral/legitimate maltreatments. Outside of businesses, container stores and currency tricks are illicit restrictions of monetary business sectors. Accounting heists, Enron, WorldCom, and Satyam, are among the cases.

13 Principles of Corporate Governance and Work Culture

Some corporate governance concepts in connection with work culture are given below.

- The board should possess required talents and comprehension to audit and challenge the executive's execution. It also requires a proper size and appropriate levels of freedom and responsibility.
- Associations should respect investors' rights and support them in exercising their rights. They can help investors exercise their rights by disseminating information transparently and adequately and allowing investors to participate in large meetings.
- Non-investor partners, such as representatives, financial supporters, lenders, providers, neighborhood networks, clients, and strategy designers, should believe that organizations have genuine, authoritative, social, and market-driven commitments.
- To provide partners with a sense of responsibility, associations should clarify and make openly available the roles and responsibilities of the board of directors and the executives. They should also conduct techniques to check and defend the organization's financial reporting integrity freely. Material information about the organization should be disseminated in an ideal and adjusted manner to ensure that all financial backers access transparent, authentic data.
- Associations should cultivate a set of standards for their chiefs and leaders that promote moral and capable leadership.

An illustration The Sarbanes-Oxley Act, better known as Sarbox, is an attempt by United States government to implement several principles outlined in the Cadbury and OECD studies. Some of them are as follows:

- Rights of shareholders need to be respected by the organizations and also help them in the execution of such rights. This can be done by communicating information freely and efficiently. Shareholders should also be encouraged to attend all-purpose assemblies.
- Establishments must comprehend their legal, contractual, social, and market-driven responsibilities to non-shareholder including its staffs, investors, suppliers, contractors, native societies, clients, and policymakers.
- Adequate skills and understanding to examine and criticize management performance must be there. There is also required sufficient size and acceptable degrees of liberation and devotion.
- Reliability and integrity is a must while deciding business leaders and board members. A code of conduct for their directors and executives backing up the moral and accountable decision making has to be created by the corporations.
- Organizations should clarify the duties and responsibilities of the board and management which have to be brought to public domain by the concerned companies and organizations so that a level of accountability can be maintained with the stakeholders. Mechanisms to independently check and protect the company's

financial reporting should also be put in place. Issues pertaining the business have to be revealed in a time-bound manner. A balance should be made while making policies and decisions to make sure that all investors have an access to transparent, genuine information.

Looking at the ongoing scenario, developing countries such as India, can focus on the following measures:

1. Ensuring proper cleanliness and hygienic living as well working conditions for all.
2. Sponsoring research activities pertinent to regional environmental issues.
3. Ensuring safety against all industrial hazards (known and proven).
4. Finding economical solutions for recovery of hazardous industrial wastes.
5. Encouraging afforestation drive.
6. Finding alternatives for proven hazardous substances which can be procured locally and not following the solutions which are used in developed countries.
7. Environmental education should be made an important aspect of the syllabi. It should be ensured at all levels.
8. Encouraging usage of alternate energy sources as, for example, wind energy and solar energy.
9. Encouraging manufacturing of environment-friendly products.
10. Popularizing biotechniques and usage of organic fertilizers.
11. Environmental impact assessment and environmental management are the key for sustainable development.
12. Need for socialization and also humanization of all environmental issues.

14 Role of Developers

It is the universal truth that the business is the major driver of economy of any nation and can help in growth and development along with poverty alleviation. Organizations and companies are also responsible for most of the global environmental changes such as loss of biodiversity, global emissions of greenhouse gases, using stock of resources available in nature, increasing usage of fresh water, use harmful chemicals, bleaching of coral reefs, and generate waste. Although business is creating problems, still it is a part of solution. Under such situation the business needs to be developed in sustainable fashion by innovation and creativity keeping in mind the needs of the future generation. Due to the efforts of the people in business enterprises, the ozone hole is healing as they have reduced the production, consumption, and thus the release of ozone-depleting substances (UNEP, GEO 2000).The following section would highlight the role of developers in any organization as a part of CSR.

In China, the government has been promoting corporate social and environmental responsibility, and the urban residential apartment development industry is under pressure for its implementation, as they have major contribution toward the gross domestic product of the nation. Since it is mandated by the government, the apartment developers execute the environment-friendly and sustainable practices in the process of apartment building in industrial sector.

15 Accountability of Software Developers

Business accountability is not the domain of business leaders only; it should be extended to other important players within any organization like the developers including the software developers who are now an integral part of any organization in the world of digitalization. The software developers should also become socially conscious and build their products keeping in mind the ethical principles and embracing CSR. New technologies like artificial intelligence are nowadays used to handle processes which were done manually, and automation is becoming increasingly used in all industries from marketing to legal affairs. Hence the role of software developers becomes critical as they need to devise programs keeping in mind the mission and vision of the company and at the same time being accountable.

To reiterate what was opined by Charles Darwin that species which are responsive to change survive and not the strongest or most intelligent ones (Charles Darwin, 1859), new technologies with new partnerships and markets would be generated by following the principles of sustainability which would be influenced by government policies and public awareness. It is a collective responsibility of all the stakeholders in business to work out strategies which makes the process sustainable. Whenever new constructions are done, builders should think about the future generations as a part of CSR and build sustainable structures with facilities for rainwater harvesting, recycling of waste water, harnessing solar energy, etc., so that we can save on resources and harness waste into wealth. The consumers also should think about sustainability before investing their money, and pressure from the policymakers can be very useful in giving an impetus to sustainable development.

16 Futuristic Thoughts About CSR in New Normal

With the COVID-19 pandemic creating havoc in lives of all humans since its first outbreak in Wuhan in December 2019, all business houses have been also been impacted and are facing threats to survival; under these changes, let us reflect on the futuristic approach of CSR. The survival of companies is at stake, and their existence is being challenged, and in this new normal, can they fulfill societal responsibilities and make enough profit to continue? At this juncture we are in age of responsibility from the perspective of CSR, which has evolved and transformed through the overlapping stages and ages of greed, philanthropy, marketing, and management. Strong governance, contribution of stakeholders, environmental integrity, and creation of values all are an integral part of CSR. The pandemic has created social, economic, physical, and mental turbulence which can lead to altered applications and implications in terms of CSR. Researchers are of opinion that for fulfilling CSR in the new normal, defining the purpose should be an essential priority using the principles of inclusion, identification, innovation, collaborating with the partners, co-creation, and engagement with stakeholders. In the pandemic situation, wherein pinning the issues and exact timings are difficult, under such conditions the organizations need to be concerned about the employees and consumers who are the major stakeholders and attend them keeping in mind the sustainability issues. Depending on the requirements and economic pressure, the organization would circumspect on what is their ability and how much is their willingness in relation to CSR. It is expected that in order to successfully emanate from the pandemic and at the same time maintaining flexibility, the organizations would have more contractual positions and lesser permanent ones. The coming years would have CSR-related programs with emphasis on workplace locations, jobs, work, work culture, and health since job and work crisis have been faced by people all over the globe. Social media and technological advancement have opened new avenues related to work which would define societal and business linkage at the same time focusing on aspects related to cyber security and governance. The CSR aspects pertaining to consumers should focus attention to product safety, physical and mental well-being, medicines, etc. In these changing times, CSR would be challenging in some sectors like hospitality and entertainment which include vacations, travel, and gaming and television programs. The initiatives of CSR in future should not be restricted to just good intentions but for larger social impacts and moving from corporate social responsibility to corporate social impacts with focus on environmental sustainability through corporate social responsiveness and corporate social performance.

17 Conclusion

Corporate social responsibility becomes an absolute reality only when it takes up social and environmental concerns. The idea of taking responsibility for helping and contributing to addressing social issues is lovely. Yet as discussed in this chapter, it is clear that several initiatives are needed on the ground. Ideas are always beautiful and welcoming, but they become fruitful and meaningful only when put into practice. The corporate world and the business leaders have to think beyond generating revenues and profits. It is acceptable that a person establishes business for profit-making. But profit-making should not be the sole aim. Businesses flourish at the cost of the quality of the environment and its resources. The health of the people is compromised. The land gets diverted while establishing and expanding the business empires. Therefore, it becomes the moral and legal responsibility of the business world to take care of the society and environment. These aspects should be given equal weightage as revenue-generating.

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Chapter 17
Plastic Pollution During COVID-19 Pandemic: A Disaster in the Making

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Abstract The COVID-19 pandemic has impacted all spheres of human life and the global environmental parameters to a large extent. Research studies by scientists across the globe pointed out that COVID-19 is both a boon and a bane for the environment. While safety restrictions imposed because of this global pandemic led to a substantial reduction in air and water pollution due to the lowering of anthropogenic activities and other associated human interferences, there has been an increasing dependence on plastics in people's lives all over the world. The astronomical increase in online shopping of groceries and associated home supplies, disposable plastic utensils, packaged food containers, and protective gears while under lockdown or in self-isolation have led to plastic pollution being out of control. The solid waste management system in the Indian cities already has its inherent shortcomings

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due to the lack of human resources, machinery, funds, awareness, etc. Excessive use of plastics has further augmented this problem, thereby jeopardizing the ambient environment. Moreover, the utilization of sealed bags in a clinical setting for the safe disposal of contaminated plastic wastes that need further sterilization adds to the existing burden of plastic wastes. The disposable masks on getting submerged in water result in the leaching of ecotoxic chemicals and nanoplastics into the environment, thereby impacting aquatic life in the long run. Exorbitant use and careless disposal of personal protective equipment (PPE) kits, face shields, gloves, disposable surgical/other masks, and shower caps have been a perennial problem during the ongoing pandemic in all cities (big or small) across the globe. Therefore, the need of the hour is to mitigate this uncontrolled rise in plastic pollution and the introduction of alternatives to conventional plastics for daily medicinal use. The focus should be on sustainable plastic waste management and moving toward eco-friendly materials such as jute, hemp, and bioplastics, etc., along with creating awareness among the public about scientific management and disposal as well as advocating the principle of 4 Rs, i.e., reduce, reuse, recycle, and refuse/recover.

Keywords COVID-19 pandemic · Single-use plastic (SUP) overuse · Plastic pollution · Sustainable waste management · Bioplastics · Biodegradation · Recycling

1 Introduction

The SARS-CoV-2, the causative agent of the novel coronavirus disease 2019 (COVID-19), reigns over the entire global community since the first outbreak of this virus in Wuhan, China, in December 2019. The World Health Organization (WHO) declared COVID-19 a pandemic on March 11, 2020, owing to more than 3 million cases and 207,973 deaths in 213 countries and territories (WHO, 2020). This infectious virus has thrown the entire world's machinery out of gear with unanticipated fear and anxiety despite the slowly emerging vaccination drives in most countries around December 2020. Needless to say, the pandemic has created unparalleled catastrophic distress in people's lives, physically, mentally, and financially (Agarwal et al., 2020; Pak et al., 2020; Alghamdi, 2021). To control the rapid spread of SARS-CoV-2, local/regional/nationwide lockdown measures had been announced worldwide during early 2020 and continued in 2021 in many countries with the emergence of new viral variants; this has left an indelible mark on the environment as well (Table 17.1). Initially, during the lockdown period in 2020, some researchers had observed an improvement in environmental parameters across the world, such as the air (Mitra et al., 2020; Wang et al., 2020) and water quality (Chakraborty et al., 2020; Dhar et al., 2020) with imposed travel restrictions and as several thousands of people were all stranded at home for months, thereby reducing the anthropogenic and/or carbon dioxide (CO_2) footprints.

Table 17.1 Environmental impacts of COVID-19 pandemic and subsequent lockdown measures

Environmental impacts	
Positive	Negative
• Improved outdoor quality of air (Bashir et al., 2020; Dutheil et al., 2020; Muhammad et al., 2020; Tobías et al., 2020)	• Deteriorated indoor quality of air (Dutheil et al., 2020)
• Decreased noise pollution	• Increased biomedical wastes, including plastic wastes (Wang et al., 2020; Kalantary et al., 2021)
• Decreased household and commercial food wastes (Jribi et al., 2020)	• Decreased recycling of wastes and increased use of landfilling and incineration as methods of solid waste disposal (Torkashvand et al., 2021)
• Decreased energy consumption and greenhouse gas (GHG) emissions (Ficetola & Rubolini, 2020; Wang & Su, 2020)	• Increased disinfection regime using toxic chemicals, including sodium hypochlorite (NaClO) (1%) and ethanol-based products (at least 70%) in both indoor and outdoor (domestic and commercial) environments https://www.mohfw.gov.in/pdf/Guidelinesondisinfectionofcommonpublicplacesincludingoffices.pdf)

On the other hand, solid waste generation has taken a gigantic leap. COVID-19 is scientifically and medically proved to be a highly contagious disease with multiple entry routes via abiotic and biotic contacts through surfaces, wastes, airborne aerosols or respiratory droplets, and oral-fecal transmission (Dietz et al., 2020; Heller et al., 2020; Kitajima et al., 2020). Owing to the persistence of the virus on inert surfaces from 3 h to 9 days (Kampf et al., 2020a; van Doremalen et al., 2020; Wang et al., 2020) and because of human-to-human transmission primarily through respiratory droplets (Chan et al., 2020; Jayaweera et al., 2020), there has been a rapid spread of infection within the community. Irrespective of nations, the central government/governing bodies in compliance with the guidelines recommended by WHO issued various safety protocols related to COVID-19, which included but were not limited to maintenance of social distancing, frequent washing/sanitizing of hands, use of face shields, face masks, and gloves along with the practice of quarantine measures upon accidental contact with COVID-19 suspects to prevent and control the rapid transmission of SARS-CoV-2 infection. However, many of these containment measures taken by public and healthcare workers have resulted in an increase in the plastic wastes by leaps and bounds, mainly in the form of disposable protective gears such as personal protective equipment (PPE) kits, face shields, surgical/other types of masks, gloves, shower caps along with packaging materials, and disposable plastic cutlery for hospitalized/home quarantined patients and/or isolated individuals suspected of COVID-19 (Adyel, 2020).

Plastics are affordable, accessible, durable, and water-resistant; thereby, they have a wide application in innovation related to modern science and technology (North & Halden, 2013). The plastics and their use are not harmful, but their mismanagement and underutilization of these multipurpose resources are causing hazards to the environment (Borg, 2020). Moreover, the announcement of lockdown measures and subsequent restriction on traffic movements and imposed curfews had resulted in panic buying of medicines as well as accelerated online and/or offline shopping for essential daily needs, including groceries, etc., leading to overuse of single-use plastic (SUP) carry bags of various shapes and sizes in a short span than never before. It is noteworthy that in order to cater to the millions of bachelors, frontline workers, working couples, and older people who did not have the time or scope to cook their meals, the online/offline home delivery services were kept accessible (some of which were even made specially available) during the lockdown period. This has created a huge demand and supply of packed or packaged food, thereby stimulating the usage of plastic food containers and accompanying cutlery along with SUP packaging materials. During the pandemic, with shops and restaurants closed due to the imposed lockdown together with the government slogan *Stay safe stay home* has changed people's consumption and living habits creating ambiguity in waste generation patterns for convenience (e.g., online shopping and food delivery) and assurance (e.g., contactless delivery) (Bengali, 2020). Figure 17.1 shows the increasing trend in e-shopping and food takeaways on a global scale during the COVID-19 pandemic. This humongous plastic waste generation during the pandemic is adding to the existing solid wastes, thereby aggravating the challenges of the overburdened solid waste management system, eventually leading to

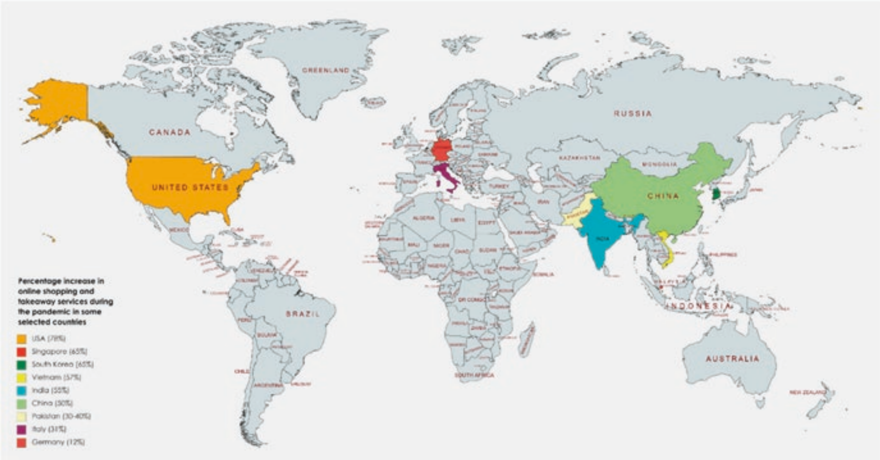


Fig. 17.1 Global map showing an increase in the percentage of e-shopping and takeaway services in a few selected nations during the COVID-19 pandemic. (Reprinted from Parashar and Hait (2021). Copyright (2021), with permission from Elsevier CC-BY-NC-ND license no. 173901166796)

deterioration in the overall health of the environment and ecosystem toxicity. Many shortcomings and discrepancies in the waste management system have been observed during the pandemic due to many reasons, which included capacity constraints of facilities, a shortfall in the workforce due to nationwide lockdown, disturbances in mechanical recycling facilities (like compactors), absence of doorstep waste collection systems daily, stigma against COVID-19 patients resulting in non-collection of their regular domestic wastes, etc. (B.I.R., 2020; Das et al., 2021). All these constraints would eventually lead to inappropriate waste disposal and massive mismanagement of municipal solid wastes in almost all big cities of the world, especially in the developing countries, causing massive deterioration of environmental health.

As is evident from both Figs. 17.2 and 17.3, the biomedical plastic wastes consisting of personal protective equipment (PPE) kits, glucose bottles, syringes, gloves, disposable face masks, etc., have been on the rise due to the global pandemic. The average daily generation of biomedical plastic wastes during the SARS-CoV-2 viral outbreak in India is represented in Fig. 17.3.

Figure 17.4 shows the various plastic types, uses, and recyclability during the pandemic.

Prior to the pandemic, the key attention was to beat the use of plastics and make crowded places such as temples, churches, mosques, markets, shopping malls, and multiplexes plastic-free. The cumulative action worldwide was to reduce plastic consumption and change customers' behavior toward plastic use by levy charges for getting access to a plastic bag(s) after every purchase of groceries/goods. However, the pandemic has dramatically augmented the complexities of plastic waste management across the globe. Researchers from Swansea University (UK) have found

Fig. 17.2 The map illustrates the average daily generation of biomedical wastes comprising discarded synthetic plastics in some selected Asian nations or their important cities during the COVID-19 pandemic. (Reprinted from Parashar and Hait (2021). Copyright (2021), with permission from Elsevier CC-BY-NC-ND license no. 173901166796)

that the disposable masks leach toxic chemicals (like heavy metals/metalloids) and nanoplastics into the ambient environment on becoming submerged in water. The levels of heavy metals such as antimony, copper, and lead were found in the range of parts per million (ppm) or parts per billion (ppb) (https://www.swansea.ac.uk/press-office/news-events/news/2021/05/nanoplastics-and-other-harmful-pollutants--found-within-disposable-face-masks.php). Although the levels are low, in the larger picture, the amount of production, usage, and disposal of these protective face masks have been increasing and would continue for quite some time in future till this pandemic is ongoing. The impact on the aquatic environment might not appear to be a big issue at present as the focus is arresting the pandemic and saving human lives. These heavy metals can bioaccumulate in the tissues of edible fish, as has been studied by Dutta et al. (2021), and they are not removed from the fish body but instead build up over time as recalcitrant xenobiotic substances that interact with socio-ecological systems, causing havoc damage to the fragile ecology of the ecosystems in consideration. As per the report of the WWF (World Wide Fund for Nature), if people only dispose of 1% of the face masks inappropriately and they are dispersed in nature, it would amount to almost 10 million masks (0.33 million

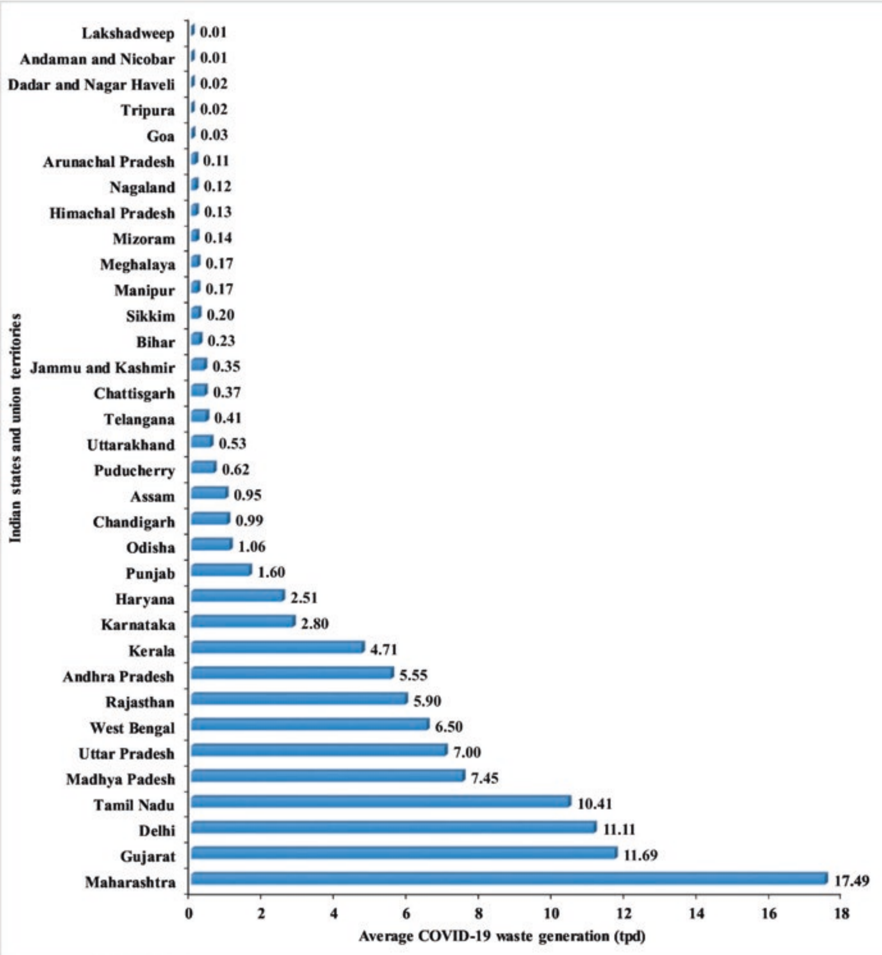


Fig. 17.3 Daily average of generated biomedical wastes comprising disposed plastics in India. (Reprinted from Parashar and Hait (2021). Copyright (2021), with permission from Elsevier CC-BY-NC-ND license no. 173901166796)

masks per day) that would be contaminating all trophic levels of the ecosystem (Italy WWF, 2020). The multilayered masks with various polymers are difficult to recycle, especially those imported from China (Monella, 2020).

The fear of the contagious disease and the protective measures used by the commoners and frontline workers following the medical/WHO guidelines resulted in the enormous use of protective gears, which have become a tremendous challenge for environmental scientists and researchers across the globe. The present pandemic needs to mitigate plastic pollution by promoting alternative biodegradable plastics (or bioplastics) and advocating and practicing the principle of 4 Rs, namely, reduce, reuse, recycle, and refuse/recover.

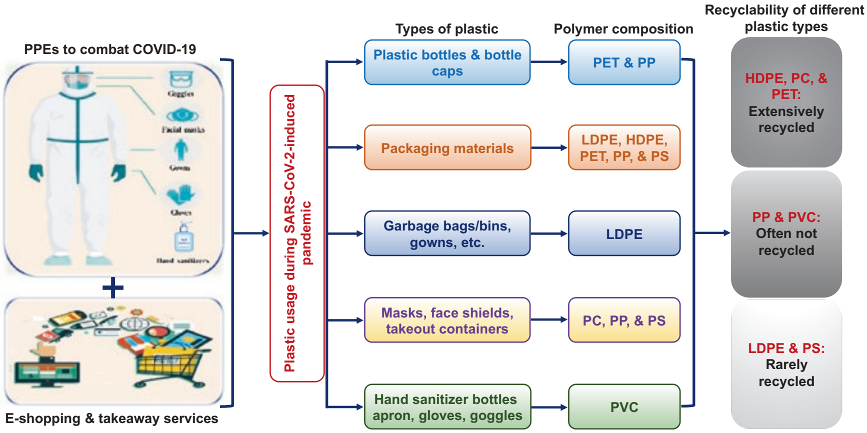


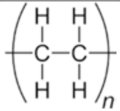
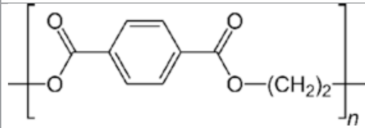
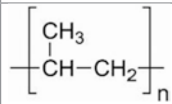
Fig. 17.4 Various categories of plastic-based biomedical and domestic/commercial wastes generated during the global SARS-CoV-2 outbreak and subsequent COVID-19 pandemic phase with their utilization and recyclability

2 Diversity of Commonly Used Synthetic Plastics

Based on the degradation pathways (associated with bonding patterns in the polymer backbone), the synthetic plastics are categorized as (1) plastics having carbon-carbon (C-C) backbone (i.e., backbone made of carbon atoms) and (2) plastics having heteroatoms in their main polymeric chain. Polythene/polyethylene (PE), polypropylene (PP), polystyrene (PS), and polyvinyl chloride (PVC) plastics with C-C backbones comprise the first group. In contrast, polyethylene terephthalate (PET) and polyurethane (PU) with heteroatoms in their main polymeric chains fall under the second group (Table 17.2).

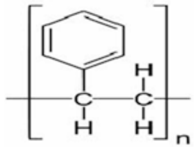
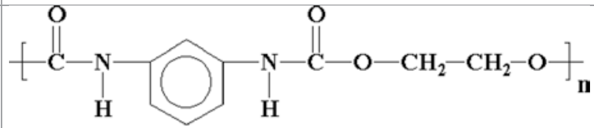
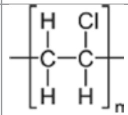
The polymeric chain is linear in PE with hydrogen-bonded carbon atoms, and its structure is semicrystalline. Based on the differences in densities, PE polymers are further classified as low-density polyethylene (LDPE), linear low-density polyethylene (LLDPE), low-molecular-weight polyethylene (LMWPE), and high-density polyethylene (HDPE). Out of all these four types of PE, the LDPE is found to be discarded mostly in landfills as plastic bags (69.13%) (Mohanan et al., 2020). However, the most abundantly used plastic is PS, owing to its low cost and good mechanical property. Based on application, PS are generally grouped as general purpose polystyrene (GPPS) or oriented polystyrene (OPS), high impact polystyrene (HIPS) (also referred to as PS), PS foam, and expanded polystyrene (EPS) foam (Ho et al., 2018). PP is a linear polymer, which is widely used among synthesized polymers. The properties of PP are quite similar to PE, but some differences exist, for instance, in hardness, heat, and chemical resistance, the former being more hard, more resistant toward heat and chemicals. PVC has been in use for many years owing to its rigidity and plasticized form. PET and PU plastics are more thermally stable in comparison to PE, PP, PS, and PVC because of the presence of heteroatoms in their main polymeric chain (Venkatachalam et al., 2012).

Table 17.2 Characteristic features, molecular formula, IUPAC nomenclature, structure, and uses of major commercial synthetic polymers

Sl. no.	Name	Highlight(s)	Formula	IUPAC name/ID	Structure	Uses/used in/used as
1.	Polythene/ polyethylene (PE)	• Most common plastic in use today	$(C_2H_4)_n$	Polyethene or poly(ethylene		Films, tubes, plastic parts, laminates, etc., in packaging, automotive, electrical appliances/ parts, etc.
2.	Polyethylene terephthalate (PET)	• Most common thermo-plastic polymer resin belonging to the polyester family	$(C_{10}H_8O_4)_n$	Poly(ethyl benzene-1,4-dicarboxylate)		Manufacturing bottles, liquid and food containers, textile fibers, and films Also, thermoforming for manufacturing and engineering resins (in combination with glass fibers)
3.	Polypropylene/ polypropene (PP)	• A thermoplastic polymer with wide-spectrum applications • Produced via chain-growth polymerization from the monomer known as propylene • Belongs to the group of polyolefins • Partially crystalline and nonpolar	$(C_3H_6)_n$	Poly(propene)		Food packaging, textiles, laboratory equipment, and automotive components

(continued)

Table 17.2 (continued)

Sl. no.	Name	Highlight(s)	Formula	IUPAC name/ID	Structure	Uses/used in/used as
4.	Polystyrene (PS)	• A synthetic aromatic hydrocarbon polymer that is made from the monomer called styrene • Can be solid or foamed	$(C_8H_8)_n$	Poly(1-phenylethene-1,2-diyl)		Packaging foam, food containers, construction materials (insulation), cassette boxes, compact disks, disposable cups, plates, and cutleries
5.	Polyurethane (PU/PUR)	• A commonly found polymer, which is composed of organic units that are joined by carbamate (urethane) links	$C_3H_8N_2O$	Ethylurea		Catheters for medical application, as foams, domestic consumables, in industrial products, adhesives, insulation, coats, tires, sponges, paints, and fibers
6.	Polyvinyl chloride (PVC)	• World's third-most widely generated synthetic plastic polymer (after PE and PP)	$(C_2H_3Cl)_n$	Poly(1-chloroethylene)		Building, transport, packaging, electrical/ electronic, and healthcare applications

3 Causes and Effects of Plastic Pollution on the Different Ecosystems: A Global Perspective

Representative examples highlighting the current global plastic pollution crisis across various geographically distinct locations and ecosystems derived from the review of recent literature with particular emphasis on the SARS-CoV-2-induced COVID-19 pandemic have been tabulated below (Table 17.3).

From Table 17.3, it can be further concluded that mushrooming of plastic waste accumulation has turned out to be a public menace and poses a severe socio-environmental challenge. Hence, the need of the hour is to develop innovative techniques or utilize existing ones for the disposal and/or degradation of plastic wastes in a sustainable manner.

4 Generation of Biomedical and Domestic/Commercial Plastic Wastes During COVID-19 Pandemic

During the period of the COVID-19 pandemic, plastic-based products have played essential roles in providing protection to people against viral infection. The extensive use of PPE during the pandemic caused significant disruption in the supply chain as well as waste disposal systems. Millions of discarded SUPs, including aprons, hand sanitizer bottles, gloves, and face masks, have been incorporated into the land ecosystems, which might eventually result in plastic surges along the sea/ocean coastlines and littering of the seabeds. Benson et al. (2021) assessed the potential environmental impacts of the synthetic plastic wastes generated globally during the pandemic. The study estimated that 1.6 million tons of plastic wastes per day had been generated worldwide since the viral outbreak. Further estimation revealed that around 3.4 billion single-use face masks or face shields are disposed of daily due to the pandemic throughout the world.

Biomedical waste (BMW) is a tricky business; it has become even more so in the wake of COVID-19. Not only has the number of biomedical wastes produced increased but also with people being quarantined at home, infectious wastes need to be collected and processed from residential complexes. Based on the State of India's Environment in Figs. 2021 (a CSE publication), there has been a 46 percent jump in the generation of biomedical wastes in India in just 2 months of April and May 2021 (https://www.cseindia.org/ state-of-india-s-environment-2021-in-figures-e-book%2D%2D10831). The report further adds that the BMW generation in India has grown from 559 tons per day to 619 tons per day between 2017 and 2019, whereas the percentage of treated BMW has dropped from 92.8 percent to 88 percent. The states of Bihar and Karnataka have been listed as the worst offenders, with 69 and 47 percent untreated BMW, respectively. At the same time, although the number of authorized healthcare units across the country almost increased twofold (i.e., from 84,805 to 153,885), the number of unauthorized healthcare units also hiked up (i.e., from 57,010 to 66,713).

Table 17.3 A comprehensive review on the causes and impacts of plastic pollution across a variety of selective global ecosystems

Sl. no.	Notable examples of plastics found	Key findings	Geographical location/ ecosystem(s)	Reference(s)
1.	• PE, PP, PPE, and PS	• The highest abundance of microplastics ranging from 37,440 to 38,790 particles per kg dry weight of sediment was detected in Jakarta Bay (Indonesia) • By far, polymers like polythene or polyethylene (PE), polypropylene (PP), and polystyrene (PS) are the most extensively used plastic categories. The PE, PP, and PS were dominant in the area under study, and their sizes ranged from 300 μm to 1000 μm; this suggests the condition of microplastic particles, which have resisted deterioration for an extended period • Data on released riverine debris collected during the first wave of the COVID-19 pandemic (i.e., March and April 2020) have shown a 5% increment in debris abundance and a 23–28% decline in debris weight relative to March and April 2016 • Plastics dominated the composition of river debris at an abundance of 46%. Personal protective equipment (PPE) (face shields, gloves, hazard suits, medical masks, raincoats, etc.) accounted for around 16% of the daily collected river debris with 780 ± 138 items or 0.13 ± 0.02 tons in terms of abundance or weight, respectively • Notably, microplastics were found in the fish intestines from Jakarta Bay and mussels from Semarang Bay	Tropical coastal and marine (aquatic) ecosystems; Indonesia	Adyasari et al. (2021), Cordova et al. (2021)

2.	• PE, PET, PP, PS, and nylon	• Continental distribution of microplastics in sediments has been reported to range between 5 and 18,000 particles per kg dry weight. The highest microplastic abundance (mainly comprising fragments and fibers) was recorded in the Tunisian lagoon sediments, Northwest Africa; this is among the highest reported microplastic sediment concentration worldwide • Microplastic concentration in collected mussels from Tunisia was also high (1031 ± 355.69 particles/kg). Most of the recovered Tunisian mussel microplastics were fibers (97%) • Microplastics in the range of 7000 particles/fish were recorded from the Mediterranean coast on the Egyptian side; this accounts for one of the highest quantities of microplastics ever salvaged from any aquatic organisms globally • The order of plastic pollutants appearing in the reviewed studies is PE > PP > PS > polyethylene terephthalate (PET) > nylon. This order is representative of the global plastic demand patterns and may also represent the plastic demand patterns of the African continent • Freshwater systems act as vital channels for microplastic contamination from terrestrial sources as they ultimately drain into the estuarine and marine environments. River Niger and River Nile, the two principal African rivers are among the top ten global sea polluters • Reports suggest that African nations are among the leading air-polluting countries globally. However, no reported studies have examined the abundance of atmospheric microplastics in Africa	Marine ecosystems; Africa	Alimi et al. (2021), Choudhury et al. (2022)

(continued)

Table 17.3 (continued)

Sl. no.	Notable examples of plastics found	Key findings	Geographical location/ ecosystem(s)	Reference(s)
3.	• CE, PE, PL, PP, and RY	• A study aiming to characterize the microplastic distribution in the estuarine surface sediments of the Kayamkulam Estuary found that maximum microplastic distribution occurs at a station located in the estuarine mouth. The average abundance of microplastics in the estuarine arms was 438.8 particles/kg (left arm) and 421.5 particles/kg (right arm). Most of the particles at the site were under 1000 μm, followed by those between 1000 μm and 2000 μm. The estuarine sediments were dominated by polyester (PL) (42.98%) and PP (34.38%), followed by PE (22.62%). Fiber-shaped microplastics were most dominant, followed by the film-shaped ones • The mean abundance of microplastics was measured to be 40.7 ± 33.2 particles/m^2 (beach sediments) and 1.25 ± 0.88 particles/m^3 (coastal waters) • The abundance of microplastics in the beach sediments and coastal waters was influenced highly by the river runoffs and anthropogenic actions. PE and PP polymers were found to be predominant in marine environments • Interestingly, the digestive tracts of 21.43% commercially important fish showed the presence of microplastic particles with microplastic composition in the order 38.46% PE > 23.08% cellulose (CE) > 15.38% rayon (RY) > 15.38% PL > 7.69% PP • In addition, a wide spectrum of heavy metals, metalloids, and several other toxic chemicals was tested positive in the collected microplastic samples from the Kerala beaches	Coastal waters; Southwest India (Kerala)	Robin et al. (2020), Radhakrishnan et al. (2021)

4.	• PPE	• During a 12-week sampling span, 138 different PPE items were detected in 11 beaches at a density ranging from 0 to 7.44×10^{-4} PPE m^{-2} • The PPE items found were in the sequence: Face masks (87.7%) > face shields (6.5%) > gloves (4.3%) > others (1.5%). Among masks, 54.5% were regular surgical masks, 12.4% were KN95, and the remaining were cloth masks or unidentified mask types. • The polluted sites were in the order: recreational beaches > surfing areas > fishing sites. It was found that rather than being washed ashore, most of the PPE was discarded by the beachgoers • Both sessile and mobile aquatic species were found to be entrapped in or associated with marine plastic litter (including synthetic textiles).	City coastline; Lima City, Peru	(De-la-Torre et al., 2021, 2021a, b)
5.	• PE, PPE	• PPE wastes were sampled four times in 40 days across nine stations across the Bushehr port coastline in the Persian Gulf • Notably, 1578 face masks (including ordinary cloth masks, N95, and surgical masks) and 804 gloves (including latex gloves, nitrile gloves, plastic gloves, and vinyl gloves) were detected across a cumulative stretch of 43,577 m^2. The presence of PE gloves and surgical masks was higher than the other PPE found in the area under study. However, alcohol sanitizer spray bottles and face shields were not found in the study site • The PPE density recorded at stations closer to crowded areas was higher than the values recorded at more distant stations • Interestingly, 10% of the PPE samples collected per sampling day from the coastal areas of Bushehr port were damaged, highlighting the risk of microfiber and secondary microplastic generation, their release into the marine ecosystems, and their consequent uptake by the marine organisms	Port coastline; Bushehr, Persian Gulf (Iran)	Akhbarizadeh et al. (2021)
6.	• PE, PP	• Sediment and seawater collected from eight sandy beaches (across the Qatar coastline) and four sea surface stations (on the eastern coast) during a survey carried out between December 2014 and March 2015 revealed the presence of microplastics in these samples. The microplastics were predominantly low-density PE and PP. The microplastic concentration in the intertidal sediments ranged from 36 particles m^{-2} to 228 particles m^{-2}, with no notable differences between the eight sandy beaches investigated	Sandy beaches; Arabian Gulf	Abayomi et al. (2017)

(continued)

Table 17.3 (continued)

Sl. no.	Notable examples of plastics found	Key findings	Geographical location/ ecosystem(s)	Reference(s)
7.	• PE, PET, PP, PS, and PVC	• A review covering 98 lakes globally (78 urban +20 rural) found evidence suggesting the presence of microplastics in one or more locations (surface waters, sediments, snow and/or ice, aquatic fauna, and tributaries) of all the lakes. The predominantly studied microplastic size range was 300 microns to 1000 microns • The most common varieties of polymers found in the surface water and sediments of the 98 lakes were PE and PP, which can be associated with the global demand for polymers in 2018 • Another study covering a different set of lakes reported the most common microplastic categories in lake systems across the world to be PE, PET, PP, and polyvinyl chloride (PVC) • Effects of microplastic biomagnification in lake ecosystems have also been observed. For instance, an examination of microplastics in lake Taihu (China) revealed that the microplastic concentration in sampled fish (16.7%) was higher than the concentration of the same in the sampled water (1.8%) and sediments (9.3%) • Analysis of the microplastic content in the two representative estuaries of North China, namely, the Haihe Estuary and the Yondingxinhe Estuary of Bohai Bay, revealed that human activities were the primary driver of microplastic pollution. This finding is consistent with other reports as well. PP was the most predominant microplastic as it is commonly used in making fishing tools and other general items. Interestingly, denser microplastics like PET, PS, and PVC were present in the surface water, whereas lighter microplastics like PE, PP, and PE–PP were found in the sediments	Lake ecosystems; global	Wu et al. (2019), Dusaucy et al. (2021), Yang et al. (2022)
8.	• PE	• In a recent study, microplastics were found at all 15 sampling sites of North German farmlands, and their composition was uniform across all the sites sampled • The mean abundance of microplastics was 3.7 ± 11.9 microplastic particles per kg dry weight • Black films made of PE were the most abundant among the microplastic particles, and the microplastic contamination was noted to decrease with increasing soil depths, despite regular plowing • There is evidence suggesting that microplastic pollution in agricultural soils can negatively impact earthworms, which might lead to a decrease in agricultural productivity	Agricultural land; Northern Germany	Harms et al. (2021)

9.	• HDPE, LDPE, PE, PET, PP, and PS	• Plastics like high-density polyethylene (HDPE), low-density polyethylene (LDPE), PET, and PS have been shown to pollute sea salt in India • PE and PP have been noted to be the most prevalent microplastics across the Coromandel Coast • Microplastics have also been noticed in the marine biodiversity hotspots such as the Gulf of Mannar • Evidence suggestive of the detrimental effects of microplastics on the coral reef found along the coastline, such as the Tamil Nadu coast, has been documented • A study aiming to estimate the microplastic contamination levels in the coral reef ecosystems of the Tuticorin (or Thoothukudi) and Vembar groups of islands (Gulf of Mannar, southeast India) documented an average abundance of 60 ± 54 to 126.6 ± 97 items/l and 50 ± 29 to 103.8 ± 87 items/kg in the water and sediments of the coral reef, respectively. PE was the most abundant polymer, with fibers (1–3 mm) being the most common form in water and fragments (3–5 mm) being the most abundant form in sediment • Benthic and littoral species and fish have been documented to be at risk of microplastic consumption and accumulation • Avian fauna is also at considerable risk of microplastic poisoning. Typically, microplastic accumulation in birds occurs by accidental ingestion during their feeding and via dietary sources • For example, on the basis of their selection of food and closeness to microplastic-impacted areas in the coast of Tamil Nadu, the brahminy kite (*Haliastur indus*), white-bellied sea eagle (*Haliaeetus leucogaster*), and osprey (*Pandion haliaetus*) are most vulnerable to microplastic contamination	Indian coastal ecosystems	Patterson et al. (2020), Vikas Madhav et al. (2020), Choudhury et al. (2022)
10.	• Microplastics	• The abundance of microplastics in the seawaters of Chinese coastal seas was found to range between 0.13 and 545 items/m^3. In contrast, the abundance of microplastics in the estuarine sediments has been documented to range between 20 and 7900 items/kg • High microplastic contamination was found in the estuarine waters, especially during the monsoon season. For example, Pearl River Estuary exhibited maximum microplastic abundance (851 ± 177 items/kg) • Microplastic levels in Chinese seas were moderate or lower compared to other countries	Coastal and marginal seas; China	Jiang et al. (2022)

(continued)

Table 17.3 (continued)

Sl. no.	Notable examples of plastics found	Key findings	Geographical location/ ecosystem(s)	Reference(s)
11.	• Microplastics (synthetic fibers)	• Microplastics were found to contaminate aquaculture installations. For example, 16.4/m^3 microplastics were detected in the region in Jurujuba cove, where mussel farming is practiced • In contrast, the overall mean abundance of microplastics in the Xiangshan Bay was 8.9 ± 4.7 items/m^3 (seawater) and 1739 ± 2153 items/kg (sediment) • The presence of microplastics has also been documented in the freshwater aquaculture environments like the fishponds in the Carpathian Basin (13.79 ± 9.26 particles/m^3), rice-fish co-culture systems in Shanghai (0.4 ± 0.1 items/l), eel culture stations in Shanghai (1.0 ± 0.4 items/l), and scallop aquaculture sites in Shandong • Microplastics have been detected in several aquatic species, namely, commercially edible species like fish, shrimp, crabs, and mussels. For instance, shrimp from coastal waters of the southern North Sea and channel area have shown the presence of synthetic fibers ranging from 200 to 1000 mm (average = 1.23 ± 0.99 items/individual)	Aquaculture ecosystems; China	Chen et al. (2021)
12.	• Microplastics and synthetic fibers	• Microplastic particles (26–51 particles/m^3) have been found in the surface water of the River Ganges, India, which is equivalent to 91% plastic fibers and 9% fragments of plastics • Based on the study findings, it is estimated that 1–3 billion microplastics finally get released into the bay of Bengal based on the flow rates at different sites	Freshwater ecosystem, River Ganges, South Asia (India)	Napper et al. (2021)
13.	• Microplastics	• Microplastics averaging 288 pieces/m^3 found in the river Netravathi, Karnataka, India, 96 pieces/kg in sediment and 84.45 pieces/kg in soil. This river finally debouches in the Arabian Sea. The categories of microplastics obtained are fibers, fragments, and films	River Netravathi, Karnataka, India	Amrutha and Warrier (2020)

On the contrary, it is noteworthy that the number of units generating hazardous wastes across the nation increased by 3.5 percent, but the generation of hazardous wastes has reduced by around 7 percent. In April 2021, India generated 139 tons per day of COVID-19-related BMW, as the world's second populous nation was battling the second wave of COVID-19. In the following month (i.e., May 2021), the figure rose to 203 tons per day (with an increment of 46 percent), which is extremely distressing. The increase in BMW has directly contributed to the astronomical increase in the plastic wastes throughout the pandemic era.

5 The Sustainable Road Ahead

5.1 Microbial Degradation of Plastics

Microbes play a pivotal role in the biological degradation or decomposition of substances, such as synthetic polymers present in the ambient natural environments; this process is known as biodegradation. Petroleum-based polymers or petro-polymers like PE, PET, PP, PS, PU, and PVC are tough to degrade naturally. HDPE and LDPE are among the most frequently utilized synthetic plastics. However, they pose serious environmental threats because of their slow degradability in natural environments. Therefore, there is an increasing interest in the biodegradation of nondegradable/recalcitrant synthetic plastics with the use of effective and selective microbes (Lee et al., 1991; Boonchan et al., 2000; Bonhomme et al., 2003; Gu, 2003; Mohanan et al., 2020).

A few microbes capable of degrading these petro-polymers (i.e., synthetic polymers) under laboratory (in vitro) conditions have been isolated, identified genetically, and characterized. The microbial enzymes involved in petro-polymer biodegradation have been successfully cloned and sequenced in a few instances. Notably, the biodegradation rate of synthetic polymers relies on multiple factors, such as molecular weights, chemical structures, and their degree of crystallinity. Generally, polymers are bulky molecules containing both irregular groups (i.e., amorphous region) and regular crystals (i.e., crystalline region) where the former imparts flexibility to the polymer molecules. Polymers with high crystallinity, such as PE (95%), are usually rigid and have a low capacity for impact resistance. PET-based plastics are also highly crystalline (30–50%), which is one of the main reasons for their low biodegradation rates. Such a slow microbial degradation of PET is predicted to take >50 years for complete degradation under natural environmental conditions and over hundreds of years if disposed into the oceans, primarily because of the low temperature and availability of oxygen (Mohanan et al., 2020).

The enzymatic degradation of plastics takes place in two distinct stages, (1) surface adsorption of microbial enzymes on the polymers, which is followed by (2) hydroperoxidation or hydrolysis of polymeric bonds. Plastic-degrading or petro-polymer-degrading enzymes can be found in microbes from a variety of environments and in the digestive tracts of a few invertebrates. Microbial and/or enzymatic degradation of petroleum-based plastic wastes is undoubtedly a promising strategy

(a) for the depolymerization of these waste petro-plastics into their respective monomeric units, which is useful for plastic recycling purposes or (b) for the bioconversion of these petro-plastic wastes into value-added bioproducts, including biodegradable polymers (or biopolymers) through mineralization (Mohanan et al., 2020).

Numerous studies have been put forward, discussing the role of several microorganisms and microbial enzymes in degrading synthetic plastics. Microbes degrade biodegradable polymers quickly, owing to their inherent ability to degrade most inorganic and organic materials, such as celluloses, hemicelluloses, lignin, and starch. Although a number of reviews and research perspectives have been published on this pertinent topic of plastic biodegradation, these articles have mostly focused on the microbial/enzymatic degradation of a single category of plastic, namely, PE (Restrepo-Flórez et al., 2014), PET (Wei and Zimmermann, 2017; Kawai et al., 2019; Taniguchi et al., 2019), PS (Ho et al., 2018), PP (Arutchelvi et al. 2008), and PU (Cregut et al., 2013; Magnin et al., 2019). Biodegradation of almost all kinds of plastic has been comprehensively reviewed by (Wei and Zimmermann; 2017; Mohanan et al. 2020). The development of biofilms (which are multicellular microbial communities) on synthetic plastic waste surfaces has been proved to be effective degrading agents with enhanced resistance toward antimicrobials.

Moreover, in the majority of natural and artificial habitats, most microbial (bacterial and fungal) populations form biofilms on the solid substratum (Atkinson & Fowler, 1974), and interestingly the metabolic activity of such biofilms was found to be higher than that of individual microorganisms (Kirchman & Mitchell, 1982). Hence, there is a tremendous opportunity for developing a biofilm-based technology for increased plastic biodegradation (Seneviratne, 2003). In order to enhance the biodegradation process, chemicals or photoinitiators (molecules that generate reactive species like free radicals, anions/cations upon exposure to UV/visible radiation) or both are often added to the PE; these modified PE are then referred to as degradable PE (DPE) (Lee et al., 1991). In one such study by Seneviratne et al. (2006), microbes associated with different disposed PE (e.g., carry bags) lying and degrading in the soils were isolated and identified for developing a fungal-bacterial (*Penicillium frequentans* and *Bacillus mycoides*) biofilm for enhanced DPE biodegradation.

Notably, biological upcycling (also referred to as bio-upcycling) of plastic wastes is comparatively a newer and innovative sustainable strategy that requires further attention (Fig. 17.5) (Wierckx et al., 2015; Salvador et al., 2019; Blank et al., 2020). Jaiswal et al. (2020) has reviewed recent state-of-the-art biotechnological approaches, including applying synthetic bacterial/microbial consortia, systems biology, and genetic engineering tools/techniques that can pave the way for bioremediation of plastics through their biodegradation in the future.

5.2 *Biodegradable Plastics or Bioplastics*

Bioplastics are a suggested alternative to conventional plastics derived from mineral oil. Bioplastics are environment-friendly because of their biodegradability. Conventional nondegradable plastics are threats to the environment, and replacing

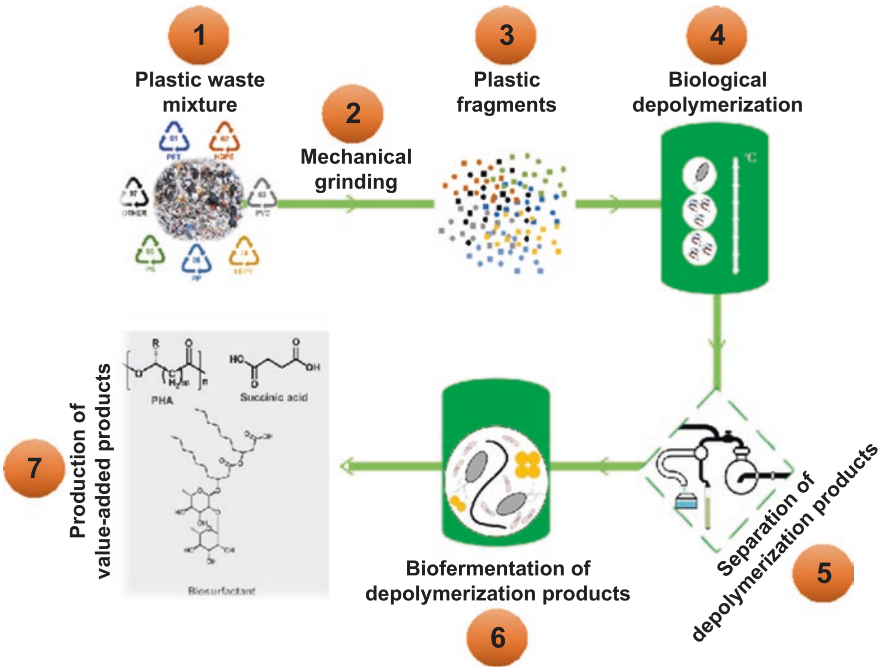


Fig. 17.5 The generalized concept of biological upcycling of plastic wastes. A mixture of various plastic wastes is first mechanically ground and biologically depolymerized using plastic-degrading microbes and microbial enzymes. The depolymerization products are then separated from the start-up culture and used as feedstock for microbial fermentation to produce chemicals/substances with high commercial value like biosurfactant, polyhydroxyalkanoate (PHA), and succinic acid. (Source: Adapted from Ru et al. (2020) with modifications)

these petroleum-based plastics with bioplastics can help overcome environmental plastic pollution; this can be a sustainable global solution. Bioplastics are made from biomass or fossils. The common raw materials that are used to produce biodegradable plastics and compostable biopolymers are maize, wheat, sunflower, wood, rice, sugarcane, etc. (Ilyas et al., 2016). Cellulose and sugar are not plastic but are converted to plastic through various innovations in polymer or fermentation technology (Misra et al., 2011). The following techniques such as extrusion (Wang, 2007), internal mixing (Mhumak & Pechyen, 2017), injection molding (Salleh et al., 2012), and casting (Yudianti & Karina, 2012) could be used for the sustainable development of bioplastics.

Polyhydroxybutyrate (PHB), a polymer utilized for bioplastic production, is utilized by microorganisms as carbon and energy sources. The enzyme that is secreted by the microbes is polyhydroxyalkanoate depolymerase to degrade the bioplastics (Mukherjee & Chatterjee, 2014). Several types of bioplastics are synthesized using various biodegradable polymers, but the biodegradability varies, and only the ones based on the polymer PHB are 100% biodegradable. The polyhydroxyalkanoates (PHA), which have been most characterized, are PHB and its copolymers, poly(3-hydroxybutyrate) [P(3HB)] and poly(3-hydroxybutyrate-co-3-hydroxyvalerate)

[P(3HB-co-3 HV)]. The polymers, PHBs, are synthesized by bacteria and are accumulated as reserve materials during their growth phase under conditions of stress (Galia, 2010), i.e., when certain nutrients become limiting like carbon (as in the case of Hyphomicrobacterium spp. and *Spirillum* spp.), nitrogen (as in the case of *Ralstonia eutropha*, *Pseudomonas oleovorans*, and *Alcaligenes latus*) and phosphates (as in the case of *Caulobacter crescentus* and *Rhodobacter rubrum*) (Kim & Lenz, 2001). More than 250 microorganisms have been identified so far, which can biosynthesize PHB naturally. However, a few are viable commercially, namely, *Alcaligenes latus*, *Bacillus megaterium*, *Cupriavidus necator*, and *Pseudomonas oleovorans*, as a low-cost and easily usable substrate having high sugar that can be utilized as a carbon source. Although greater than 300 variety of microorganisms are known to synthesize PHA, only some of these are best suited to produce high-yielding PHA (e.g., *Alcaligenes latus*, *Azotobacter vinelandii*, *Ralstonia eutropha*, recombinant *Escherichia coli*, and several strains of methylotrophs) (Lee, 1996; Lee & Chang, 1995). Bioplastics can be derived from various sources, and some common bioplastics produced from these sources are given in Table 17.4.

5.2.1 Toxicological Impact of Biodegradable Plastics

The toxic effects of pure plastics on living organisms are less because of their relative chemical inertness and water insolubility. For altering the tensile strength of plastics, plasticizers like adipates and phthalates are mixed with various plastic products, including PVC as an additive, which percolates from the plastic products in trace amounts. It has been predicted that PS present in the food containers leached and entered the body tissues of humans, causing hormonal imbalance; PS is highly carcinogenic and may have adverse impacts on living organisms. Notably, the parent polymer products are not toxic, but the monomers used during the production process are highly toxic (Venkatesh et al., 2021). Aswale (2010) investigated the impact of biodegraded PE on the germination of seeds in plants such as groundnut, safflower, sesame, soybean, and sunflower. A reduction in seed germination percentage was observed in the case of pre-treated seeds during the study. Other groups of researchers studied the microbial degradation of LDPE/PE, using both bacteria (*Pseudomonas aeruginosa*, *Staphylococcus aureus*, *Streptomyces* sp.), fungi (*Alternaria alternata*, *Aspergillus* spp., etc.), and bacterial-fungal biofilm (*Bacillus mycoides* and *Penicillium frequentans*) along with the level of biodegraded PE toxicity (Seneviratne et al., 2006; Pramila & Ramesh, 2011; Ameen et al., 2015). It is to be noted that the main product produced during PE degradation is CO_2.

Moreover, the granules produced from the bio-treated PE negatively impacted the plant roots, resulting in abnormalities in polysaccharide and protein production and uptake of nutrients (Abrusci et al., 2011). According to the report of Bonhomme et al. (2003), the only degradation products of environmentally degradable commercial PE, produced in the presence of the selected bacteria (*Nocardia asteroides* GK 911 and *Rhodococcus rhodochrous* ATCC 29672) and fungus (*Cladosporium cladosporioides* ATCC 20251) after two (abiotic and biotic) stages of OXO-biodegradation [i.e., "degradation resulting from oxidative and cell-mediated

Table 17.4 List of bioplastics, their compositions, and microbes used for their biodegradation

Sl. no.	Types of available bioplastics	Substrate(s)/source(s)	Composition	Microorganism(s) used for degradation	Reference(s)
1.	Cellulose-based bioplastics	Pomegranate (*Punica granatum*) peel	Pectin, celluloses, hemicelluloses, and lignin	*Bacillus subtilis*, *Pseudomonas aeruginosa*	Gumienna et al. (2016), Ko et al. (2021)
		Orange (*Citrus sinensis*) peel	Pectin, starch, lignin, celluloses, and hemicelluloses	*Bacillus subtilis*	Bátori et al. (2017), Umesh et al. (2018)
		Water hyacinth (*Eichhornia crassipes*)	Celluloses, lignin, and hemicelluloses	*Bacillus subtilis*, *Pseudomonas aeruginosa*	Preethi and Vineetha (2015)
		Rice (*Oryza sativa* L.) straw	Celluloses, hemicelluloses, and lignin	*Pseudomonas aeruginosa*	Bilo et al. (2018), Suardi et al. (2018)
2.	Starch-based bioplastics	Banana (*Musa balbisiana*) peel	Starch, celluloses, hemicelluloses, protein, and pectin	–	Mehta et al. (2014)
		Potato (*Solanum tuberosum* L.) peel	Starch, non-starch polysaccharides, lignin, polyphenols, protein, and lipids	*Alcaligenes latus*, *Bacillus subtilis*, *Micrococcus*	Wang et al. (2013), Trivedi et al. (2016), Priedniece et al. (2017))
		Cassava (*Manihot esculenta*)	Starch, soluble sugar, uronic acid, lignin, and ash	*Acetobacter xylinum*	Adhani et al. (2019)
3.	Protein-based bioplastics	Wheat (*Triticum aestivum*) gluten	Glutenins and gliadins	–	Jiménez-Rosado et al. (2019)
4.	Oil-based bioplastics	Soybean (*Glycine max*) oil	Protein, fat, and carbohydrate	–	Park and Kim (2011)
		Cotton (*Gossypium hirsutum*) seed oil	Fatty acids and triacylglycerols	*Ralstonia* spp.	Magar et al. (2015)

(continued)

Table 17.4 (continued)

Sl. no.	Types of available bioplastics	Substrate(s)/source(s)	Composition	Microorganism(s) used for degradation	Reference(s)
5.	Polylactic acid (PLA) bioplastics	Starch, lignocellulosic biomass, agro-industrial wastes, and glycerol	Starch, lignin, and celluloses	*Lactobacillus amylophilus, Lactobacillus bulgaricus, Lactobacillus delbrueckii, and Lactobacillus leichmannii*	Jiménez et al. (2019)
6.	Polyhydroxyalkanoates (PHA) bioplastics	Corn (*Zea mays*) starch, glucose	Starch and glucose	*Azotobacter* sp., *Bacillus* sp., *Bacillus subtilis*, *Burkholderia* sp., *Cupriavidus* sp., *Pseudomonas* sp., and recombinant *E. coli*	Singh et al. (2009), Gupta et al. (2020)

phenomena, either simultaneously or successively" as defined by the European Committee for Standardization (CEN) in CEN/TR 1535–2006 (Hann et al., 2016)], were protein and polysaccharides. Kannahi and Sudha (2013) noticed the production of aldehyde, carboxylic acids, and ketones in the smoke of LDPE film extrusion.

5.3 Advocating the Principle of 4 Rs

As per the data on global urbanization released by United Nations, 55% of the world's population urbanized in 2018, compared to 30% in the year 1950 (United Nations, 2018). With a projected rate of urbanization to be 68% in 2050, the concept of sustainable living becomes more and more crucial and of paramount importance. The vision of a sustainable city is based on a closed system of manufacturing and utilization. Rural employment is reducing as agriculture is getting modernized with less mechanization; the charm and enchantment of city life allure the rural population to move to the adjoining cities. As the population of cities is sprawling, the resources need to be shared, recycled, and reused effectively for sustenance. One of the most challenging tasks ahead is managing the flow of materials in the increasing urban population. In the present *era*, the management of solid wastes, especially persistent plastic components, is vital for sustainable growth and development.

The burden of plastic wastes can be minimized by changing people's traditional thinking and practicing the principle of 4 Rs, i.e., reduce, reuse, recycle, and refuse/recover (Fig. 17.6).

1. Reduce: The foremost principle in managing wastes is reducing and avoiding waste accumulation. It emphasizes discontinuing those processes that produce hazardous wastes and replacing them with environmentally friendly activities; this leads to less waste generation, and the related overheads on treatment, disposal, and environmental effect are also reduced. The substitute or replacement of synthetic plastics would imply using eco-friendly alternatives like jute, cotton, or hemp, as they are made from plant materials.
2. Reuse: The following principle favors the concept of reutilizing materials or things that could be discarded or trashed, and this is primarily applicable to the end users. At times, reuse might require repairing the item or making it suitable for at least short-term if not long-term usage. This principle can help in reducing the generation of plastic wastes.
3. Recycle: The following principle in the waste management hierarchy is recycling, which involves electrical or mechanical processes to convert waste materials into valuable items for use afresh. Although recycling is eco-friendly, it is labor- and cost-intensive. Hence, waste reduction, avoidance, and reuse are recommended before recycling.
4. Refuse/Recover: Above all these, it facilitates minimizing waste generation if the end users refuse. Recovery of useful plastic monomers/components from plastic wastes is a futuristic concept and would be extremely expensive and would require a massive setup and enormous workforce unless robotics are

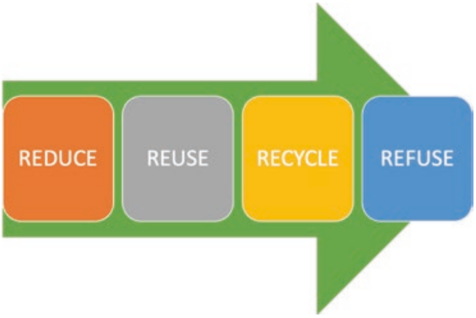


Fig. 17.6 Illustration of the principle of 4 Rs

introduced. If the concept sees the light of the day, then it will revolutionize the entire plastic waste management system.

5.4 Circular Economy

The concept of zero waste is part of a circular economy where all the wastes move from a linear model to a circular one wherein the wastes from consumption become the raw material for the new product (Fig. 17.7).

The concept of circular economy has various benefits, some of which are listed below.

- It helps in reducing the environmental plastic footprints.
- It helps in minimizing wastes.
- It helps in increasing income, eventually, the economy of the whole nation.
- It helps in reducing the dependencies on resources.

6 Conclusions and Way Forward

Synthetic polymers/plastics are indispensable in our current lifestyle. Consequently, daily use of synthetic plastics results in plastic pollution, which is among the most alarming issues of recent times from the environmental, organismal, and human health perspective. This current trend of uncontrolled synthetic polymer or SUP use coupled with improper plastic waste management, leading to plastic accumulation, is undoubtedly a wake-up call for global citizens, environmentalists, law, and policymakers. Although many will argue that plastic pollution is the problem of the underdeveloped or developing nations, the fact that plastic waste generation and disposal of the Asian, North, and South American nations can accumulate as a gigantic floating gyre of marine debris (the Great Pacific garbage patch) in the central North Pacific Ocean near Hawaii-California-Japan refute that argument. Moreover, from Antarctica (South Pole) to the tip of the Himalayas (the Mt. Everest, Nepal), from the tropical rainforest of Amazon, Brazil to the mangrove forest of

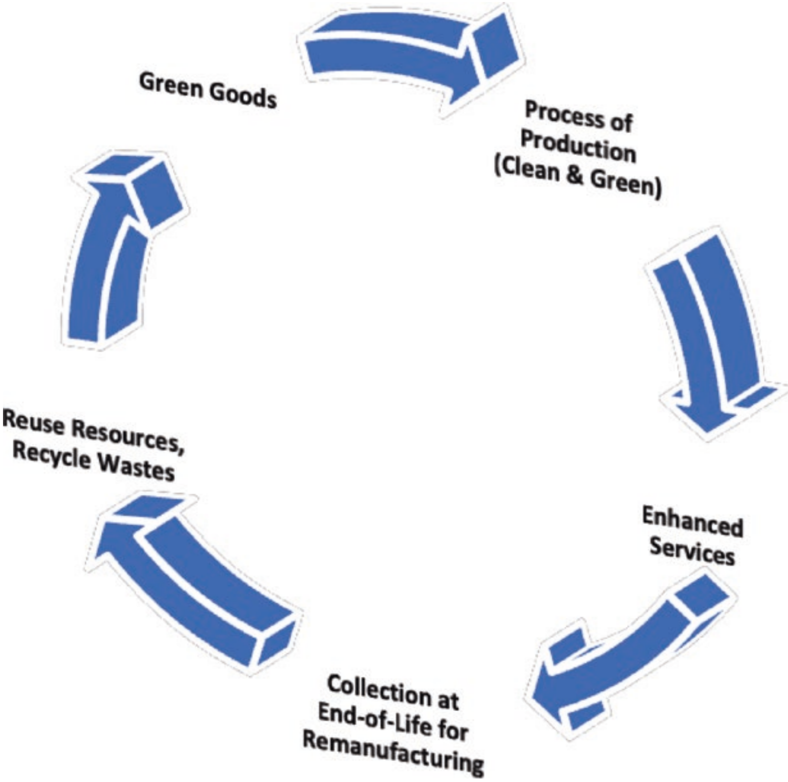


Fig. 17.7 Representative flow diagram of circular economy

Sundarbans, India, and Bangladesh, from the Sahara desert, Africa to the Pacific Ocean, there is hardly any place on earth where plastics have not left their footprints.

In addition to the existing problem of plastic overuse, the COVID-19 pandemic came as a bane for the global environment. While safety restrictions imposed because of the pandemic led to a substantial reduction in air and water pollution due to the lowering of human activities, there has been an exorbitant increase in plastics' use worldwide. The astronomical hike in online shopping for groceries and associated essential home supplies and use of disposable plastic utensils and packaged food and protective gears while under lockdown or in self-quarantine have led plastic pollution out of control. The solid waste management system in developing countries like India already has its inherent lacunae because of a shortage of human resources, machinery, funds, policies, public awareness, etc. Excessive use of plastics has further augmented this problem, polluting the ambient environment.

Moreover, the biomedical plastic waste generated in overloaded hospitals is adding to the existing plastic waste burden. Upon getting submerged in water, the disposable masks cause the leaching of toxic chemicals like heavy metals and nanoplastics into the environment, thereby impacting aquatic life in the long term. Massive use and casual disposal of PPE suits, disposable surgical/other masks, face shields, gloves, and shower caps has been a perennial nuisance during the ongoing pandemic worldwide. Therefore, there is a crucial need to mitigate this uncontrolled rise in plastic pollution by introducing eco-friendly alternatives to conventional synthetic plastics for daily household or medical use.

Petro-polymers, including PE, PET, PP, PS, PU, and PVC, are highly recalcitrant to normal biodegradation pathways. Natural degradation of synthetic plastic with the action of microbes and microbial enzymes is prolonged and can take several hundred to thousand years, even though total degradation is never possible. The plastic biodegradation rate depends on many factors like the type of plastic used or their chemical structures, molecular weights, and degrees of crystallinity. For optimal microbial biodegradation of plastics, it is highly recommended to select appropriate microbial strains, adapt suitable in situ and ex situ bioremediation techniques, continuously monitor bioremediation sites, and adequately maintain such sites by providing adequate aeration, necessary nutrients for optimum microbial growth, and appropriate physicochemical conditions. Additionally, improvement and acceleration of bioremediation of plastic wastes and their disposal can be made through high-throughput genetic identification and molecular analyses of microbial genes expressing plastic-degrading enzymes in conjunction with recombinant DNA technology (for creating synthetic polymer-degrading genes). The focus should be centered on sustainable plastic waste management and shift toward plant-based green materials like jute, hemp, bamboo, coir, and bioplastics; thus, an immediate solution to this problem is the manufacture and commercialization/use of biodegradable plastics, which can undergo up to around 60% decay based on current innovations. Other options for sustainable plastic waste management are highlighted here.

1. Creating public awareness about plastic pollution and its ill effects on living organisms (through area-wise mass-level monthly campaigns on plastic pollution).
2. Scientific management and proper disposal of plastics; dissemination of appropriate plastic disposal methods among people must be done using all available media platforms. Moreover, awareness on plastic disposal should start at the primary school level by guiding students and their parents about proper segregation of biodegradable and nonbiodegradable plastic wastes before their disposal.
3. Encouraging people to use bio-based products.
4. Building strict laws and policies.
5. Advocating the principle of 4 Rs, i.e., reduce, reuse, recycle, and refuse/recover within the global community in the present and in the post-pandemic *era*.

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Chapter 18
Integrated Water Resources Management in Developing Nation: Status and Challenges Toward Water Sustainability

Supriya Nath, Jitesh N. Vyas, R. B. Deogade, and Prabhat Chandra

Abstract Water is essential for life: serving as the cradle for the origin of life and its sustenance. Even if it covers two-third of the earth, the availability of fresh water sources is limited making it a very precious resource. Rapid population growth and indiscriminate use in an unsustainable manner have led to depletion and degradation of water. Urban infrastructure and development pace led to indiscriminate consumption of water which has made water scarce. There is a lot of scope in urban space to restrict wasteful use and enhance the reuse and recycling of water for achieving zero water wastage. The principles of integrated water resource management (IWRM) when applied effectively can solve the water crisis in major parts of the world and help us transit toward a greener economy and environmental governance.

In this chapter, the evolution of IWRM as a concept has been discussed and its application in managing water in developing nations to achieve sustainability. The procedure for carrying out IWRM has also been elaborated. There is an analysis of how the IWRM model helped in achieving the goal of effective water governance and Sustainable Development Goal 6 (SDG 6) implementation. In this chapter, the status of the implementation of IWRM in developing countries has been analyzed. There is also discussion on challenges in achieving SDG 6 and the way forward.

Keywords Sustainable Development Goal 6 · Zero water wastage · IWRM model · Water crisis · Effective water governance · Environmental governance

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1 Introduction

In a world where climate change has painstakingly increased the severity of the water crisis, we direly need to manage our water resources sustainably. The urgency further increases because many urban centers are on verge of severe drought situations during summer and face floods during the monsoon. This indicates that all the urban amenities will seem worthless if there is no proper water management system as water is the most significant element in our daily lives.

There are plethora of problems which are affecting urban areas, and the most significant among them is the water crisis. This water crisis is due to indiscriminate expansion of urban areas, reducing fresh water sources and climate change (Doshi & Sharma, 2022). The present water reserves in cities are under great strain due to overexploitation by increasing population, higher living standards (Pokhrel et al., 2022), infrastructure development, and industrialization. In this context, water governance gained worldwide attention since Boon Freshwater conference of 2001 (Doshi & Sharma, 2022), and various concepts for increased sustainable use of water has been promoted like IWRM in the Netherlands and "One Water approach" in Singapore, Australia, and the USA (Pokhrel et al., 2022), water-sensitive cities (Brown et al, 2008),green infrastructure, and sustainable urban drainage system (Doshi & Sharma, 2021)for effective water governance.

The Global Water Partnership (2000) defines IWRM as *a process that promotes the coordinated development and management of water, land, and related resources in order to maximize the resultant economic and social welfare in an equitable manner without compromising the sustainability of vital ecosystems*.

IWRM utilizes both traditional knowledge and modern technological advancements (Mudrakartha et al., 2010). It also emphasizes the need for a participatory approach where all the stakeholders participate during the decision-making process. IWRM when effectively implemented can resolve problem of food security as in case of Namibia (Haulofu et al., 2022) (Fig. 18.1).

1.1 The Three E Pillars of IWRM

There are three focus areas, namely, economic, equity, and environment which are said to be pillars of IWRM and require to be prioritized while preparing any IWRM framework (Global Water Partnership, 2000):

- *Economic perspectives of water-efficient use:* Since water is a finite resource and has economic value in resonance with the Dublin principle, it requires to be used judiciously through various management instruments like allocation of budget for its development and regulations.
- *Equity:* The social aspect of water availability is predominantly determined by how effective and equitable distribution of water resources takes place since water is the basic necessity of all humans. The adequacy and potability should be

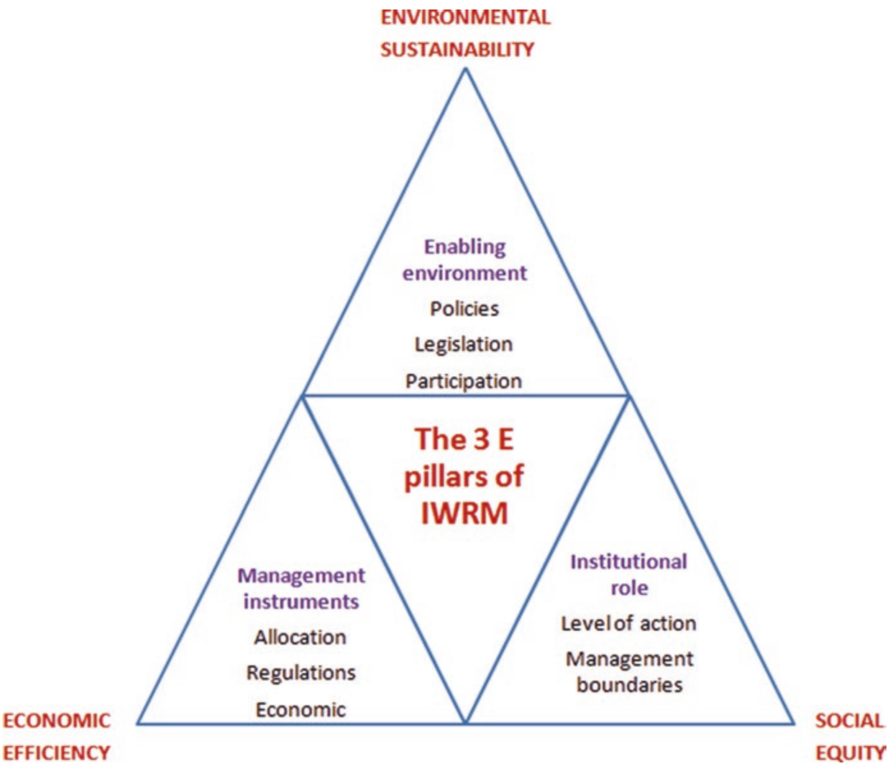

Fig. 18.1 The three pillars of integrated water resource management. (Modified from Vyas and Nath, 2021)

ensured while distributing it to the common citizen without any social discrimination according to class. Local government bodies, like Panchayati Raj Institutions in India, and states play a major institutional role in deciding management boundaries.

- *Environmental sustainability:* Judicious use of water resources must also ensure that current generation needs are fulfilled without compromising the needs of coming generations to meet SDG6 (Braune & Xu, 2008).

1.2 Process of IWRM

The IWRM process is a cyclical process as depicted in Fig. 18.2 which has following steps:

It starts with the establishment of the current scenario of water resources, surface as well as groundwater resources, present in that area as well as the progress of work achieved under previous IWRM conducted (if done). In this step commitment

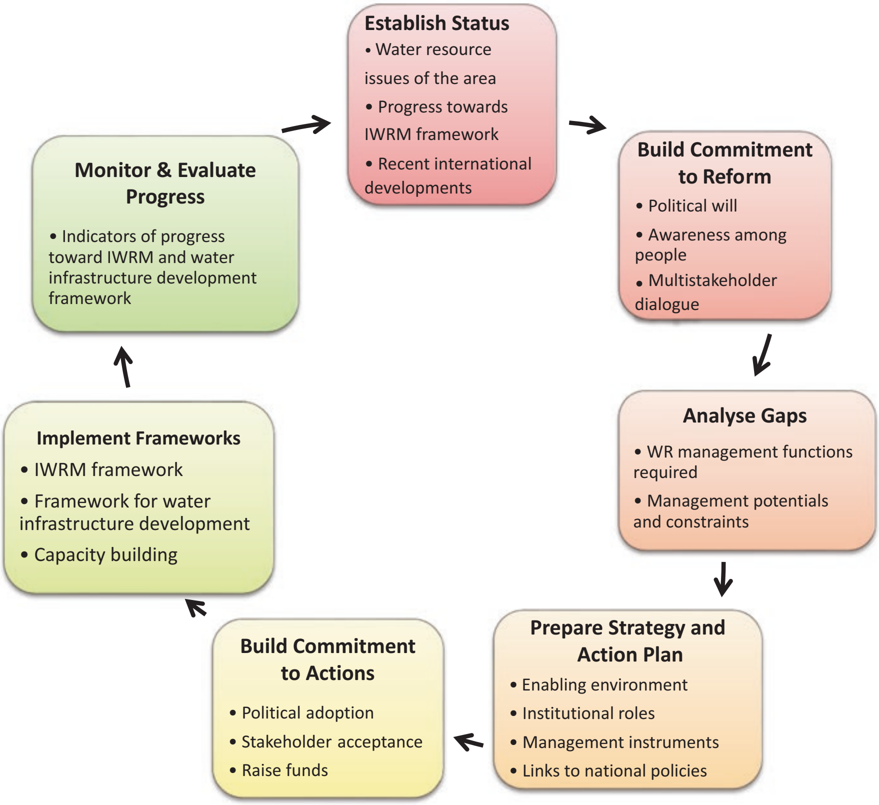

Fig. 18.2 The process of integrated water resources management. (Modified from World Bank Garcia and Puz, 2010)

toward the IWRM framework is promoted through awareness through multistakeholder dialogue and building political will toward it. The shortfall in demand and supply of water is analyzed so that a better water resource management plan may be planned accordingly. While preparing the action plan, all the three "E pillars of IWRM" are considered. The action plan prepared is in consonance with the national water policies of the nation. Further, an action plan needs to be executed for which funding must be raised and political organizations should adopt it so as to ensure there is proper implementation. Acceptance by the stakeholders is also very essential to create commitment during execution. IWRM framework is finally implemented through the implementing agencies after capacity building. The final step is to regularly monitor and evaluate the progress of work for effective implementation of the IWRM framework.

This process continues until all the objectives are achieved. Global Water Partnership has provided comprehensive processes for implementation of the IWRM (GWP 2009), by providing a checklist of procedures that must be adhered which are as follows:

1. It requires formation of river basin management systems and river basin organizations.
2. There is a need to mobilize funds for the proper implementation of IWRM activities.
3. There must be stakeholder participation during IWRM.
4. There should be planning and development of management action plans.
5. There is a need to establish monitoring and information systems.
6. There should be a communication of all the achievements.
7. The important component of IWRM process is planning which has been discussed in detail in the next subsection.

1.2.1 IWRM Plan

IWRM plan, as illustrated in Fig. 18.3, is prepared by mainly considering the available water resources of that area (supply) and how much water gets consumed by the various sectors (demand). The water demand side is calculated by considering the requirement of water by agriculture, industries, and drinking and sanitation requirement of citizens. After considering all the demand and supply factors, the gap between demand and supply must be estimated that needs to be fulfilled through the IWRM plan. This exercise is an essential precursor to the preparation of the IWRM plan.

IWRM helps in providing strategic information about the availability of all the studies carried out at regional as well as national agencies, and the information thus gathered is utilized in quantifying the requirements of different nations for the present as well as future generations. The various objectives of the integrated water resources master plan (IWRMP) are as follows:

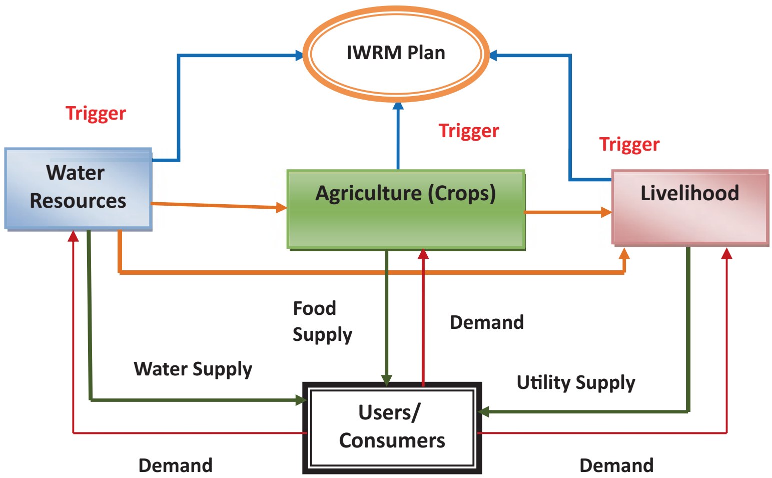

Fig. 18.3 Demand and supply factors considered for IWRM planning

1. Identifying data-deficient areas regarding water resource development and management in areas facing a water crisis
2. Investigating the possibility of groundwater use
3. Identifying other sources of water
4. Developing national water distribution criteria
5. Recommending water quality management interventions
6. Recommending a course of action for catchment management
7. Evaluating to find priority sectors in water resource development
8. Developing an action plan and finding funding for IWRM

In the next section, evolution of the concept of IWRM has been discussed with a discussion on the historical background of the development of the concept which kept on evolving with time.

2 Evolution of the Concept of IWRM

The IWRM initially originated as a concept at UN Water Conference in 1977. IWRM was formally established after Dublin 1992 principles gained acceptance in ensuring water reforms. Four Dublin principles which have been propagated were as follows: fresh water is a finite resource; management of water should ensure participation of all stakeholders involved; women were kept at the center as they take lead in the collection, management, and protection of water at household level; and water needs to be accepted as an economic good which will establish its economic value. Sustainable development goals got conceptualized during Rio Summit 2012 in the Rio + 20 outcome document, and these were included in the UN Development Agenda in 2015 (https://sustainabledevelopment.un.org/focussdgs.html).

Global Water Partnership in 2009 provided a checklist for implementation of the IWRM (GWP 2009), which has been discussed earlier. UNESCO has provided a guideline for IWRM execution in 2009 (Benson et al., 2020).

IWRM has gained prominence as the dominant concept in water management globally (Allouche, 2016; Benson et al., 2020). There is an overt focus on the water-centric approach in IWRM which has caused debate, and there is a development of an alternative concept that has more holistic resource management approach – "water-energy-food nexus" (Benson et al., 2015, 2020).

In the subsequent section, effective water governance and its components for effective IWRM implementation have been discussed.

3 IWRM and Effective Water Governance

The major issue in the water crisis globally is due to lack of good water governance (UNESCO, 2006; Allan & Rieu-Clarke, 2010). This may resolve only when there is improvement in water governance at every level of governance – be it local, national, and international levels. Various nations have keenly supported this necessity through many international policy documents, like the *2000 Ministerial Declaration of The Hague on Water Security in the twenty-first Century, the 2001 Bonn Keys of the International Conference on Freshwater, the 2002 Plan of Implementation of the World Summit on Sustainable Development, and the 2003 Ministerial Declaration of the Kyoto third World Water Forum* (Allan & Rieu-Clarke, 2010). Global Water Partnership has identified indispensable principles that are prerequisites for effective water governance which are transparency, inclusiveness, coherence, integration, equitability, performance and operation, accountability, efficiency, responsiveness, and sustainability (Rogers & Hall, 2003; Rogers, 2006; Allan & Rieu-Clarke, 2010).

The Second UN Water Development Report suggested various components required for efficient water governance (UNESCO, 2006) depicted in Fig. 18.4.

4 IWRM for SDG 6 Implementation

Among the various sustainable development goals (SDG), SDG 6 is an important goal that has been defined as *ensure availability and sustainable management of water and sanitation for all* (UN, 2017). Various indicators measure the achievement of these SDG as defined in Chap. 40 of Agenda 21, envisaged in the UN Rio Earth Summit in 1992 (UNCED, 1992). These SDGs have further been classified into targets like Target 6.1 refers to *ensuring access to drinking water, while stating that such access should be equitable and affordable* (UN, 2017). Here we are concerned with the Target 6.5 which is related to the IWRM. It says Target 6.5 for implementing *integrated water resources management (IWRM) at all levels* (UN-Water, 2017a; UN-Water 2018; Benson et al., 2020).

Under Target 6.5, IWRM is measured by how much national institutional implementation took place and, for transboundary basins, the proportion of area which is cooperating (UN-Water, 2017a; UN-Water 2018). Two indicators are used for measuring the progress in accomplishing this target:

6.5.1: Degree of integrated water resources management implementation (0–100)

6.5.2: Proportion of transboundary basin area with an operational arrangement for water cooperation (UN-Water, 2017a; UN-Water 2018) (United Nations Economic Commission for Europe [UNECE] and the United Nations Educational, Scientific and Cultural Organization [UNESCO], 2021

The indicators mentioned in IWRM focus mainly on institutional development, which is easy to assess but it does not consider the comprehensive nature of IWRM as a process (Benson et al., 2020). For measuring indicator 6.5.1, a self-assessment survey approach is used that evaluates four constituents of IWRM – conducive situation, good implementing agencies, management tools, and financial support (UN-Water, 2017b; Benson et al., 2020).

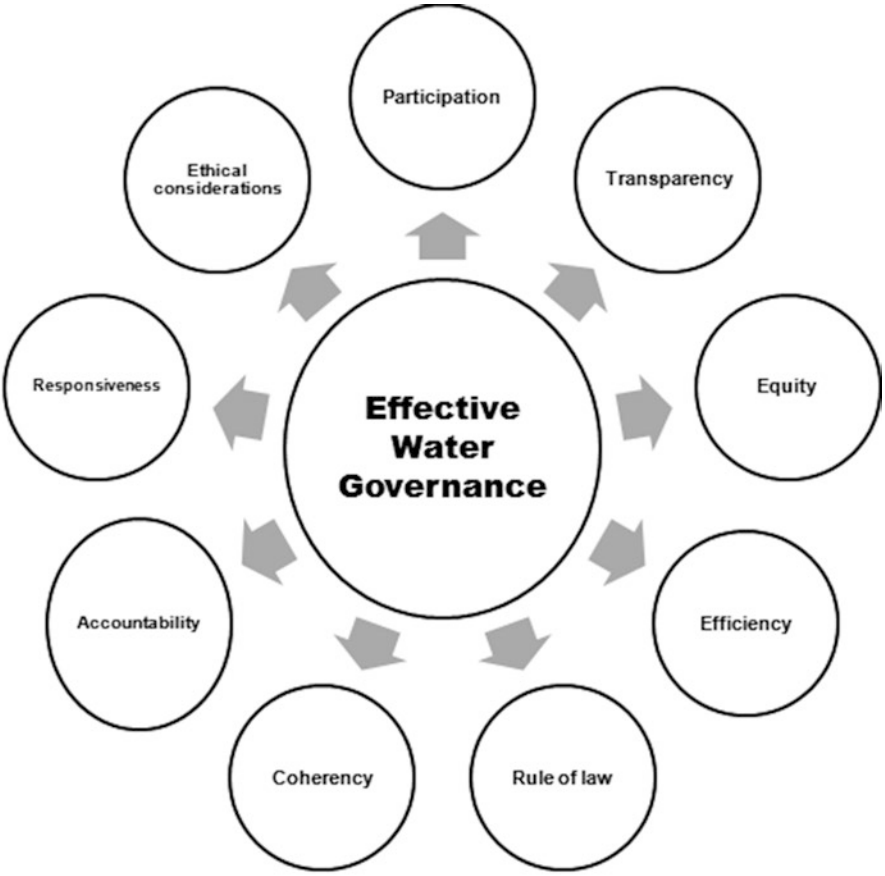

Fig. 18.4 Components for effective water governance according to the second UN Water Development Report, UNESCO, (2006)

5 Status of IWRM in Developing Countries

According to the UNEP (2021), India ranks very low in the score for IWRM implementation levels and score thresholds with a score of 45, which is in the medium-low category. Similarly, neighboring countries like Afghanistan, Bhutan, and Nepal rank very low in scores, namely, 12, 33, 37, respectively. Some of the developing Asian countries performed better than India, like Indonesia, Malaysia, Bangladesh, and Pakistan with scores of 66, 63, 58, and 56, respectively (UNEP, 2021). This UNEP report also found that the Southern Asian region has to catch up a lot as they have made inadequate improvement in IWRM implementation compared to the rest of the world. This also correlates with the development status of the region and has indicated that developed nations have fared well like New Zealand, Australia, Europe, and North America which reported considerably high average IWRM implementation (UNEP, 2021). According to the UNEP (2021), India ranks well in cross-sectoral coordination, but it again scores low in *national law development and implementation reflecting IWRM principles* and *private sector participation in water resources planning, development, and management*. According to the UNEP (2021), India ranks medium-high for the *development and implementation of mechanisms for the participation of vulnerable groups in water resources management*. According to the UNEP (2021), India ranks low in the accomplishment of *gender mainstreaming in water resources management* and realization of *capacity development programs*. India ranks high in *development and implementation of monitoring frameworks for water availability* and *data and information sharing (including all stakeholders) on water resources management*, *development and implementation of water-related disaster risk reduction management instruments*, transboundary data- and information-sharing mechanisms, and *financing for transboundary cooperation on water management and development*. India ranks medium in *development and implementation of management instruments for freshwater ecosystems*.

Various nations, like Kyrgyzstan, Panama, and Belarus, have constituted river basin organizations or committees which prepare basin plans (UNEP, 2021). According to the UNEP, 2021, most of these nations are going to implement river basin plans. However, some nations, like Tunisia and Lebanon, are yet to take initiative (UNEP, 2021) mostly because of legislative constraints. In some developing nations, like Myanmar, Nicaragua, El Salvador, basin plans have been prepared only for stand-alone projects (UNEP, 2021). The UNEP, 2021 reported that few countries, which have scored high on basin management instruments, like Estonia and China, found that the basin management instruments performed below expectation, while other nations like Guatemala and Sierra Leone were finding it difficult to apply the basin planning approach practically.

6 Challenges and Future Prospects

The biggest challenge in IWRM is its successful execution which requires one coordinating body with political will and participation of people in coordination with the implementing agencies. Another challenge is that IWRM has been reported to have a top-down approach (Biswas, 2004; Benson et al., 2020) which reduces the public participation in developing nations, thus defeating the whole purpose of IWRM. Based on their cultural heritage of water management system and variable climatic conditions, bottom-up approach is better suited. This will also ensure the inclusion of local people in decision-making at grass root level which will resolve the difficulty in the application of IWRM plans. The developing nations require a more holistic approach in place of the sector-by-sector approach (UNESCO-WWP, 2006; Anderson et al., 2008) which will be pragmatic as these countries differ from developed nations.

There is a need to focus on effective water governance as discussed earlier. Another challenge is that the UN report assesses the performance of nations regarding SDG indicator 6.5 on the basis of the survey-based approach (Bertule et al., 2018), which lacks transparency, and there is an issue of subjectivity in their results. This makes these results difficult to compare (Benson et al., 2020). The status of the IWRM plan, institution, and effectivity of management is also questionable (Benson et al., 2020) unless there is proper formation of the IWRM concept in an objective manner (Biswas, 2008; Benson et al., 2020; Saravanan et al., 2009) to reduce the vagueness and subjectivity in interpreting. There is a need for clarity in theoretical and conceptual aspects of IWRM (Acheampong et al., 2016; Benson et al., 2020) which is the major barrier in achieving SDG 6.5.

7 Conclusion

IWRM has played an important role in making various cities achieve the sustainability goals in many developed nations, but developing nations are lagging behind. There is an inequitable distribution of water resources, and there are many environmental and social as well as economic challenges faced by these developing nations in ensuring proper management of water resources. There is a need for capacity building, community awareness, and public participation for ensuring the proper implementation of IWRM plans. It is necessary to address all the challenges like lack of funds, lack of political will, public apathy toward government projects, etc. in a time-bound manner by a nodal agency that will act as a coordinating body in a nation. IWRM should be seen in a holistic manner as its proper implementation not only helps in achieving SDG6 but also other interlinked SDGs like SDG 11, SDG 1, SDG 2, SDG 3, etc. Effective water governance will help in the successful execution of SDG6 for Agenda 2030.

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Chapter 19
Anti-Dam Discourse: Stakeholder Engagement and Decision-Making

Tanisha Gogoi

Abstract Dam building holds high in India's state development agendas. It signifies a certain kind of developmentalism that does not seem to have lost its appeal since the early days of independence. The legitimisation of large hydro energy as green, clean, reliable and sustainable is widely contested. Participatory decision-making by affected people in developmental projects like large dams is often considered impossible, in spite of its support and advocacy by the World Commission on Dams. The report of WCD 2000, described as 'new framework for decision-making', centred on 'rights and risks' approach, has been able to draw global attention to the fact that decisions regarding large dams are not restricted to merely structural design or physical description. There are other equally significant and associated aspects that have not received due attention. Drawing from an extensive study on Lower Subansiri Hydropower Project (LSHP) in Assam, this chapter seeks to understand if community participation is considered significant, particularly by the people who would be directly affected by the project. The primary source of data collection includes a multisited ethnographic account of the field of contestations, including the downstream and upstream of the dam construction, their notion of development and the various organisations representing different sections of the society involved in the protests. The aim here is to analyse the multilevel decision-making process so as to determine why, how and whether planning and decision-making has been opening up to diverse societal interests like resettlement and rehabilitation, ecological sustainability and public involvement in the decision-making processes.

Keywords Development · EIA · Large dams · Participatory decision-making · North-East India

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1 Introduction

Post-independence, construction of big dams has been an integral part of India's development paradigm. The Indian government resort to building huge dams to meet the needs of the struggling industrial as well as agricultural demands (Jain, 2017). The design on which these dams are based and emphasised is fundamentally related to specific weightage given to 'development' in the late colonial and early independent India. The decision of which was largely in the hands of engineers who took pride in themselves for creating huge monuments regardless of the time and cost involved (Thakkar, 2005). A phenomenon which the first Prime Minister of India, Pandit Jawaharlal Nehru referred to as 'disease of gigantism', a progressive myth that something huge has to be built to meet the needs of an ever-growing population of the Indian nation.

Thus, the trend that was set in the 1950s is still continued as far as water resource management is concerned. India's seventh Prime Minister Rajiv Gandhi while addressing a conference of Irrigation Ministers in 1986 said:

> The situation today is that since 1951, 246 big surface irrigation projects have been initiated. Only 66 out of these have been complete, 181 are still under construction. Perhaps, we can safely say that almost no benefit has come to the people from these projects. For 16 years, we have poured out money. The people have got nothing back, no irrigation, no water, no increase in production, no help in their daily life. (Ibid: 2)

No concrete step has been taken to change such pattern, even though the observation made was correct. The post-independent Indian developmental imperatives have not undergone much change. However, it does not mean that modern Indian state has not transformed since independence, rather it only implies that normative implication of adaptation of certain progress-oriented values (in economic terms) has compelling impact in current development framing (Thakkar, 2008). Notwithstanding, these dams have failed in incurring the estimated benefits with many economic miscalculations both in case of supplying water for irrigation purpose and in producing electricity; the government of India is still promoting these projects in the name of development. Another reason for pushing these dams besides irrigation and electrical power supply is, as a flood control measure, especially in the North-East of India, as flood creates havoc each year in the monsoon period. On the other hand, the existing dams have only added more to the already devastated situation in the region.[1] Yet these flood control failures have only continued to provide support to undertake more such projects. In relation to the annual flooding of the Brahmaputra river in Assam, although recurrent floods are a natural phenomenon, they are as well effects of anthropocentric interventions such as increased deforestation in Eastern Himalayas. The plan to construct large dams in upstream areas of Arunachal Pradesh is likely to exacerbate this process (EPW, 2021).

[1] The Ranganadi dam in Arunachal Pradesh on Ranganadi River which is a mere 405 MW is accused of causing flood in the districts of Lakhimpur and Dhemaji in Assam releasing water by opening the flood gates during monsoon season.

Thus, even in face of constant public protests, overwhelmingly negative impact assessments, and immense academic critique of such linear modernisation process, such infrastructural development projects are continuously framed under 'national interest' of the state development vision. The construction of dams is placed in the modernist framework and nation-building that has not yet become aware of its own historical redundancy. Even the social critique of development in policy-making level has failed to reach the ground empirical decision-making and social engineering. What is the reason behind such gap in political decision-making and implementation? This study seeks to analyse the embedded social and political relations which characterises such decision-making process of the current development model of India. In order to understand this, it is important to assess the politics of knowledge production and naturalisation of dam construction as an inevitable political choice. In this developmentalist endeavour dam construction is regarded as only a mere technical intervention which has resulted in their incontestable legitimisation on sociopolitical grounds.

Looking at various arguments against large dams – socio-economic, environmental and strategic (location) put within the development framework of 'greater common good' – also has its political implications. In other words, the question is not necessarily what 'development' is, or if large dams are advantageous for the people, but rather what people have meant and means when they talk about development in their own terms of livelihood. Who gets to decide, define and represent these voices within the development framework will be dealt with in this study. This level of analysis would require to challenge and counter the statist development agenda and its embedded legitimising process.

This chapter involves an extensive study on Lower Subansiri Hydropower Project (LSHP). The LSHP was envisaged by the Brahmaputra Flood Control Board, a river basin agency responsible to the Ministry of Irrigation (now renamed as Ministry of Water Resource) as early as 1955. LSHP was envisioned as a multipurpose dam. While a multipurpose dam has various components like irrigation, flood control, navigation and fisheries, in addition to power/electricity generation and the benefits met are more than the loss incurred. However, LSHP was primarily designed as flood control measures and for irrigation purpose, near the present dam site. Three other alternate sites were also investigated in the upstream due to the soft nature of the Shiwalik range. Later, in the year 1977, the Board of Consultants of the Brahmaputra Board, after reviewing the advantages and disadvantages of all the alternative sites, ultimately decided the present site.

Originally the dam height was proposed as 257 m high rockfill dam, and a detailed investigative study was carried out. For the first time in April, 1983, a feasibility report was submitted by Brahmaputra Board. However, the project was opposed by the Arunachal Pradesh state government, as many of the villages and some towns will be 'flooded' if a dam of such height was constructed in the area. Subsequently, the height of the dam was reduced to 116 m high concrete, and Brahmaputra Board handed over the project to National Hydroelectric Power Corporation (NHPC), along with the full details of the investigation completed by them, in the year 2000 (personal conversation, 2017).

The 2000 MW Lower Subansiri Dam, thought to be India's largest hydropower project if commissioned on time, is being built on the Subansiri River in the North-eastern region of India. The dam is situated at the border of Assam and Arunachal Pradesh, wherein the storage reservoir and the powerhouse were to remain at Arunachal Pradesh and the colonies for the staff and the offices would be built at the state of Assam.

Following the new economic policies, i.e. post 1991, there was a thrust to bring the peripheral regions into the nation-building agendas by expanding the state institutions into these regions. Sanjib Baruah (2003) termed this process as 'nationalizing frontier space'. He explains, such measures are intended or unintended consequences of Indian state government to assert control over the natural resources of the frontier region and make it a part of India's national space. The whole question lies in the process of integrating marginal landscape into the nationalist dream of production of capital. Emphasising on the unevenness of the development pattern, it is argued that the region's natural resource bases are exploited to benefit the rest of the country (Baruah, 2012). In case of LSHP, the project design documents include a segment on 'power evacuation', which gives details on 'the transmission arrangements that would take electricity from power generation facilities to the national power grid' (ibid, 2012). That is, even if there is the speculation that the region is underdeveloped due to energy shortage, the electricity produced from these hydropower projects are not benefitting the region. The construction of dams has also raised a bone of contention between the two states – Assam and Arunachal Pradesh. It has evoked a sense of fear, social and political disempowerment and economic impoverishment among the otherwise nature loving indigenous communities of the region.

2 'Growth-Rate' Driven Development Perspective: The Problem

Emerging from the colonial rule, independent India, like many of the third world countries,[2] perceived development as a growth in gross national product (GNP) and measured it with per capita income. To achieve high growth rate, India relied on heavy industrialisation, technological growth, modernisation and urbanisation processes. There was strong focus on economic development as demonstrated by

[2] The term 'Third World' is used synonymously with other terms like 'developing countries', 'South' and 'Postcolonial World'. The Third World is a cluster of countries in the Middle East, South, East and Southeast Asia, Central and Latin America and Africa. In spite of their differences in terms of culture and political identity, these regions have common economic situations characterised by poverty and underdevelopment and marked societal inequalities. Besides, these states were colonies of either European power or Japan. Post-cold war era, these colonies include the states that emerge following the disintegration of the Soviet Union and erstwhile socialist states of East Europe.

growth in GNP, industrialisation and modernisation leading to sectoral development, marginalisation and increase in environmental degradation. The fact that the subject matter is 'growth and not distribution' (Esteva, 2010: 8) reflects the mainstream concern for economic growth that permeated the whole field of development thinking. The development pattern driven by economic growth is not only regarded as a process of improvement but is concerned with rapid industrialisation and large-scale improvements in the living of the masses of poverty-stricken, malnourished and illiterate people (Adhia, 2015). These concerns with rapid and large-scale improvements intended to resolve the pressing and immediate problems are widely accompanied by social inequalities, social injustice and severe damage to the natural environment.

India has come a long way since then and reached a key moment in its history with rapid growth in global market. India has improved its competitiveness and become a favourite destination for corporate, business, journalistic and technological indulgence. It has proved as an emerging global power when the Foreign Affairs in 2006 described India as 'roaring capitalist success'. The nation's success has been quite a spectacular and has evoked euphoria and adulation from both home and abroad. However, there is another narrative, another India, opposite to this shinning India, the India where incidents of farmer suicides and poverty are on the rise. There is a huge gap between the upper and lower rung of people and mostly as a result of developmental activities, what Bhaduri (2007) terms it as 'developmental terrorism'. He states that Indian government irrespective of the political parties in power allied with corporations and marched endlessly towards disadvantage of the poor and marginalised them, through various land grabbing acts for countless developmental projects. He talks about two glaring contrasts in Indian society: India of glitter and privilege and an India of despair, rage and inhuman poverty. There are conflicts between the two over the claim for the use of natural resources as there is a competing rise in the number of users of natural resources.

While dam building in India was not solely a post-independence project, ideologically it was only after independence that large dams in India are considered symbol of modernity and technological revolution[7], what Prime Minister Nehru referred to as 'temples of modernity' and spearheaded the nation to progress. India, post-independence became one the highest dam builders in the world. By 1979, there were some 1554 large dams at the cost of Rs. 10,560 crore, nearly 14 percent of the total planned expenditure. By 1990s, India had more than 2240 large dams. The total installed hydro-generating capacity as on 1982 was 13,856 MW as compared to about 1000 MW in 1950 (Singh, 1990: 562). According to the National Register of Large Dams (NRLD) 2017 reports, India has 5701 large dams. There is an increase of over 510 dams in 5 years, i.e. in 2012 edition, the number of large dams listed was 5190, which is over a 100 dams per year.

However, the question is how development as modernity was made so important or essential, what Warner (2015) states that 'the problem lies in the historicist essentialisation of categories', like post colonialism, modernity and development; for instance Europe's claim vis-a-vis the 'universalizability' of her modernity. Kaviraj's (2005) theory of modernity is composed of two parts: first it explains the sequential process of social change such as industrialisation, emergence of nation-state and the rise of capitalism increasing importance of scientific reasoning. Second it asserts a homogeneous and uniform spread worldwide through institutional development. He further explains that we should accept the first and reject the second indicating the institutional differences of non-European societies and rejects the unilinear claims of modernisation theory. Thus, differences rather than homogeneity seem to be the base for the spread of modernity to the non-European societies. While one cannot deny the powerful normative claims of such categories in the current debates on development, it would be wrong to assume that these meanings do not vary over time and space.

The Indian model of development and its exposure to modernity have only led to a revival of traditional identity in a framework of a new institutions and ideas. For Kothari (1970), 'the Indian response to modern stimuli consisted of asserting the Indianness of India, reformulating this Indianness, and giving it a modern character' (1970: 85–86). The modern values and ideas only awaken the ancient identity and gave them a contemporary meaning. Therefore, it is important to understand the relationship they enter and the processes with which they function with each other. This process of diffusion was not a homogeneous process, and a large section of the Indian population was left out of this strange idiom of modernity. The strong conviction that India needs to be transformed into modern nation-state, a justification for the British rule in the first place, was now taken up by the Indian nationalist who associates Indian backwardness and traditionalism to colonial rule. Thus, when a new political system emerged (after independence) mainly comprising of the nationalist elites, it referred to modernity to legitimise their statist developmental intervention.

Post 1990s, India's progress has been lagging by an acute power shortage. A need for harnessing power from all potential sources was strongly felt. In the past few decades, the dam construction was concentrated mostly to the Western and Southern region of India. However, dam propagation in the North-eastern region of India began in 2001 when Central Electric Authority (CEA) in its preliminary ranking study of the hydroelectric potential identified the Brahmaputra river basin as one of India's largest storehouse of hydropower (Menon et al., 2003). The study identified 168 large projects in the Brahmaputra river basin, which would generate 63,328 MW of hydropower, of which 87 of these projects are in the state of Arunachal Pradesh.

There is a spate of Memorandums of Understanding (MoU) with different hill states of North-East India. 'A 50,000 MW hydropower initiative was launched in May 2003 by the then Prime Minister Mr. A. B. Vajpayee. Under this plan, pre-feasibility reports of 42 projects in Arunachal Pradesh have been prepared. These dams are expected to generate a total of 27,293 MW (Megawatts). Nineteen of them, totalling a generation capacity of 21,800 MW, have been shortlisted for further investigation, based on the lowest tariff. Prior to these studies, projects on the Siang, Subansiri, Kameng, Dikrong and Debang Rivers in the state were already at an advanced stage of planning and clearance' (Menon, 2009: 129). There is no doubt that this will be a major intervention in the hydrology of the region. Not only are dams to be constructed on almost every river in the region, it is also further envisaged to channelise the waters of the Brahmaputra into the Ganga (HT: 26/9/2010). It is interesting to note that the energy requirement of the region is quite modest. The per capita energy use in the North-East Region is only a third of India's national average, and the industrial use of energy is less than one percent of India's total (CEA, 2016). The region wise installed electricity generation capacity from all sources is quite minimal compared to other parts of India. The accessibility of electricity in the interior villages is very less as compared to the rest of the country. Nonetheless, the new hydropower project meant to produce is almost entirely for use elsewhere.

One of the significant arguments put forward to carry out these developmental projects is that there is relatively small human displacement as compared to the other parts of the country and that makes these projects as benign. However, the ground reality reveals that displacement in terms of livelihoods and livelihood rights is grossly underestimated. Due to the hilly topography of the region, there is little land where permanent cultivation is possible. Virtually all available cultivable land of the region is submerged by such developmental projects. Land is collectively owned and governed by these communities,[3] and as a result, incidence of landless household is negligible (Marchang, 2017: 65). Since land is the basic resource, agriculture or shifting cultivation is the primary mode of livelihood for the people. These households mostly cultivate small or medium size of land, rendering a sustenance economy. Thus, the degree of impact has to be measured keeping in mind their lifestyle and the extent to which it will be altered with these myriad projects. These communities have led a life that quite satisfied their material and cultural needs and demands, for which they were totally dependent on a small plot of lands. The notion of land as a commodity is undoubtedly alien to them. Private land ownership has evolved in recent times. However, it has mostly been restricted to individuals for housing, permanent cultivation or farming, etc. (ibid: 67). So displacing these people from their land and habitat would deprive them of their work and livelihood and mean a loss of their very essence of existence.

The upstream, downstream and cumulative social impact on the Brahmaputra and Barak Valley river system have become a subject of intense debate and concern in the state legislative assemblies and the parliament as well. The emergence of these dam-related controversies is partly due to failure to explain and communicate the intentions of development projects, faults in designs since they do not consider these areas as historically significant lived landscape, a failure to engender consent and fair benefits between the stakeholders.

[3] Even though land tenure system differs from one community to another within the same state.

3 The Approach of the Study

This study analyses both primary and secondary data. Qualitative method is adopted for collecting primary data, as the study is a political analysis to determine whether reform is possible in a given political context. Under qualitative research the strategy for primary source of data collection involves an multisited ethnographic account of the field of contestation including the perception of the local people, agitators, their responses and understanding of development as against the state-led development agendas. The field work was conducted in a period of 2 years from 2016 to 2018, in the state of Arunachal Pradesh for the analysis of upstream impact as well as in the state of Assam, the downstream impact analysis in the anticipated three districts.

The tools of data collection include semi-structured interview schedules for the household respondents, besides there were in-depth interviews with people directly affected (upstream of the dam) and indirectly affected (downstream of the dam). The sampling technique used, to select the subjects, was snowball sampling technique. The downstream impact includes three main districts, namely, Lakhimpur, Dhemaji and Majuli. Keeping in mind, the multisited ethnographic nature of the study, the investigation is not bounded, and the field of investigation is kept fluid. The people who participated actively in the protest from these three villages were contacted and interviewed. There were people who influenced and mobilised large number of villagers to participate in the protest that was at the peak during the period 2010–2011. Group discussion was done, in which they narrated incidence of clashes between police and protestors. Key informants were interviewed with semi-structured interview schedule to study the socio-economic level of the people and to assess how the dam will affect their livelihood.

4 Participatory Decision-Making and Legitimising: A Saga of Resilience

Post 1950s was a significant period in the construction of large dams in developed countries such as the United States of America, Former Soviet Union, Canada, Japan and Australia. The Tennessee Valley Authority (TVA) and institutions like the Bureau of Reclamation and the Corps of Engineers were considered significant throughout the world for promoting economic growth and development. TVA was considered a prototype, following which, India formed, Damodar Valley Corporation (DVA). However, DVA failed due to problems of technology transfer between the two countries, besides social, cultural and economic conditions (Karambelkar, 2017).

This was also a period when many Asian and African countries shed off their colonial history. Many of these newly independent nations accelerated towards economic growth and development. Water was considered as one of the significant asset and construction of hydroelectric power project contributed to achieve such progress and economic growth. Sudhir Sen, the first Chief Executive Officer of DVA stated:

> At the dawn of independence India relied, wistfully, on her high dam- builders… During this TVA phase of India's economic development, a well- known Indian engineer used to proclaim off and on that he was going to build the highest dam in the world, suggesting implicitly a new yardstick for measuring national greatness—the height of a dam and the millions of cubic yards of concrete pored. (Thakkar, 2005)

In the above quote, Sen, who was among the first elite bureaucrat of independent India, is referring to the iconic Bhakra dam. The 'well known Indian engineer' that he referred to is Ayodhya Nath Khosla, the Engineer in Chief who designed and executed the project. He was also the first Chairmen of Central Water, Irrigation and Navigation Commission (CWINC) and therefore was also the one who processed and cleared the project. Thakkar (2005) reveals how people who took decisions on large dam construction in the early years of independence were not accountable in the real sense. It failed to acknowledge the impact of such projects on the displaced population and the environment. It is remarkable, as it indicates the political economy of large dam building in India. Such trend of decision-making that was practiced in 1950s continued till today, in so far as decisions relating to water resource development is concerned. The question is how decisions on construction of large dams can be attained through transparent, scientific and democratic exchange of information among different stakeholders. The objective is to address challenges created by the task of developing water equitably and environmentally sustainable. Such process needs an interdisciplinary scientific viewpoint and wide acceptability among diverse stakeholders (Jain, 2012).

Participatory decision-making by affected people in developmental projects like large dams is often considered impossible, in spite of its support and advocacy by the World Commission on Dams. As mentioned above, the report of WCD 2000, described as 'new framework for decision-making', centred on 'rights and risks' approach, has been able to draw global attention to the fact that decisions regarding large dams are not restricted to merely structural design or physical description. There are other equally significant and associated aspects that have not received due attention. Besides sustainable water development management, the 'rights and risks' approach aims to involve and encourage participation of population affected by dam projects in every step of decision-making. The report states:

> Those whose rights are most affected, or whose entitlements are most threatened, have the greatest stake in the decisions that are taken. The same applies to risk: those groups facing the greatest risk from the development have the greatest stake in the decisions… and, therefore, must have a corresponding place at the negotiating table. (WCD, 2000)

However, the report stirred considerable disagreement and debate in different parts of the world. The commission believes that 'politics' is inherent in macroscale decisions like that of billion dollar projects. It is impossible to be purely 'non-political'. However, placing healthy politics at the centre should be a solution and emphasised on a multidisciplinary approach. The guidelines and recommendations (listed 26 in total) proposed by the report received a mixed reviews. Some believed that the guidelines listed were impractical and unrealistic and would prevent construction of dams in future. While others believe that these guidelines will help prevent past failures, if and when adopt by specific nations or river basins will produce best practices. Some countries (like Germany and Japan) and private companies (like HSBC Bank) supported the report. The World Bank considered its recommendations useful but not obligatory while regarding the report generally in favour of its strategies (Moore et al., 2010: 6). The Ministry of Water Resource (MOWR), under the government of India, comprehensively rejected the WCD report, while the environmental activists held it with utmost enthusiasm. The MOWR's response to the WCD report was negative and questioned the composition of the commission, its methods and adequate representation of the sample studied, i.e. Sardar Sarovar Dam. The MOWR was doubtful of the way the report was finalised, unbiased and objectivity of the analysis and findings. The guidelines and recommendations were considered unacceptable and anti-development (c.f: Iyer, 2001; Bandyopadhyay et al., 2002).

While analysing the WCD report, the major question revolving around decision-making is the involvement of experts from other disciple, besides just the engineers and economists. An approach to include the rights and risks of the people displaced/affected. Thus, even though the government of India rejects the WCD reports in toto, India embarks on a system of environmental impact assessment (EIA), positioned to appraise and reduce the environmental impact.

5 India's North-East and Anti-Dam Protest

Any discussion on the North-eastern part of India is unlikely to be devoid of its sociopolitical history of the region. Historically this sub-Himalayan area acted as a 'ethnoscape' (Appadurai, 1990) with people shifting from various civilisation of Asia. British geographer William Kirk (1962) in his study of the region stated that this Himalayan region is:

> a geographical area in its own right. It has received peoples and cultures from many directions, at various times, but has imposed on them its own peculiar regime born of the unity of high places … This is one of the earth's greatest highland zones, nourishing its own complexities of race and culture, and exhibiting its own internal environmental contrasts. (1962: 156)

In an attempt to analyse the reason behind one of the earliest and longest conflict ridden North-East India, it is largely considered to be lack of development in the region. However, when the decision for the massive expansion of hydropower development in the untouched 'frontier' of Eastern Himalayan region began in the early 2000s, it was not received as expected. The region witnessed one of the largest mobilisation against these large developmental projects. The problems of big dam construction, mainly across the state of Arunachal Pradesh, as one of the world's most seismically active regions, have created debate in the civil society of Assam. It is debated that the construction of big dams will pose a serious threat on the environment as well as the sociocultural milieu of the people residing in the downstream of the dam construction. The impact on the traditions, culture and food habits of the people will be immense as all these practices are related to riparian life of the people. The protest brought together thousands of peasants belonging to different indigenous communities for whom development is an imposition.

On 28th of July, 2001, the Assam State Pollution Control Board (ASPCB) had put up an advertisement in an English language newspaper announcing the environment public hearing for Lower Subansiri project, to be conducted at the dam site, Gerukamukh on 4th September 2001. However, the executive summary of the project, prepared for the public hearing, was not as per the norms subscribed by the EIA notification 1994 (Vagholikar & Ahmed, 2003: 30). After the EIA report was made public, Kalpvriksh Environmental Action Group, a civil society organisation, voiced their concern over the EIA report and demanded legal action against NHPC.

According to a member of an environmental organisation, Aranyak, who represented at the public hearing, said that the public hearing involved only a few bureaucrats and professors, who spoke in favour of dam construction. When he raised environmental concerns for construction of dams of such magnitude in an ecologically fragile site, the dam developers responded by saying that:

> the dam construction began after experts from IIT Rourke have conducted studies and there are no such downstream impacts (personal conversation, May 2017).

The EIA report was criticised on the ground that that the submergence area for the project site includes a region rich in wildlife and biodiversity. It was only a four-page document with information on the physical dimensions and certain numerical data related to engineering features. There was not a single mention of the EIA study or environmental impact. When some civil society members raised the issues of the downstream people, they were ignored. Meanwhile, members of All Mishing Student Union also known as Takam Mishing Porin Kebang (TMPK) organised a meeting for the first time in June 2003, to discuss the EIA report. An appeal was made for conducting a second public hearing, as people were not aware of the first public hearing held in 2001. The announcement for the first public hearing was made in an English language newspaper which is not circulated widely at the region. In addition, since it was a first large hydropower project in the area, people were not acquainted with the proceedings of a public hearing. However, this appeal was never considered.

Further, a small group of 12 people residing in the downstream area came together to form an organisation named People's Movement for Brahmaputra Subansiri Valley (PMBSV). Due to their limited access to important project documents, it became difficult for them to mobilise villagers in the region. Progressively, district members of student organisations, All Assam Student Union (AASU), along with TMPK started organising protests at the dam site. Although these protests gatherings were in small numbers, it successfully received the attention of the state government and dam developers. They also organised a series of public meetings with the village heads to discuss the impacts of large dams on their livelihood. A massive cycle rally was organised from the dam site to the district of Majuli, across two districts of Lakhimpur and Dhemaji, who stand to face the risk of the project. They travelled alongside the riverbanks into the remote villages to mobilise the people. A local daily was also circulated to create awareness amongst the local people. Subsequently, the Supreme Court in 2004 allowed the Lower Subansiri but passed a stay order on any more construction of dams in the river Subansiri due to the unavailability of a cumulative impact assessment report.

By 2005, the protest in Assam gained momentum while simultaneously the construction too began in earnest. Two of the most influential state-wide organisation, AASU and KMSS, came together to lead the agitation against LSHP. Demands were made to conduct fresh environmental clearance even after almost 7 years of commencement of construction; however it was never paid any heed by the government. Thousands of peasants, farmers, women and children came out to demonstrate their apprehensions against such large dams in the region. The issues now focussed on dam safety, impacts on the downstream inhabiting communities and the distribution of costs and benefits which did not receive any attention during the project approval process. It was argued that Arunachal Pradesh being the host state will gain revenue as well as 12 percent of electricity produced as royalty, whereas Assam will face the potential adverse impact. Asom Gana Parishad, who was the state's main political opposition, also merged with the protest. After many protest demanding proper study of downstream impact, in December 2006, a tripartite meeting was held involving Assam Government, NHPC officials and AASU. This was a critical step in the anti-dam discourse in Assam. An active AASU member said:

> It was like a victory for all of us who were part of the protest. Our almost 5 years of struggle was materialised when they agreed to form a committee. However, the study took 4 years to release a report as the dam developers, that is, NHPC was delaying to award the study. It was a strategy of the State government and the dam developers to pacify the protest for some time. While in these 4 years the construction continued rapidly and completed more than 50 percent of the project work.

After the expert committee report was published, which stated that 'the selected site for the mega dam of the present dimension was not appropriate in such a geologically and seismologically sensitive region… Therefore, it is recommended not to construct the mega-dam in the present site' (2010, chapter X: 10); the protest against dam exhilarated as it confirmed the fears and inhibitions of the people.

6 Conclusion

Until LSHP, the NE together has only three large hydropower projects, namely, Loktak Hydroelectric Project in Manipur, Teesta V in Sikkim and Ranganadi in Arunachal Pradesh. The LSHP was the first largest in the entire North-eastern region, and the people of the region is unfamiliar with any of the processes of dam-making. Walter Fernandes says there are so many restrictions and flaws in the decision-making process of large dams.

> I am not sure that the villages that were to be affected were fully aware of what was happening. That is where the very process can be questioned not just as it happened but as it is planned even, and as it happened is much worse than as it is planned. That is the problem (Personal conversation dated October 2017).

The EIA which has become mandatory since 1994 has become a mere formality, as the qualities of most of the EIAs are rather poor. The MoEF, that is supposed to be responsible for the process of conducting public hearing, clearance from State Pollution Control Board, etc., is rather involved actively in helping the project authorities getting the due processes. The EIA notification requires that the report of the public hearing for such projects should come to the MoEF with inputs from the state environment department and State Pollution Control Board. However, before the state government could take a decision about these projects, the MoEF gave clearance to the projects. Such decisions have serious ramification on the people of the area, since they have to bear the brunt of such reckless decisions and have serious environmental crisis. Moreover, it is a serious violation of the role of state government and the State Pollution Control Board as enunciated in the EIA notification and enshrined in Article 48A of the Constitution of India.

The state interventionist development paradigm is presumably different from the vision of development of the people. As a villager said, 'we want development, of course, but not of this kind, and manner'. A defensive attitude, however, such developmentalism is rejected as an inadequate and incompetent point of departure. It is all the more challenging when the decisions (of shape and objective) of such development are designed elsewhere. A key critique of statist developmentalism is that it defines the needs without consulting and involving the 'needy'.

The severe criticism against large dams from various participants as well as the representatives of international anti-dam network has resulted in the establishment of an independent World Commission on Dams (WCD) to review the effectiveness of large dams, assess alternatives and develop internationally acceptable guidelines and standards for the planning. After the WCD (2000) critical appraisal, large dams were considered as environmentally unsustainable and socially unethical. The report marked a low point for the global dam industry. Although India rejected the WCD report in toto, international financial banks like the World Bank reduced lending assistance for dam construction. Intense civil society advocacy pressured these financiers of mega infrastructure to withdraw from dam projects like from the infamous Narmada Dam. Nonetheless, in the past decades the dam projects have again been featured in the development planning. The dominant discourse legitimises large hydro energy as green, clean, reliable and affordable. Dam development is positioned as the only alternative to fossil fuel-based electricity, including funding by the World Bank (Huber & Joshi, 2015: 13). According to the Vice President of World Bank for sustainable development, Rachel Kyte, 'the earlier move out of hydro was the wrong message… that was then. This is now. We are back' (Schneider, 2013).

The social critique of development framework adopted in this study does not suggest a 'self-sufficient' image of the village but rather to analyse the proximity between what the actual needs and the definition of needs are. Thus, the construction of large dams is not considered necessary. However, it does not imply that the region is developed or has everything that they need, what is crucial is an analysis of the ideology of development that dissociates between those who define development and those for whom it is implemented but who are not thought to be a participant in the respective decision-making processes.

7 Notes

This chapter includes data and analysis from my Ph.D. thesis submitted to Jawaharlal Nehru University (2021).

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Chapter 20
Environmental Management and Sanitation: Perspectives on Waste

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Abstract The rapid upsurge of industrialization and increasing global population has led to the tremendous generation and indiscriminate disposal of waste without corresponding treatment and management plans. Moreover, the rise in global economic development and living standards of people especially in developed nations has greatly increased the quantity and complexity of generated waste and consequentially, promoting environmental pollution. This chapter outlined some fundamental and theoretical aspects of environmental management and sanitation. The earlier sections considered briefly the concept of waste, its generation, classification and types, and the available treatment and management technologies. Later in this chapter, some challenges facing these management technologies alongside some sustainable measures in ensuring adequate environmental sanitation were highlighted. Finally, possible ways of achieving sustainable development goals (SDGs) via proper environmental management and sustainable practices were put forward.

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1 Background

The continuous migration of people from rural areas to urban cities among other factors such as industrialization, abrupt climatic change, and fossil fuel overconsumption has resulted in a huge quantity of wastes which in turn had caused serious environmental pollution (Das et al., 2019; Ajibade et al., 2021b). For the well-being of man and the environment (which encapsulate proper sanitation), engagement of techniques leading to environmental management and sanitation is of paramount importance (Abdel-Shafy & Mansour, 2018). Managing waste efficiently could be a herculean task if proper guidelines are overruled, but it could also be a smooth and continuous process without a hitch if established guidelines are adequately followed (Ferronato and Torretta 2019). Furthermore, the efficiency and sustainability of this process will only be guaranteed if the concept of environmental management and sanitation is properly defined and engaged.

Environmental management is a concept which involves the allocation of both natural and artificial resources with the aim of making optimum use of the environment to satisfy human needs at the minimum and if possible, for an indefinite future (UNEP, 2004–5). Environmental management can also be regarded as the definite decisions and actions taken concerning policy and practices with regards to how environmental resources are protected, allocated, developed, used, rehabilitated, remediated, monitored, and evaluated (Mitchell, 2002; Scarlat, 2015). For efficient environmental management, environmental managers must have a good system and plan that provides a framework for managing environmental responsibilities in a way that is integrated into the overall operations. In the same manner, environmental sanitation refers to activities aimed at controlling man's environmental factors

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that may cause disease and improving the standard of basic environmental conditions that affect the well-being of man (Alabi, 2010). Some of these environmental conditions include clean and safe water supply, adequate and safe housing, clean and safe ambient air, proper waste management and disposal, and protection of food from biological and chemical contaminants (Ekong, 2015).

Having considered the concept of environmental management and sanitation, it is of utmost importance to operate whatever waste management schemes or activities are employed in a way that reduces environmental health hazards and risks and also ensures economic growth and social progress (Chang & Pires, 2015). The purpose of this chapter is to highlight some components of waste alongside their common treatment methods and to also emphasize the need for environmental management and sanitation of waste generated. Furthermore, possible challenges facing waste treatment and management were discussed. All these thus provide a solid framework on environmental sanitation and sustainability on waste, which can be adopted for more sustainable development goals attainment.

2 The Concept of Waste

Waste has been a great matter of public concern since the existence and habitation of humans in conglomerate forms such as cities and towns. The mass of waste that had since then been produced in the world has grown considerably, and this growth has been witnessed more in high-income countries revealed by the link between national gross domestic product (GDP) and waste generation per capita for each country. The voluminous state of waste generation has caused data on waste to often be incomplete and quite unreliable. Recent estimates suggest that globally, the municipal solid waste (MSW) alone generated more than 2 billion tonnes per year at the turn of the millennium (Hoornweg & Bhada-Tata, 2012). Defining "waste" could be controversial because of its perception which differs from individual to individual and one region to the other. What tends to be termed a waste by an individual may be a useful resource by another. This ambiguity has resulted in an avalanche of definitions given by different organizations and experts. Outlined as follows are some definitions of wastes given by world-recognized agencies, which is believed to largely represent the perception of every individual irrespective of their age, race, and gender and are generally acceptable.

As formulated by the European Union, "Waste shall mean any substance or object which the holder discards or intends or is required to discard" (European Commission, 2006).

The Basel Convention on the international movement of hazardous waste gave a similar definition on waste, but it was related to national legislation *as* "substances or objects which are disposed of or are intended to be disposed of or are required to be disposed of by the provisions of national law" (Bassel Convention, 1992). The use of the words *discard* and *dispose of* makes it another difference between these definitions which meaning has been disputed. Subsequently, European Commission added definitions of *by-products* and criteria for when waste ceased to be waste *as end of waste.* (European Commission, 2008).

The US Environmental Protection Agency (EPA) defines waste as "any unnecessary resource use or release of substances into the water, land or air that could harm human health or the environment" (USEPA, 2021).

Vividly, the stated definitions of waste try to capture the various perspective of every individual or organization as initially iterated. However, it seems impossible to distinctly define any material properties as waste, except for states and situations where it appears or declares as such.

3 Waste Generation and Influencing Factors

An unavoidable consequence of all processes where any class of object identified as "materials" is used is the *constant generation of waste*. Processes ranging from industries such as manufacturing of goods and extraction of raw materials, domestic/municipal, commercial, and so on all generate wastes (Karak et al., 2012). There is an increase in the volume of waste generated nowadays compared to previous decades or even centuries ago when the fraction of human and activities were small (Iraia et al., 2015; Liu & Wu, 2010). In addition, waste generation varies by quantity and complexity from region to region and season to season, and it is directly proportional to economic activities. The quantity of waste generated per capita in developed countries is higher when compared to that of developing countries (Lagerkvist & Dahlén, 2012). The present world population of 7.7 billion could reach around 9.7 billion by 2050 (UN 2018). The world generates about 1.3 billion tons of waste per year (1.2 kg/capita/day), and the data is set to increase to 2.2 billion tons in 2025 (Hoornweg & Bhada-Tata, 2012). Therefore, the situation is expected to worsen as the amount of waste generation continues to rise across the globe outstripping the rate of urbanization. By 2050, the world is expected to generate 3.40 billion tons of waste annually, increasing drastically from the recent 2.01 billion tons (Kaza et al., 2018). One-third of this waste will come from Asia, with major contributions from China and India. Waste generation in urban areas of India will be 0.7 kg per person per day in 2025, approximately four to six times higher than in 1999 (Kumar & Smith, 2017). This increase in the long term might lead to serious pollution with their impact on human health and wellness of the environment highly consequential unless an effective management system is put in place. Waste generation in most parts of the world is dependent on the type of activities and processes dominant in that region (Olabode, 2018; Chu et al., 2016; Iraia et al., 2015; Liu & Wu, 2010; Rafia et al., 2011). Some of these factors include but are not limited to the following:

(i) Population: This factor seems to have the most dominant impact on waste generation especially solid waste generation in most parts of the world.
(ii) Lack of advanced technology and facilities for separation at the source.
(iii) Strength of solid waste management policy and enforcement.
(iv) Income status of the individual.
(v) Environmental education and awareness.

4 Waste Classification and Types of Wastes

Waste classification is a vital exercise of grouping produced wastes into different categories to avoid/prevent pollution problems that can endanger public health or by complying with legislation to avoid potential fines. Waste can be characterized based on its different features such as its source (i.e., their places of origin) and their nature (whether they are dangerous or not). These wastes also exhibit different properties such as biological/biodegradable properties, mechanical and physical properties, chemical and elemental properties, and combustible properties (Chang & Pires, 2015).

4.1 Classification of Waste Based on Source

Wastes classified based on their sources include a municipal waste (such as commercial and services waste), industrial waste (such as manufacturing, chemical, construction, energy, refineries, mining, and agricultural), medical waste, and other waste not considered as municipal, industrial, or medical waste. When the source of waste is properly identified (particularly municipal waste streams), it aids the understanding of the classifier in the proper classification process. A schematic representation of waste classification by origin with some main activities generating different types of waste is shown in Fig. 20.1.

4.1.1 Municipal Waste

As the name suggests, these are wastes from household, commercial, and institutional outlets and this also includes collections from public and private service areas such as market, street cleaning, sewage cleaning, garden, park and so on. They belong more to the category of waste discarded by the end consumers. Common components of wastes found in municipal wastes streams are paper (soft and hard), glass, plastics, aluminum, textiles, wood, organic waste, aluminum, and ferrous materials (Chang & Pires, 2015). This waste when generated is dealt with locally and almost immediately by landfilling, incinerating, or other suitable local treatment (Baccini & Brunner, 1991). Similar to our discussion in Sect. 3, the generation of the waste components is influenced by education level (in terms of recycling knowledge), economic level (in terms of income and standard of living), climatic conditions, and festive or special seasons like carnival, Christmas, New Year, and other celebrations (G'omez et al., 2009). As a subheading consideration, municipal waste can also be further characterized by its nature which may either be hazardous or nonhazardous or even possesses inert properties (Ludwig et al., 2003; Chang & Pires, 2015).

Fig. 20.1 Waste classification by origin with different activities generating the waste

4.1.2 Agricultural Waste

Agricultural wastes are wastes generated from various agricultural practices ranging from crop planting to animal farming, and this could be at either subsistence or commercial level. According to the OECD, agricultural waste is waste produced as a result of various agricultural operations. It includes manure, slurries, crop residues, and other wastes from farms, poultry houses, and slaughterhouses; harvest waste; fertilizer run-off from fields; pesticides that enter into the water, air, or soils; and salt and silt drained from fields (OECD, 1997). The growing capacity of agriculture in most countries has led to an increase in agricultural wastes which in most cases is more than four times municipal solid waste produced in such countries.

4.1.3 Industrial Waste

Industrial wastes are waste generated from activities emanating from different industrial sectors such as manufacturing, mining, construction/building and demolition, metallurgy, non-metallurgy, and food processing industries (EIONET, 2009). Although, the waste components generated from industries may differ from one industry to another, depending on the used raw materials, the manufacturing processes, and the product outlets. However, the common end products are sludges, product residues, kiln dust, slags, and ashes (JeyaSundar et al., 2020). These waste components can be subclassified into solids, liquids, and gases in which the efficient management of the liquid waste produced posed the main treatment concerns for industrial waste. In another sense, industrial waste components can be further subclassified as hazardous (such as flammable waste, corrosive waste, and toxic materials) and nonhazardous (such as carton, glass, rock, metals, plastic, and organic waste) (Millati et al., 2019). Their classification may sometimes involve using specific methodologies such as material flow analysis and also depend on the waste destination and processing method (Chang & Pires, 2015).

4.1.4 Medical Waste

Medical wastes (also known as hospital or health-care wastes) are wastes mostly in the class of solid or liquid which are generated from human or animal health-care facilities and/or related research. The common components of waste found include cotton swabs, needles, syringes, razors, scalpels, chemical solutions, blood containers and samples, tissues parts, body parts, fecal samples, other surgical devices, and radioactive materials. Some of these wastes are produced when patients (human and animal) are immunized, examined, or treated, while others are produced through laboratories, research and development outlets, and other related centers. Similar to municipal and industrial wastes, medical wastes can also be subclassified into hazardous (such as infectious, toxic, and radioactive materials) and nonhazardous waste which is not dangerous neither do they pose serious risks of infection to anyone in case of improper handling (Mbongwe et al., 2008; Jeyasundar et al., 2020). However, the World Health Organization (WHO) made some distinct classification of these medical wastes (WHO, 2012) as given in Table 20.1.

4.2 Classification of Waste Based on Nature

Wastes classified based on their nature include hazardous waste and nonhazardous waste. Each of them is elaborated in subsequent sections.

Table 20.1 WHO classification of medical wastes

Medical waste type	Waste component
Infectious waste	These are wastes from patients in isolation wards (containing blood and its by-products), discarded diagnostic samples, infected animals from laboratories, contaminated materials (swabs, bandages), and equipment (such as disposable medical devices)
Pathological waste	These are body parts (either recognizable or non-recognizable) and contaminated animal carcasses
Sharps	These include syringes, needles, disposable scalpels, blades, and other sharp instruments
Chemicals and heavy metals	These include broken mercury thermometers, mercury, solvents, disinfectants, and chemical derivatives
Pharmaceuticals	These include drugs that are expired, unused, and contaminated; vaccines and sera
Genotoxic waste	These are highly hazardous, mutagenic, teratogenic, or carcinogenic materials, such as cytotoxic drugs and their metabolites resulting from their use
Radioactive waste	These contain glassware that are contaminated with radioactive diagnostic or radiotherapeutic materials

4.2.1 Hazardous Waste

Waste is classified as hazardous when it has a greater risk of posing a severe threat to human beings and the environment. The components of these wastes include corrosive products, infectious products, explosives, radioactive/nuclear substances, flammable materials, oxidizers, and so on. Almost all categories of waste type (be it municipal, industrial, or medical) contain some number of hazardous substances or materials having the capacity to adversely impact human's life whether in the short or long term. The distinction between a waste being classified as hazardous or nonhazardous can sometimes be debatable depending on whether it is viewed scientifically or in legal terms. Generally, in the environmental context, a material is deemed to be hazardous when it contains properties such as toxicity, reactivity, corrosivity, and ignitability, and this is mostly in line with a legal standpoint (Jeyasundar et al., 2020), while from a scientific perspective, the basis of research being carried out determines the actual definition of hazardous waste. For example, a waste generated during scientific research may contain hazardous substances, but the waste itself may not be classified as hazardous, depending on whether the concentrations of the hazardous compound in it are sufficiently low (Vallero, 2019). This is where the legal perspective seems different, as their definition is based on the expectations of the harm the waste may like cause, especially in the long term. Because of this, various countries (specially developed ones) have various rules and regulations with codes to identify if wastes are hazardous or nonhazardous.

4.2.2 Nonhazardous Waste

Waste is classified as nonhazardous when no characteristics of hazardous can be traced from it prior to any physical, chemical, or biological transformations (Chang & Pires, 2015). A larger portion of the wastes generated from municipal, agricultural, and even industrial or medical are nonhazardous. Some examples of nonhazardous wastes have been highlighted in the discussion on municipal, industrial, and medical wastes in Sects. 4.1.1, 4.1.2, and 4.1.3, respectively.

5 Waste Treatment and Management Technologies

When waste is processed in such a manner that it has little or no effect on the environment, it is termed waste treatment or waste management (Tchobanoglous et al., 2014). There are various forms of technologies that can be employed in treating waste of any kind. These can be broadly categorized into physical, chemical, biological, thermal, and sustainable treatment methods. Under each of these methods are different techniques used which are peculiar to the waste type. A detailed explanation of these treatment techniques is not covered in this chapter. Meanwhile, a brief description of the physical, chemical, biological, thermal, and sustainable treatment methods is discussed in the following sections.

5.1 Physical Treatment

The physical treatment method is achieved by using techniques that are void of chemicals or microbes for waste treatment. Some of the major processes include sorting/screening, flotation, sedimentation, filtration, evaporation, sir stripping, and membrane-based filtration processes. The dominant use of the physical method is in treating liquid waste (especially hazardous wastewater), and before the operation commences, the solid wastes are firstly separated from the liquid waste to reduce the cost of treatment. Generally, it is relatively cheaper to treat a low volume with high concentration waste than complex unsegregated waste (Christensen, 2011). Part of the most important aspect of the physical treatment processes is to segregate or classify the waste into categories of solid, liquid, or gas. By so doing, the volume of waste will be reduced, and this will facilitate the treatment process (Jeyasundar et al., 2020). In a broader perspective and for the optimum waste treatment process, the physical method can be combined alongside other methods.

5.2 Chemical Treatment

The chemical treatment method is used for treating waste by applying chemical reactions techniques to reduce harmful waste into less harmful ones in the environment. Some of the major processes include oxidation, reduction, neutralization, precipitation, coagulation, and flocculation. They are closely related to physical treatment methods except that chemicals are adopted for its implementation. They are advantageous in volume reduction and resource recovery from wastes, which makes them a fit for off-site landfilling before disposal. Liquid waste, which is prohibited from being disposed for landfilling without any form of pretreatment, is also treated chemically to make them less toxic or nonhazardous before disposal.

5.3 Biological Treatment

The biological treatment method can be adopted for both organic solid waste and organic liquid waste. This can be achieved either by engaging (i) microbial mediated methods such as anaerobic digestion and composting via aerobic process and (ii) plant-mediated methods such as phytoremediation (El-Haggar, 2007). During implementation, either method can be used individually or both can be combined for more effective output. For anaerobic processes, anaerobic bacteria degrade waste without oxygen, and they are mostly adopted for treating concentrated organic waste or organic sludges, while for the aerobic process, oxygen is needed to degrade waste, and they are mostly used for the treatment of industrial and municipal wastewater (McDougall et al., 2001; Chang & Pires, 2015). In recent years, advanced techniques had been developed to treat petroleum-contaminated soils using aerobic bacteria (Jeyasundar et al., 2020).

5.4 Thermal Treatment

The thermal treatment method is used mostly for treating solid wastes, especially municipal solid wastes. It is the process of using heat to treat and reduce waste materials. Most commonly used techniques in this category include open burning, incineration, gasification, and pyrolysis. Amongst them, open burning is the most popular with long-standing history, but it is environmentally harmful because it is a form of incinerator with no pollution control mechanism (Oluwatuyi et al., 2020; Ajibade et al., 2021a). Meanwhile, there are controlled incinerators in which the temperature can be adjusted to control the burning of waste and liberation of gases and heat energy (Zaman, 2009; Havukainen et al. 2017). Basic incinerator types are fixed-bed or fluidized-bed plants. They are more advantageous than open burning in that they do not only reduce waste volume and transportation costs; they help in drastically reducing harmful greenhouse gas emissions (Sharma, 2015; JeyaSundar et al., 2020). Pyrolysis and gasification are closely related techniques that decompose organic waste using either no or low quantity of oxygen and high temperature. The former requires no oxygen while the latter requires little oxygen for the treatment process. In practice, gasification allows the burning process to recapture energy without leading to air pollution which makes it more advantageous than pyrolysis.

5.5 Sustainable Treatment

The sustainable treatment method is not a popular concept when it comes to discussing the available waste treatment techniques. However, it has recently been established and defined as the type of treatment which combines various two or more types of treatment, and process can recover raw material from waste with a prospect of conserving them for full reutilization (El-Haggar, 2007). A perfect example of this treatment method is waste recycling which entails converting waste into raw material and then producing other products from it (Adama, 2012; Hotta & Chika 2014). Composting is also a form of sustainable treatment which through a biological treatment means converts organic waste into a safe by-product.

6 Challenges Facing Waste Treatment and Management Technologies

Globally, many countries face critical problems concerning waste management. The development level of a country greatly determines how their waste will be managed and the impact those treatment and management measures will reflect (Zhao & Duo, 2015). Choice of waste management depends on the decisions taken by city leaders as well as the structures related to the nature, quantity, and quality of local waste produced (Baldwin & Dripps, 2012). Some of the challenges that can be encountered in waste management include insufficient government priority and political support for action; poor finance; inadequate long-term planning, indiscriminate disposal of waste; poor handling and disposal of hazardous wastes; insufficient recycling and reuse; ineffective legislation and institutions; lack of skilled personnel; and poor monitoring and enforcement (Adewumi et al., 2020). Summarily, these challenges are discussed under five source areas.

(i) Lack of environmental awareness in society

Environmental awareness plays a major role in sustainable waste management and sanitation in society. The involvement of people in waste management has a major effect on the overall operational efficiencies of any waste management system or approach adopted. For instance, the inefficient recycling activity can be directly traced to poor waste-sorting behavior among people. When materials that are recyclable are mixed with other wastes, they result in environmentally and economically inefficient recycling operations (Jagdeep et al., Singh et al., 2014). As noted by Mbeng et al. (2009), strong concern among people for a clean environment and the belief that learning, information, and awareness campaigns are important drivers to behavior change. However, this does not necessarily translate into increased participation in recycling or reuse initiatives. In developed countries, although disposal and management of waste are of great environmental concern, they are not fully aware of its consequences at the global level. There is still a need to have proper understanding about how resource issues are linked to global environmental issues such as climate change, which is an issue that is of a particular concern to people. Thereby, resulting in poor public participation in waste management. Hence, there is a need to successfully educate the public to be aware of the association between people's waste disposal behavior and global concerns in the same way as they are aware of how climate change is linked to car use and local flooding. Consequently, the public would be conscious of their actions and will improve participation in waste management.

(ii) Increasing global quantities of waste

The increase in the amounts of waste generated globally has shown the effect of economic growth on waste amounts. The waste generation rates per capita in developing countries are relatively low as compared with developed countries. However, waste generation rates in developing countries are increasing rapidly. The increase in waste generation rates even at already high waste generation rates, especially in developed countries, can be linked to the rate of consumption of resources in the world (Jagdeep et al., 2014).

Innovation in production has led to the generation of new and increased amounts of wastes that are entering into the waste streams. Consequently, the world is still faced with challenges to manage wastes sustainably due to inadequate waste sorting, products that are not suitable for recycling. Even developed countries with relatively developed waste management facilities are not left out. This understanding, therefore, underscores that despite the development and improvement in the waste management system, the overall waste management is still not sustainable (Jagdeep et al., 2014).

(iii) The increasing complexity of product composition and variety in the production and consumption systems

During extraction processes, high-quality material resources produced are used to make various products in the manufacturing industries by combining various raw materials. Therefore, the manufacturing systems combine materials to production. These products enter the consumption system and leave the system in various form of wastes, further resulting in the dilution of resources in space and time. Also, as reported by Gößling-Reisemann (2011), these transformations lead to changes in physical, chemical, and biological properties of the material resources.

Waste management processes either "concentrate" these resources through, for example, recycling, or further "dilute" them in one of their residues, such as through incineration or composting. From a resource scarcity perspective, the dilution of the many scarce material resources is not sustainable, and these resources should be reintroduced into the socio-technical systems. The manufacturing and consumption systems dilute the resources to a critically low level owing to the increasing product composition complexity. This leads to energy-intensive and hence costly recycling operations. This is the case for many materials where recycling is not economical or not possible technologically. When limited energy is available, the cost of production of pure substances will prevent the recycling of materials beyond certain limits. Therefore, as reported by Vesilind et al. (2007), using nonrenewable resources is not sustainable, and attempts to close their loops will lead to greater damage than good. Furthermore, the recycling of complex waste streams poses great technological challenges, thereby reducing their potential utility (Gößling-Reisemann, 2011). Product diversity has considerably increased over the last few decades which consequently, there is an increase in waste materials discarded in the waste management systems with the potential to further increase. However, waste is classified and sorted in limited numbers of fractions. At the end of their use, products with complex material compositions are often difficult to treat when disposed of. This is a challenge for the current waste management system to handle the wastes more sustainably due to complicated waste treatment processes (United Nations Environment Program, 2011). Hence, to enhance efficient cycles of reuse such as remanufacturing and reassembly, it is essential to maintain resource quality throughout the production chain in the industrial sector. Consequently, it is very necessary to properly consider the possibility of a system to concentrate or dilute the resources.

(iv) Barriers to practical implementation and performance of various approaches to waste management

Apart from the lack of facilities for proper waste management, there exist many factors which are inhibiting execution and performance of various innovations in resource management, and this is yet to be properly addressed. Consequently, policies, during implementation stages, fail owing to reasons such as an economic situation or competition existing approaches. Therefore, there is failure of the policy decisions to achieve the intended goals. For example, Walls in 2006 noted that the concept of extended producers responsibility (EPR) has been introduced to enhance product development processes, particularly design for environment, in companies and to achieve greatly needed resource recovery. However, the external costs of waste management are not well captured in EPR which results to reduction in incentives for waste prevention and green products design (Dubois, 2012). Jagdeep et al., (2014) noted that findings have revealed that the EPR lacks needed potential to drive eco-design at least in the short run where (1) prices of product are inelastic and the effects of the EPR equal for all producers (Gottberg et al., 2006) and (2) in cases where such innovations become economically harmful to "green technology loses and profitability wins" (Vesilind et al., 2007).

(v) Private sector

Generally, there is a lack of funding that may be used to establish or equip a waste management system operated by private contractors. This is caused by little or no incentives or initiatives for the private sector in waste management and the unwillingness of authorities to give waste management services to private operators. Another factor affecting the involvement of private individuals is poor public awareness. However, if the people are willing to participate and the private sectors are motivated to contribute to waste management, there is a need for support and provision of funding from the government for effective and sustainable participation.

7 Ensuring Environmental Sanitation and Sustainability on Waste: Achieving SDG

7.1 Environmental Sanitation and Sustainability on Waste

The need to ensure proper environmental sanitation and sustainable practices especially on proper waste management and treatment is not far-fetched. Poor sanitation leads to the spread of infections and diseases which are detrimental to human health. Schistosomiasis (sometimes referred to as bilharziasis), one of the human parasitic diseases, is ranked second after malaria in terms of public health and social-economic importance in tropical and subtropical areas as the disease is prevalent in more than 70 developing countries, infecting over 200 million people in which 20 million suffer severe consequences from the disease (UNICEF & WHO 2019). Comprehensive environmental sanitation management will ensure that proper intervention is introduced and implemented to encourage behavior change.

Also, improper environmental sanitation or hygiene has great financial and economic implications, both directly and indirectly. The impact of inadequate environmental sanitation on health results to direct medical costs associated with treating and controlling sanitation-related illnesses. Certainly, this will lead to reduced or lost human productivity and increased government expenditures on the provision of health services. Furthermore, poor sanitation can discourage tourism thereby leading to reduction in revenue generated from tourism due to the high risk of disease contamination. If the economy of such a city depends largely on tourism, that will lead to a recession. According to an analysis conducted in Ghana, the health cost resulting from poor water, sanitation, and hygiene is equivalent to 2.1% of the annual gross domestic product (GDP). Poor environmental sanitation practices, especially in the context of indiscriminate littering and improper discharge of sewage and solid waste into water bodies, render the habitat unsafe for aquatic animals, thereby leading to their death and consequently can lead to loss of biodiversity.

In the light of the above discussion, improved environmental sanitation management will not only enhance the sustainability of environmental resources but also present a more secure and healthier future for people. On the one hand, as healthy people make a healthy community, a healthy community is a more lucrative place for goods, services, and investment which in the long term will ensure economic sustainability.

7.2 Achieving Sustainable Development Goals

Sustainability has a major focus of environmental studies and human development and resource use. While the idea of sustainability has many aspects, as touching environmental management, its central idea is to use resources in ways that do not diminish them. Natural resources such as wildlife, land, and water should be protected so that coming generations can enjoy healthy living. However, one of the most important questions in environmental studies is how to improve the well-being of man within the limits of the earth's natural resources. A viable way out of this condition is sustainable development. Sustainable development can be explained as the development that meets the present needs without compromising the ability to come generations to meet their own needs (Mitchell, 2002).

To achieve the sustainable development goals relating to environmental sanitation and waste management, the adoption and effective implementation of the following actions are recommended.

(i) Establishment of efficient solid waste regulations

A very vital aspect of sustainable waste management is proper planning. Although waste management services and operations are typically handled at the local level, both local and federal governments significantly contribute to defining the regulatory framework within which the development of solid waste management services can be placed. It is the responsibility of national governments to establish environmental regulations. National laws encourage local governments to adhere to common social and environmental standards. Local governments also establish rules and regulations that guide households and institutions on the proper management and disposal of waste. Typically, the section that regulates waste management is separate from the section that operates services to promote accountability.

(ii) Adopting a circular model of consumption

A major structure of resource consumption at the global level is the linear system of resource consumption. Various resources are transformed into diverse products in a predominantly global production system. These products are distributed to consumers on the global market and wastes disposed into the water management system. Despite the increase in the rate of recycling of materials, such as paper and metals, the linear production-consumption chain is still predominantly in use (Jagdeep et al., 2014).

To make resource management sustainable, it requires "decoupling" resource consumption with the economic growth and a transition towards a circular model of resource consumption, where reuse and recycling of resources are introduced through strategic planning from the production to the consumption chain (Jagdeep et al., 2014). This calls for a definite approach to a waste management system that must go beyond the mere safe disposal, or recovery, of generated waste and seeks to address the fundamental causes of the problem by attempting to change unsustainable patterns of production and consumption (UN, 2018).

(iii) Citizen engagement

The role of a strong relationship with the public in successful and sustainable waste management cannot be overemphasized. To achieve sustained waste management, public engagement is very essential. Citizens are relied on to consciously reduce the quantity of waste they generate, manage specific waste types at home, dispose of waste properly, abide by waste management rules and regulations, pay for waste management services, etc. To motivate this support, it is necessary that governments gain public trust. Cities and countries are encouraged to engage the public by providing high-quality services that earn approval and trust that will motivate citizens to pay for services, be environmentally conscious, and abide by guiding rules and regulations.

(iv) Education

Educational programs are a key aspect of raising awareness on waste and ensuring proper waste management. Contrary to popular belief, many people do not know enough that at the local level, inadequate collection of waste, uncontrolled disposal, and inappropriate siting of waste facilities can negatively affect both environmental and public health. Many are not aware that at a global level, waste contributes to climate change and is one of the major sources of pollution in oceans. A number of countries reach citizens using media. Effective programs can be organized, and interesting environmental content can be organized in diverse languages through media and advanced technology, such as television, radio, and on social network platforms. Educating young by adopting an environmental-related subject in the school curriculum can be very vital to public education. This will not only educate young citizens, but they will also become more environmentally conscious.

(v) Integration of waste pickers and strengthening of the recycling value chain

Recognizing and formalizing informal waste pickers can lead to improved waste collection and recycling. The collection and sale of recyclable materials to middlemen who then clean and aggregate materials to distribute to the industry are vital roles played by waste pickers in the recycling value chain. Through proper integration and formalization, governments and associated corporations can improve the prospects of waste pickers by ensuring an innovative partnership model between the private sector and waste pickers. Also, governments should oversee the transaction and ensure that fair prices and bargaining material from the middlemen. Formal recognition of waste pickers will also allow them to boost of job security and acknowledgement of their work and therefore improve their productivity and commitment.

8 Conclusion

Undoubtedly, the economic performance coupled with the habitual living standards of people living in a country or region will continuously affect their waste generation rate, which in the long run may become either a blessing or menace, depending on the management and sustainability strategies put in place. Ensuring effective environmental sanitation and sustainability, especially in the area of waste, is one of the main objectives that SDGs seeks to address. Therefore, this chapter has provided information on how this can be effectively achieved by considering the concept of environmental management and sanitation and how they relate to waste generation, waste classification and waste treatment, and management technologies. Moreover, possible ways to ensure proper environmental management and sustainable practices with adequate perspective on waste to meet the SDGs were put forward. These actions and measures, if painstakingly given due diligence, will result in a truly sustainable environment that continually promotes the well-being of the individuals living in them.

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Chapter 21
Promoting Sustainability in a Brazilian Higher Education Institution with Development of Sustainable Competencies

Melissa F. Cavalcanti-Bandos and Alberto Paucar-Caceres

Abstract One of the current challenges of higher education institutions is to incorporate transformative changes in the context of the United Nation (UN) Sustainable Development Goals (SDGs) that, through the implementation of sustainability principles in the educational system, will develop sustainable competencies in all stakeholders (students, professors, university staff, and community). Therefore, the main objective of this chapter is to describe real actions in the Brazilian university situated in the state of Sao Paulo, through a case study, with a focus on promoting sustainability, even during the Covid-19 pandemic, in 2021. These actions are within the scope of a project that aims to welcome early-year students, with actions that contribute to their formation as human beings, so they can internalize their role in society with ethics and citizenship. Even in the context of the pandemic, in 2021, the institution articulated actions in line with the SDGs so the students could experience good practices. The action allowed the collection of food for people in vulnerability, supplements for cancer patients, and some actions in the social network to raise awareness with measures to prevent and control the Covid-19 pandemic. The project included an online conference discussion with people who work for causes related to developing decent work and economic growth, for the reduction of inequalities regardless of disability, and for the support of patients with a severe illness such as cancer. The project was described based on its results and sustainable competencies provided.

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1 Introduction

This project, called Solidary Hazing (SH), emerged 30 years ago in a Brazilian higher education institution (HEI), located in the state of São Paulo, with the aim of encouraging social actions instead of violent practices among the freshmen and their seniors. The central scope of the project is to integrate students from the early periods to the academic community, with actions that demonstrate solidarity with society.

The project predates the law number 10.454 of 1999 that prohibits violent hazing among university students in the state of Sao Paulo (Brazil); however despite of the prohibition, it is still possible, nowadays, to find university students subjected to humiliating practices that put their health and physical integrity at risk. Thus, HEI has an important role to receive the freshman with warm and welcoming practices that protects them from violent practices.

In this context, over the years, the SH has this role of welcoming with security but also of developing important competencies in young professionals. Thus, it was adapted to a competition to welcome freshmen, and the actions included in the competition were contextualized in the United Nations (UN) Sustainable Development Goals (SDGs), aiming to awaken and promote sustainable competencies among university students.

It is known that one of the current challenges of HEIs is to incorporate transformative changes in the context of the SDGs that, through the implementation of sustainability principles in our education systems, will develop sustainable competencies in all stakeholders (students, professors, university staff, and community). Therefore, the main objective of this chapter is to describe real actions in a Brazilian university situated in the state of Sao Paulo, through a case study – the Solidary Hazing – with a focus on promoting sustainability, even during the Covid-19 pandemic, in 2021.

The chapter poses the following research questions (RQs):

RQ1: Is it possible to encourage and promote sustainable competencies in first-year higher education students?

RQ2: How to develop sustainable competencies in university students even in the pandemic context?

The study is important, as it relates the significant role of the HEI in welcoming the early-year students with security and welcoming practices, but it also makes them to look at the environment in which they are in and put them in a prominent role as responsible for social actions in the context of the UN SDG. These actions contribute to their formation as human beings, so they can internalize their role in society with ethics and citizenship, even in the context of the pandemic, in 2021.

This chapter first presented, the literature review, which approached the HEI promoting sustainability with the SDGs and the sustainable competencies developed in students. After that, we explained how we wrote this chapter; we described the SH project and its results. In the end, we presented the conclusion, recommendations, and further research.

2 Literature Review

2.1 Promoting Sustainability and Sustainable Development Goals (SDGs) in Higher Education Institution (HEI)

The 2030 Agenda adopted in 2015 by all the United Nations member sets 17 SDGs, with the objective of coordinated actions among governments, companies, academia, and civil society. The 17 SDGs are a global urgent call to action with the purpose to end poverty, protect the environment and the climate, and ensure that people everywhere can enjoy peace and prosperity (United Nations, 2021).

The 17 SDGs focused on promoting sustainability are: (1) No Poverty; (2) Zero Hunger; (3) Good Health and Well-being; (4) Quality Education; (5) Gender Equality; (6) Clean Water and Sanitation; (7) Affordable and Clean Energy; (8) Decent Work and Economic Growth; (9) Industry, Innovation, and Infrastructure; (10) Reduced Inequality; (11) Sustainable Cities and Communities; (12) Responsible Consumption and Production; (13) Climate Action; (14) Life Below Water; (15) Life on Land; (16) Peace and Justice Strong Institutions; and (17) Partnerships for the Goals. As we can see, they are ambitious and interconnected goals that address the main development challenges faced by the world, and they were conceived from the millennium goals established in 2000 (United Nations, 2021).

In this perspective, the HEI has an important role in promoting sustainability, disseminating, and promoting actions so that the SDGs can be achieved. Blanco-Portela et al. (2018) explained the HEI key role as agents of change to transform the world. Rezende (2021) explained that the universities are an important source of knowledge and experimentation, in which interaction can contribute to the production and dissemination of knowledge as a basis for action.

Hernandez-Dias et al. (2021, p.1) proposed "an integration of sustainability throughout the university as a system, considering existing tools and frameworks, and proving the theoretical proposal in an empirical context." These authors highlighted the importance of considering sustainability from a whole-institution perspective, in the same way Longoria et al. (2021) explained that HEIs are introducing and implementing sustainability in a holistic way, connecting people, and including social and institutional considerations, with students being the principal component of change.

The SH project puts the students as protagonists, responsible for changes and actions, that, in the circumstances of the Covid-19 Pandemic, increased and developed new sustainable competencies.

2.2 Sustainable Competencies

In an attempt to describe the sustainable competencies that can be developed in students, it is important to clarify that it is intended to identify the description of the knowledge, skills, experience, and attributes necessary to effectively carry out the sustainability. Crick (2008, p.313) explains as “a complex combination of knowledge, skills, understanding, values, attitudes and desire which lead to effective, embodied human action in the world, in a particular domain.” Brundiers et al. (2021) summarized the key components of sustainability competencies from Wiek et al.’s (2011) research. For them, the key components are systems thinking, futures thinking, values thinking, strategic thinking, and interpersonal competencies.

Tilbury (2004) explained futures-thinking, critical and creative thinking, participation in decision-making, partnerships, interdisciplinary and systemic thinking like principles discussed by several authors in the context of Educational for Sustainable Development (EDS). We can understand that these principles will subsidize the competencies required for students. Added to that, we should think of sustainability as a learning process as proposed by Blewit (2006), learning to know, learning to do, learning to live together, and learning to create productive learning communities for sustainability.

Still in the context of EDS, Cebriàn et al. (2020, p.2) “understand the term sustainability competency as the combination of cognitive skills, practical abilities, and ethical values and attitudes mobilised in a real situation or context related to sustainability.” Cebriàn and Junyent (2014, p.37) developed a theoretical framework of the professional competencies in ESD with some components:

1. Future/alternative scenario visioning: Understanding the different scenarios, possible futures, promoting work with different visions and scenarios for alternative and future changes.
2. Contextualizing: Taking into account the different dimensions of a problem or action, the spatial dimension (local-global) and the temporal dimension (past, present, and future).
3. Work and live with complexity: The ability to identify and connect the ecological, economic, and social dimensions of problems. Generate the conditions for systems thinking in the school environment.
4. Think critically: Creating the conditions for critical thinking to question assumptions and to recognize and respect different trends and views in different situations.
5. Decision-making, participation, and acting for change: Moving from awareness to action; sharing responsibilities and engaging in joint action.
6. Clarify values: Values clarification and strengthening behavior toward sustainability thinking, mutual respect, and understanding of other values.
7. Establish a dialogue between disciplines: Developing teaching and learning approaches based on innovation and interdisciplinary.

8. Manage emotions and concerns: Promoting reflection on one's own emotions and as a means to reach a deeper understanding of problems and situations.

In this chapter, we are going to work with the sustainable competencies and not specifically with the competencies for EDS. The difference between them is that we are going to focus the practice of the student as citizen to contribute with a sustainable life, both professionally and personally in aiming to achieve the SDGs. The EDS competencies focus on the competencies educators related to help student develop competence through innovative teaching and learning practices (Lira & Martins, 2021).

In a synthetic way, the sustainable competencies listed previously by Brundiers et al. (2021, p.15) from Wiek et al. (2011) will be considered for the purposes of this chapter, as seen below.

1. System thinking competency – analyze complex problem in current state and its history.
2. Value thinking competency – map, specify, apply, reconcile, and negotiate sustainability values.
3. Future thinking competency – create nonintervention scenarios or craft future sustainability vision.
4. Strategic thinking competency – develop sustainability transition strategies.
5. Interpersonal competency – collaborate in each step of the problem-solving process.

The methodological aspects will be presented below.

3 Methodological Aspects

This chapter was written with the objective to describe real actions in a Brazilian university situated in the state of Sao Paulo, through a case study, with a focus on promoting sustainability, even during the Covid-19 pandemic, in 2021. The proposal is to understand how students in their early-years are immersed in an institutional project of welcoming practices with the perspective of developing sustainable competencies aligned to the SDGs.

With this purpose, a literature review was presented based on two central theoretical aspects: the promotion of sustainability and the SDGs in HEIs and the sustainable competencies. A description of the mentioned project, based on secondary data obtained from the institution's website (with authorization of the competent authorities), was performed. Other information came from one of this chapter author and from an institutional YouTube video explaining the whole project. It was possible to verify the awakening of sustainable competencies from the speech of the students in this institutional YouTube video.

4 Promoting Sustainable Competencies: A Brazilian Welcome Early-Year Student Project

4.1 The Welcome Early-Student Project: "Solidary Hazing"

In this section, we report the welcome early-student project, called Solidary Hazing (SH), in a Brazilian HEI as an institutional initiative with the aim of inserting the freshmen in the academic environment, focusing on social promotion and promoting sustainable competencies.

The project started with a group of university students in the 1990s with the aim of ending violent practices that occasionally happened to freshmen outside the university walls. The idea was to internalize among seniors the importance of welcoming the freshmen through solidarity actions.

Over the years, the SH project transformed and is now known as a welcome gymkhana, where students are divided into teams. At the beginning of the year, the HEI decides about a central theme to explore, with special colors and a special identity with the objective of customizing the actions, for this group of freshmen. Until 2019, the actions were essentially in person, and in 2020, faced with the Covid-19 pandemic, the actions only started in person and went online in the way it was possible. We can see the explored themes, in the last 10 years, in Table 21.1 below.

The project is promoted by an HEI that is 70 years old, with around 2000 students, 3 units, and 13 courses (Business, Accounting Sciences, Advertising, Civil Engineering, Production Engineering, Computer Engineering, Information Systems, Computer Science, Medicine, Psychology, Nursing, Languages, and Mathematics).

For the HEI managers, the reception through the SH is a way to celebrate the student's entry into higher education with responsibility, providing opportunities for the development of sustainable competencies in his/her professional future. This project is in line with the mission of the HEI: "To build and spread knowledge, contributing to the formation of human beings, so that they can practice their role in society with ethics and citizenship" (Uni-FACEF, 2021). The HEI had the following objectives (Paucar-Caceres et al., 2021):

(a) Train people with skills both for a high technical-professional performance and for the exercise of citizenship, with an ethical and participative experience in the social world.
(b) Promote the development of knowledge, its critical transmission and understanding of the current world, particularly with regard to national and regional needs.
(c) Participate in the development of conditions and actions that demonstrate "learning to learn" and promote continuing education in the fields of professional activity with which they identify.
(d) Share with all segments of society, the identification, analysis, and search for solutions to the problems of the community, both local and regional, and of the wider society; encourage participation in scientific research; and publish and disseminate work at events.

Table 21.1 Themes of solidarity hazing

Year	Theme
2021	"Solidarity in pandemic times. A look at the next one."
2020	"Together we are more."
2019	"Inclusion."
2018	"Joy."
2017	"The most important is to have attitude."
2016	"For solidarity, there are no borders."
2015	"Culture and solidarity. This is Uni-FACEF."
2014	"I am Uni-FACEF. Shirt 10 of Solidarity."
2013	"Do the good."
2012	"Environment. I want it whole!"

With this project, the academic community has the opportunity to carry out practical activities in the context of SDGs, disseminated within the organizations of the UN.

In 2021, due to the Covid-19 pandemic, the project was adapted to follow sanitary protocols, and it was planned to be developed, between February and March, into two parts: the first called "Solidarity gymkhana" and the second "The closing night." The students of the 13 courses were divided into nine teams: business, accounting sciences, advertising course, nursing, engineering (civil and production), languages and mathematics, medicine, psychology, and computer courses (information system, software engineering, and computer science). A regulation with the competition rules was published on the HEI website, establishing the goals and the schedule. However, before starting, an online meeting was scheduled for general explanations and questions, and at least two students from each team should be present.

The first part, "Solidarity gymkhana," had three phases: (1) collection of food for people in vulnerability and supplements for cancer patients, (2) Covid-19 awareness, and (3) solidarity food collection.

In the first phase, the students were tasked with collecting supplement cans for cancer patients and collecting "food kit" to be donated to vulnerable people. The regulation established which items and their respective quantity to be part of the "food kit" and the characteristics of the food supplement. A single day was also established, and different times were schedule for each team's deliveries, in a drive-thru organized in the parking lot of one of the HEI units. The number of kits to be delivered as well as the number of supplement cans depended on the number of students per team. This phase was contextualized in SDG 2 (Zero Hunger) and SDG 3 (Good Health and Well-being).

In the second phase, the freshmen were asked to develop a short video, with the aim of population awareness with measures to prevent and control the Covid-19 pandemic, such as the importance of distancing, the use of mask, hand sanitization, isolation of people who contracted the virus, vaccine importance, and social help for those financially affected. The video should be sent to the SH organizing committee to be evaluated by external people from the IES linked to the area of social communication based on some criteria, as the length of the video, message relevance, and creativity. This phase is based on the need for awareness of the academic community about correct attitudes during the pandemic.

In the third phase, the organizing committee chose nine supermarkets so that the team had a food collection point (box). This way, any person from the society who wanted to collaborate with the team could put their donation in the boxes. Social media was used to disseminate and encourage people to participate. This phase is contextualized in SDG 2 (Zero Hunger) and SDG 17 (Partnership for the Goals).

The second part, "The closing night," was organized as an online meeting, using the Zoom platform for the conclusion of the SH and dissemination of the results. During this online meeting, the videos produced in phase 2 of the first part were shown, and three people from the community who deal with social causes were invited to share with the students their experiences and practical actions, inviting them to support the causes and participate. The student listened to the president of the city's Solidarity Social Fund, who is responsible to carry out professional training and income generation courses; they talked with the president of the health volunteer group that provides voluntary services to cancer patients at the city's hospital and with the director of an organization responsible for caring for people with disabilities. At the end of the online event, the organizing committee announced the result, described in the next topic.

4.2 Results of the Project

The organizing committee ranked the based the scores acquired in the three phases of the first part: (1) collection of food kits and supplement cans, (2) video, and (3) food collection in supermarkets with the population involvement. The first three team winners were respectively: nursing, medical course, and languages/mathematics. All the nine teams together collected approximately 5500 kilos of food and almost 500 cans. Food deliveries to the city's entities that care for vulnerable people took place during drive-thru week. Many kits were donated to the city's Social Solidarity Fund serving several families economically affected by the Covid-19 pandemic.

4.3 Competencies Developed

The 2021 SH project, "*Solidarity in Pandemic Times. A look at the next one*", we can see sustainable competencies developed in the freshmen from practices that observed the health protocols enforced due to the pandemic.

The first part of the SH, the "Solidarity gymkhana" with the three phases, stimulated the development of the following sustainable competencies:

1. System thinking competency – This year, the students were led to think about the problem of Covid-19 pandemic and its interfaces with the society in which they live, encouraging them to see the whole problem and seek practical solutions and actions for those who are hungry (SDG 2) and sick (SDG 3). The students immersed in the problem and encouraged to take concrete actions for solutions and support. The actions that are linked to HEI's mission "[…] they can practice their role in society with ethics and citizenship."
2. Value thinking competency – The freshmen through short videos that would encourage good attitudes in the pandemic context, such as distancing, use of masks, among other practices. This opportunity made them specify, apply, and negotiate sustainability values in the pandemic scenario.
3. Strategic thinking competency – Throughout all the tasks conceived in the context of the solidarity gymkhana, the students were led to develop sustainability transition strategies.
4. Interpersonal competency – This competence is stimulated soon in the formation of the teams, and then in the interaction withsociety, especially in the solidarity food collection (third phase).

The second part of the SH, "The closing night," we can see the promotion of some sustainable competencies as system thinking, value thinking, and interpersonal thinking. However, the future thinking competency was the most evident because each guest in the online meeting brought their reality with concrete actions crafting the future sustainability, especially the Social Solidarity Fund which is responsible to carry out professional training and income generation courses.

From the institutional YouTube video, we can see in the freshmen testimonies the awakening of sustainable competencies after being immersed in this SH project. The system thinking presents itself when they highlight the cause as important and their role in helping the vulnerable and the cancer patient. Interpersonal competency could be evidenced when students related the importance of teams, the mutual people support and the value-thinking competency between the lines.

5 Conclusions, Recommendations, and Further Research

This chapter describes the SH and its role of welcoming the freshmen with security but also of developing important competencies in young professionals, especially sustainable competencies. We described how SH is contextualized nowadays in the UN SDGs, aiming to awaken and promote sustainable competencies among university students. The purpose of the project is not to put an end to it but to show a way forward.

Our main conclusion is that the SH project is an important starting point to promote sustainability in freshmen from sustainable competencies that will be consolidated over the years in students and will have repercussions for them as professionals and citizens. The HEI studied many other practices related to other projects that involve the consolidated sustainable competencies awakened at the beginning of the course with the SH, as can be seen in Cavalcanti-Bandos and Paucar-Cáceres (2021), Cavalcanti-Bandos et al. (2021), and Paucar-Caceres et al. (2021).

Answering the research questions:

RQ1: It is possible to encourage and promote sustainable competencies in first-year higher education students. The SH project described the whole experience in the year 2021 promoting ethical values and attitudes mobilized in a real context related to sustainability.

RQ2: The HEI developed sustainable competencies in the students even in the context of the pandemic, using strategies based on secure protocols. It was possible to awaken in the students the system thinking, future thinking, value thinking, strategic thinking, and interpersonal competencies.

We recommend the HEI: increase the visibility of student practices in Brazil with the SH project and insert other ODS in the SH project. It is suggested as future research to verify in the state of Sao Paulo (Brazil) how other HEIs receive their freshmen and check if there are similar projects to seek parallel analyses; besides it is suggested to research similar projects at an international level.

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