Climate Change Management

Walter Leal Filho
Evangelos Manolas
Anabela Marisa Azul
Ulisses M. Azeiteiro
Henry McGhie *Editors*

Handbook of Climate Change Communication: Vol. 2

Practice of Climate Change Communication

Springer

Climate Change Management

Series editor

Walter Leal Filho, Hamburg, Germany

More information about this series at http://www.springer.com/series/8740

Walter Leal Filho · Evangelos Manolas
Anabela Marisa Azul · Ulisses M. Azeiteiro
Henry McGhie
Editors

Handbook of Climate Change Communication: Vol. 2

Practice of Climate Change Communication

Springer

Editors
Walter Leal Filho
HAW Hamburg
Hamburg
Germany

Evangelos Manolas
Department of Forestry and Management
Democritus University of Thrace
Orestiada
Greece

Anabela Marisa Azul
Center for Neuroscience and Cell Biology
University of Coimbra
Coimbra
Portugal

Ulisses M. Azeiteiro
Department of Biology & CESAM
University of Aveiro
Aveiro
Portugal

Henry McGhie
Manchester Museum
University of Manchester
Manchester
UK

ISSN 1610-2010 ISSN 1610-2002 (electronic)
Climate Change Management
ISBN 978-3-319-70065-6 ISBN 978-3-319-70066-3 (eBook)
https://doi.org/10.1007/978-3-319-70066-3

Library of Congress Control Number: 2017957177

Printed on acid-free paper

This Springer imprint is published by Springer Nature
The registered company is Springer International Publishing AG
The registered company address is: Gewerbestrasse 11, 6330 Cham, Switzerland

Preface

Climate change is a very complex issue. Communication about climate change is therefore anything but a simple task and one which needs to take into account a variety of factors. Apart from the need to provide due consideration to cultural values, traditions, and lifestyles, there is a perceived need to take into account the social and economic contexts which surround people and which influence their views and perceptions on climate change.

Therefore, in order to yield the expected benefits, initiatives on climate change communication need to have a sound practical basis.

This book, titled “Practice of Climate Change Communication”, addresses the need for peer-reviewed publications which examine and discuss practical initiatives, projects, and experiences surrounding communication related to climate issues. It documents and promotes innovative approaches from researchers and practitioners on climate change communication from around the world, and illustrates a variety of methods and strategies being used today, to communicate climate change across a variety of audiences.

We thank the authors for their willingness to share their experiences and initiatives, as well as the many reviewers who have checked and provided valuable insights to their contributions, making sure that they are of the highest quality. Enjoy your reading!

Hamburg, Germany	Walter Leal Filho
Orestiada, Greece	Evangelos Manolas
Coimbra, Portugal	Anabela Marisa Azul
Aveiro, Portugal	Ulisses M. Azeiteiro
Manchester, UK	Henry McGhie
Winter 2017/Spring 2018	

Contents

Contributors

Naif Alghamdi Department of Architecture and Building Sciences, College of Architecture and Planning, King Saud University, Riyadh, Saudi Arabia

Fátima Alves Departamento de Ciências Sociais E Gestão, Universidade Aberta E CEF Universidade de Coimbra, Lisbon, Portugal

Anup K. C. Department of Environmental Science, Tribhuvan University, Amrit Campus, Kathmandu, Nepal

Ulisses M. Azeiteiro Department of Biology and CESAM—Centre for Environmental and Marine Studies, University of Aveiro, Aveiro, Portugal

Rosalind H. Bark School of Earth and Environment, Maths/Earth and Environment Building, University of Leeds, Leeds, UK

Emilia Bassar Center for Public Relations Outreach and Communication (CPROCOM), Bogor, Indonesia

Julie Biddlecombe-Brown Department of Geography, Durham University, Durham, UK

Heitor de Oliveira Braga Centre for Functional Ecology—CFE, Department of Life Sciences, University of Coimbra, Coimbra, Portugal; CAPES Foundation, Ministry of Education of Brazil, Brasília, Brazil

Rebecca Carruthers Den Hoed Department of Communication, Media, and Film, University of Calgary, Calgary, Canada

Eric Chu Planning and Human Geography, School of Geography, Earth and Environmental Sciences, University of Birmingham, Birmingham, UK

Viktoria Cologna School of Earth and Environment, Maths/Earth and Environment Building, University of Leeds, Leeds, UK

Syarifah Aini Dalimunthe Research Center for Population, Indonesian Institute of Sciences (LIPI), Jakarta Selatan, Indonesia

Rasu Eeswaran Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka

Peter Elias Department of Geography, University of Lagos, Lagos, Nigeria

Judith Emanuel Steady State Manchester, Manchester, UK

Dirk Hoffmann Bolivian Mountain Institute—BMI, La Paz, Bolivia; Klimablog, Berlin, Germany

Joyeeta Gupta Amsterdam Institute for Social Science Research, University of Amsterdam, Amsterdam, The Netherlands

Adam Holden Department of Geography, Durham University, Durham, UK

Fraser How How Creative, Independent Consultant, Manchester, England, UK

Impron Department of Geophysics and Meteorology, Bogor Agricultural University (IPB), Bogor, Indonesia

Mbilam Samson Jumbam Faculty of Educational Sciences, University of Oslo-Norway, Oslo, Norway

Carolyn Kagan Steady State Manchester, Manchester, UK

Claire Lambert Department Geography, Planning and International Development Studies, University of Amsterdam, Amsterdam, The Netherlands

Sideri Lefkeli Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, Orestiada, Greece

Dula Lima Universidade Da Amazónia UNAMA, Brasil & Centro de Ecologia Functional Da Universidade de Coimbra, Lisbon, Portugal

Gina Lovett Department Geography, Planning and International Development Studies, University of Amsterdam, Amsterdam, The Netherlands

Jemima M. Mandapati Strategic Marketing and Communication, International Crops Research Institute for the Semi-Arid Tropics (ICRISAT), Patancheru, Telangana, India

Evangelos Manolas Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, Orestiada, Greece

Camilla Nichol UK Antarctic Heritage Trust, Cambridge, UK

Leonor Bacelar Nicolau Instituto de Medicina Preventiva E Saúde Pública & ISAMB, Faculdade de Medicina, Universidade de Lisboa, Lisbon, Portugal

Paula Bacelar Nicolau Departamento de Ciências E Tecnologia, Universidade Aberta E CEF Universidade de Coimbra, Lisbon, Portugal

Njodzeka Gilbert Njodzeka Green Care Association, Kumbo, Northwest Region, Cameroon

Thomas Nocke Potsdam Institute for Climate Impact Research, Potsdam, Germany

Ndze Albert Nsoseka Kailan Foundation, Kumbo, Cameroon

Ngoran Divine Nyarka Century College, St. Paul, MN, USA

Jouni Paavola School of Earth and Environment, Maths/Earth and Environment Building, University of Leeds, Leeds, UK

Miguel Ângelo Pardal Centre for Functional Ecology—CFE, Department of Life Sciences, University of Coimbra, Coimbra, Portugal

Joost Platje WSB University in Wrocław, Wroclaw, Poland

Sri Hartini Rachmad Researcher at BPS Statistics Indonesia and Lecturer at Statistics Institute, Directorate Analysis and Statistics Development, Jakarta, Indonesia

Garrett Ward Richards School of Environment and Sustainability, University of Saskatchewan, Saskatoon, Canada

Stephen Roderick Rural Business School, Duchy College, Callington, Cornwall, UK

Birgit Schneider Professorship for Media Ecology, University of Potsdam, European Media Studies, Potsdam, Germany

Melissa Swartz Department of Geography, Durham University, Durham, UK

Vincent Itai Tanyanyiwa Department of Geography & Environmental Studies. Faculty of Science & Technology, Zimbabwe Open University, Mt Pleasant Harare, Zimbabwe

Joanne Tippett Planning and Environmental Management, School of Environment, Education and Development, The University of Manchester, Manchester, UK

Sabine Tröger Geography Department, University of Bonn, Bonn, Germany

Georgios Tsantopoulos Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, Orestiada, Greece

Suiven John Paul Tume Green Care Association, Kumbo, Northwest Region, Cameroon

Markus Will University of Applied Sciences Zittau/Görlitz, Zittau, Germany

Becky Willson Rural Business School, Duchy College, Callington, Cornwall, UK; The Farm Carbon Cutting Toolkit, Coleshill, Highworth, Swindon, UK

Paramitha Yanindraputri Indonesian Association of Urban and Regional Planners, Jakarta, Indonesia

Lawong Judith Yenla Local Government Training Centre, Buea, Southwest Region, Cameroon

List of Abbreviations and Acronyms

CBD	Convention on Biodiversity
CCE	Climate Change Education
CEPA	Communications, Education and Public Awareness
COP21	The 21st Conference of the Parties
DEFRA	Department for Environment, Food and Rural Affairs
DECC	Department for Energy and Climate Change
ESD	Education for Sustainable Development
EE	Environmental Education
ErE	Education related to Environment
EZ	Ministerie van Economische Zaken (Ministry for Economic Affairs)
IENM	Ministerie van Infrastructuur en Milieu (Ministry for Infrastructure and Environment)
INDC	Intended Nationally Determined Contribution
OECD	The Organisation for Economic Cooperation and Development
OSCE	Organisation for Security and Cooperation in Europe
SDGs	Sustainable Development Goals
UNCCD	United Nations Convention to Combat Desertification
UNECE	United Nations Economic Commission for Europe
UNEP	United Nations Education Programme
UNDESD	United Nations Decade of Education for Sustainable Development
UNIDO	United Nations Industrial Development Organisation

Weather Forecasting Using Local Traditional Knowledge (LTK) in the Midst of Climate Change in Domboshawa, Zimbabwe

Vincent Itai Tanyanyiwa

1 Background

Zimbabwe's economy is agriculture-based, and agriculture provides employment for 70% of the population (Chenje et al. 1998). Because agriculture is heavily dependent on weather, and on rainfall and temperature particular, in areas where rainfall is erratic and inadequate, agricultural productivity becomes highly correlated with weather. Zimbabwe is becoming more vulnerable to climatic changes and local climatologists predict various sectoral impacts that will affect the environment, agriculture and food security, health, water resources, economic activities, human migration and physical infrastructure. Not all farmers, particularly those in remote areas, have access to radios and other media that communicate weather forecasts, nor do they have the capacity to interpret such forecasts. At this juncture, Agritex officers should fill the gap, but the situation on the ground defies this logic. Agritex officers are crippled by the department's lack of resources, a consequence of the economic challenges that Zimbabwe has experienced in the past decade (1999 to present). The importance of indigenous, traditional, and local knowledge in agricultural sustainability has been much discussed, yet on the ground it is only applied sparingly. "Indigenous knowledge" goes by many names: traditional knowledge, ancestral knowledge, local knowledge, and traditional ecological knowledge (Dewalt 1994). Although each term carries its own connotations, there is substantial overlap. The International Council for Science defines traditional knowledge as "a cumulative body of knowledge, practices and representations maintained and developed by peoples with long histories of interaction with their natural environment" (ICSU 2002). Huntington asserts that traditional ecological knowledge is "knowledge or insights gained through extensive observation of a particular ecosystem" (2000,

V. I. Tanyanyiwa (✉)
Department of Geography & Environmental Studies. Faculty of Science & Technology, Zimbabwe Open University, P.O. Box MP 1119, Mt Pleasant Harare, Zimbabwe
e-mail: tanyanyiwavi@yahoo.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_1

1270). Viswanathan refers to it as “a common body of knowledge about trees, fodder, forest products, seeds, medicine, [and] building” (2005, 89). Local communities are keepers of valuable knowledge that can help in their development and should therefore be empowered to blend traditional knowledge systems with modern technology as a step toward launching green revolution.

2 LTK in Climate Variability and Change in Agriculture as Postcolonial Theory

The post-colonial state as a successor to the colonial state was basically a political construction. The institutional framework that has informed the post-colonial state has its foundation in a colonial state whose interests cannot be said to be the same as those of the post-colonial state (Mapara 2009). For example, many African leaders easily retreat into the argument that Africa’s lack of development is a consequence of colonialism (Ashcroft et al. 1995). However, evidence on the ground shows that the post-colonial African state has failed to objectively determine the type of institutional framework that is needed to inform the state’s actions, the role of non-state actors, and choices regarding the correct circumstances for state intervention. Post-colonial theory posits that from its beginning, colonialism on the African continent despised everything that was traditional or indigenous (ibid). African traditional religion was abandoned and this interfered with African social, economic and political systems, under the mistaken belief that everything traditional was primitive. An attempt was made by colonialists to dislodge indigenous institutions and pave the way for the establishment and perpetuation of western supremacy. This prejudicial stance was influenced by the ‘centre-periphery’ hypothesis, whose purpose was to deliberately dislocate traditional African culture (the periphery) and replace it with western culture and civilization (the centre). However, some vital traditions still exist; little did the colonialists realise that African beliefs and practices were grounded in hard empirical evidence based on past African experiences, including, for example, the ability to monitor weather and climate.

Local Traditional Knowledge (LTK) is more than just a display of the knowledge and belief systems of the previously colonized; it is one of the responses to the myth of Western hegemony and superiority (Tatira 2000; Mararike 1999). Some of this knowledge was labelled as unconventional and as not based on empirical evidence. However, LTK is one of the ways in which the formerly colonised are reclaiming the self-esteem and humanity that they had been deprived of by colonialism. It is also an effort to show the world that they are not always on the periphery but rather are equal to their former colonisers in some respects (UNEP 2000). By using examples of the achievements of the formerly colonised, the once-colonised are asserting their visibility in history, education, architecture, philosophy, language and science. In a way, this is to show that that the formerly colonised have either been misunderstood or were deliberately ignored. LTK as postcolonial theory also challenges the colonial label of the 'other,' as LTK has its own past glories and achievements, including LTK repositories. LTK systems are forms of knowledge that are characterised by integrated systems of cognition, belief and practice that are embedded in proverbs, myths and some religious rituals. Those who understand the languages that carry these practices can best appreciate them.

Indigenous knowledge is the basis for local-level decision-making in many rural communities (Mararike 1999). It has value not only for the culture in which it evolves but also for scientists and planners striving to improve conditions in rural localities. Incorporating indigenous knowledge into climate-change policies can lead to the development of effective adaptation strategies that are cost-effective, participatory and sustainable. In this chapter, we will use "indigenous knowledge" or "local traditional knowledge" to refer to the understanding of the local environment developed by Zimbabwean communities over the last several millennia; this includes practices, techniques, technologies and spiritual knowledge that encompasses every aspect of human existence (Mapara 2009). It is worth noting that communities in Zimbabwe know that climate is closely linked to the sustainability of their livelihoods. Patterns of weather, how and when local natural disasters occur, when they are likely to recur, and how to plan to cope with their impacts on the natural environment, as well as on livelihoods and lives, have all been noted down. In Africa, many communities have developed techniques and strategies for forecasting and managing climate variability, including coping mechanisms to respond to both the normal and harsh conditions of their local environments. This forecasting depends on observation of the natural environment, including flora, fauna and stars.

3 Bridging the Gap Between Traditional Knowledge and Climate Science

Western science is a systematic and methodological approach to answering questions; science is equated with knowledge that promotes the solution of problems. Western science is based on the principles of repeatability and predictability. It is unfortunate that Western science tends to label LTK as anecdotal, non-quantitative, without method, and unscientific, though LTK offers basic knowledge that is available to all. As opposed to LTK, Western climate science uses knowledge of atmospheric physics to predict the most probable future weather/climate scenarios. Although the two knowledge bases (LTK and Western climate science) are very different, both try to solve the same problems. Thus, the fusion of the two, or using the knowledge base that is readily understood by local people, will help the community adapt to climate change. Table 1 shows the main differences between LTK and western science.

Table 1 Comparison of scientific knowledge and local knowledge

Factor	Science	Indigenous knowledge
How approached	Compartmental	Holistic
How communicated	Written, easy to translate and communicate. Somewhat standardized terms	Oral, in local language, and needs to be interpreted
How taught	Lectures, theories, and observations useful for scientific interpretation and modelling	Observation, experience Observations are of importance to daily life
How explained	Theory, "value free"	Spiritual, social values
Repeatability	Repeatable measurements Can use same monitoring equipment in different places	Possibly poor repeatability Cannot expect similar perceptions and experiences for same observation
Precision	More precise, errors more objective and amendable Results from repeated measurements	Perceptive, individual, errors difficult to evaluate Every individual has different perceptions, possible bias
Spatial coverage	Time and space sparse, interrupted time-series Depends on monitoring network	Dense in space and time, long term observations Every individual is an observer
Tool	Designed instruments, limited, focused, recorded	Many undefined instruments, unfocussed observation, mostly unrecorded Different sensors, word of mouth, passing of information through generations
Scale	Large scale, general, conceptual	Smaller scale, specific, practical

Source Adapted and modified from Dewalt (1994)

LTK is a key source of information and insight in agroforestry, traditional medicine, biodiversity conservation, customary resource management, impact assessment, and natural disaster preparedness and response (Makwara 2013). Indigenous observations and interpretations of meteorological phenomena are at a finer scale, have considerable temporal depth and highlight elements that may be marginal or even new to scientists. They focus on elements of significance for local livelihoods, security, and well being and are thus essential for adaptation. Strategies such as engaging in multiple livelihood activities and maintaining a diversity of flora and fauna varieties provide a low-risk buffer in uncertain weather environments. Traditional systems of power and social networks develop the capacity to collectively control variety and distribute resources, while dissipating shocks and reinforcing new capacities.

4 Why Indigenous Knowledge Is Important for Climate Change Adaptation

Previous studies have demonstrated that rural communities respond actively to the challenges posed by climatic variability and change, thus showing that these communities are not inactive. For example, in Tanzania, farmers faced with drought switch crops, expand cultivation and seek alternative employment (Berman et al. 2012). Local communities are dependent on *their* knowledge, *their* special relationship with the environment, and *their* ways of organizing themselves and *their* values. In the southern Arctic, Inuit people have made adjustments in hunting patterns as the climate has warmed (Berkes and Jolly 2001). Most existing studies of climate change and variability are anecdotal; few scholars have offered an overarching theoretical framework for understanding how traditional knowledge supports adaptation. LTK can be used to forecast the total rainfall for an agricultural season and inform the farmers' cropping activities. This is especially common in cases where conventional weather information is not easily accessed or understood by the recipients, as in Zimbabwe. Nyong et al. (2007), in their study of LTK in the Sahel, get closest, suggesting that traditional knowledge is important for five reasons:

- it adds cultural context;
- it is often "appropriate and sophisticated";
- it increases community buy-in;
- it promotes "equity, efficiency, and the environment";
- it increases "communication and understanding" (Dewalt 1994)

LTK is useful in two particular ways, as indigenous communities can help scientists understand both current and expected climate change impacts. Indigenous knowledge in the form of weather forecasting strategies, knowledge of crop varieties, agricultural practices, water storage methods, building techniques, and more can help communities preserve their quality of life even in the face of climate change. Western scientists can benefit from indigenous observations of weather and environmental change. LTK is equitable and environmentally friendly, as suggested by Nyong. Unfortunately, this creates a tendency to view all indigenous peoples as living in harmony with one another and with nature. This is, however, too simplistic because any given community is not innately more noble or even more sustainable than another given community. Suffice it to say that traditional communities know things about their environment that outsiders do not; such knowledge is, in fact, "appropriate and sophisticated" and can help in the development of more valuable adaptation programs.

Both scientific knowledge and LTK have limitations. Historical and contemporary evidence show that indigenous peoples have also committed environmental 'sins' through over-grazing, over-hunting, or over-cultivation of the land. Contrary to the popular viewpoint that whatever indigenous people do is naturally in harmony with the environment, LTK is not as always ‘good,’ ‘right’, or ‘sustainable.’ For example, because of globalisation and migration, in areas where local people are recent migrants from a quite different ecological zone, they may not have much understanding of their new environment. Economic and social forces may contribute to the erosion of LTK due to integration with society at large, which will result in the breakdown of social structures, beliefs, mores, norms, and the educational and religious systems that generate indigenous knowledge and practices. This results in the ‘homogenization’ of the world’s cultures and the subsequent alteration of indigenous beliefs, values, customs, know-how and practices, thus resulting in an incomplete knowledge base (Grenier 1998). Socio–ecological systems are undergoing severe environmental degradation, and LTK that was once well adapted and effective for securing a livelihood in a particular environment is becoming unsuitable (Thrupp 1998). When change is rapid or drastic, the knowledge associated with LTK may be rendered inappropriate and even destructive in the altered conditions (Grenier 1998). Sometimes, the knowledge that local people rely on is incorrect or even harmful (Thrupp 1998). Practices based on mistaken beliefs, flawed experimentation, or incorrect information can be risky and may even obstruct improvements to the well being of indigenous people (Thrupp 1998). Moreover, LTK is mainly contained in the mind of its beholders, and when they die, their knowledge dies as well. Without documentation of this knowledge, the surviving generations can only misquote and misinterpret it. LTK has been ignored in the past and, in some cases, has actually been lost. The skills of recognizing, gathering, and building up LTK into formats that are usable today are essential to ensure the sustainability of this knowledge. Our focus on marrying local knowledge with modern science to promote sustainable agriculture will be futile without documentation (Dewalt 1994). Over-reliance on western science, which is not sufficiently location-specific, seems to be one of the most important challenges threatening the sustainability and viability of indigenous knowledge. In a given area and in different villages, the knowledge bases of LTK may be different. Thus, there is a need to harmonise LTK in districts and the country at large.

5 Research Aim and Scope

Climate variability and change is increasingly becoming a serious challenge to ecology, health, human well being, livelihoods, and future sustainable development for people in emerging economies, especially in Africa. Climate deviations that are too far from the norm can be extremely disruptive to communities. Traditional weather forecasting has been used since time immemorial to identify matters affecting the vulnerability of ecosystems and communities. Credible environmental information has the potential to empower people at all levels to influence decision-making (Chenje et al. 1998; Makwara 2013). This information can thus be helpful to government departments, Non-Governmental Organisations (NGOs) and ordinary people, helping them to better appreciate the environments in which they live and possibly adjust their plans to improve their livelihoods. Use of indigenous knowledge of weather forecasting is a strategic mechanism to support sustainable development because it may inform people about past and current weather conditions (Makwara 2013). Experiences of scientific weather forecasting by the Meteorological Services Department (MSD) in Zimbabwe have demonstrated that relying on western scientific methods does not always yield accurate weather estimates (MSD 2012). IKS can therefore be harnessed to complement scientific methods of weather forecasting. The impacts of climate variability and change are multifaceted and may be accompanied by multiple additional stressors such as poverty and land degradation. Hence, there is a need for multifaceted responses such as the use of indigenous knowledge. This section describes how farmers in Domboshawa in particular predict rainfall using local environmental indicators and astronomical factors. Even without the modern system of dividing time into months, seasons and years, humans have been able to appreciate diurnal and seasonal changes in the environment. This knowledge can be used in determining the timing of important farming activities and in predicting disasters. Being able to predict weather is an important ability of humanity. This research aimed to:

(1) Identify, document and analyse LTK indicators used in drought forecasting in Domboshawa;
(2) Assess the possibility of providing a localised drought early warning system based on a traditional calendar of drought indicators and;
(3) Assess the possibility of integrating LTK indicators with meteorological forecasting indicators to improve seasonal forecasts at the local level.

5.1 Materials and Methods

Simple random sampling was used to select respondents from five wards in Domboshawa, producing a sample size of fifty (10 from each ward). Purposive sampling was used to select interviewees, including the Chief, Headmen of Agritex, and EMA Officials. Purposive sampling was also used to select 20 farmers who responded to questionnaires. This sampling technique was chosen because it helped to select only those informants judged to be knowledgeable about the data sought (Kumar 2010). Ten focus group discussions (FGDs) were conducted in the five wards of Domboshawa. Two FGDs were conducted per ward and these comprised mainly farmers because the majority of the households are farmers. Various data collection methods (key informant interviews which were based on situational and behavioural responses, structured open ended questionnaires and field observations) were employed for triangulation purposes, which served as a tool for cross-checking the authenticity and validity of the various data sets generated through FGDs. Emic knowledge and interpretations exist within a culture and are influenced by local customs, meanings and beliefs though etic (scientist-oriented) approaches where used as well (Albuquerque et al. 2014). The two complement each other. The research was conducted within a period of 6 months i.e. from October, 2013 to March, 2014 mainly because this is the main rainfall period in Zimbabwe. Data were analysed using MS Excel and SPSS and coded and categorised into themes and sub-themes. Afterwards, data were analysed through thematic content analysis. Descriptive statistics, frequencies and percentages were also used in data analysis.

6 Context of Research

The research was carried out in Domboshawa (its geographical coordinates are 17° 36′ 18″ South, 31° 8′ 24″ East), which comprises approximately 40,000 households with an average household size of 5 people and with more than 75% of these people relying on farming for their livelihoods (Mashonaland East Provincial Census Report 2012). There are 5 wards in Domboshawa. The population has increased due to natural increase and net migration. Domboshawa has a land area of 35.312 hectares and is situated in natural farming regions 2 and 3 on the Highveld of Zimbabwe at 1200 m.a.s.l. The average rainfall ranges from 800 to 1000 mm per annum (Unganai 1996). During drought years, however, the rainfall tends to decrease, e.g., during the 1991/92 drought the rainfall was 405 mm. Rainfall is seasonal, with approximately 90% falling from October to March (Vincent and Thomas 1960). Temperatures in Domboshawa are generally warm in the summer months, ranging from 22 to 30 °C (MSD 2012). However, winters can be quite cold, with temperatures dropping down to freezing levels. Because the majority of people make their livelihoods from horticultural crops, they need adequate protection in winter, especially in dry areas, so that their crops are not damaged by frost. The soils of Domboshawa are generally coarse-grained sands/sandy loams, which are naturally deprived of principal plant nutrients (the paraferralitic group of soils). Paraferralitic soils absorb and lose water easily (Surveyor General 2014). The topography of the area is quite varied, with some undulating areas, but generally the area is rugged and rocky (hence its neglect by early colonial settlers) (GRDC 1996). The Ngomakurira Hills (Mountain of Drums) and the Domboshawa Hill (The Red Rock) are some of the area's spectacular topographic features that attract tourists. Vegetation is mainly Miombo woodland dominated by muzhanje (Uapaca kirkiana), muhacha (Parinali curatefolia), munhondo (Julbennadia globifora), musasa (Brachystegia spiciformis), mupfuti (Brachystegia boehmii), mususu (Terminalia sericia) and muunze (Brachystegia globifora). The Miombo vegetation is declining due to uncontrolled cutting of trees by urban, peri-urban and communal residents. The few remaining woodlands form part of the grazing lands and are restricted to rugged terrain, which cannot be used for crop production. Varying climate and vegetation characteristics depicted in each Ward were captured. Households in each ward were randomly selected. The questionnaire was pilot tested before it was used for the larger sample. Households' varied perspectives on LTK and on drought forecasting dry spells and droughts were obtained with the use of this structured questionnaire. Aspects such as demographic features of the population and drought history; response to droughts; drought adaptation strategies; local traditional indicators as well as respondents' perceptions and knowledge of meteorological drought forecasting methods were also included (Fig. 1).

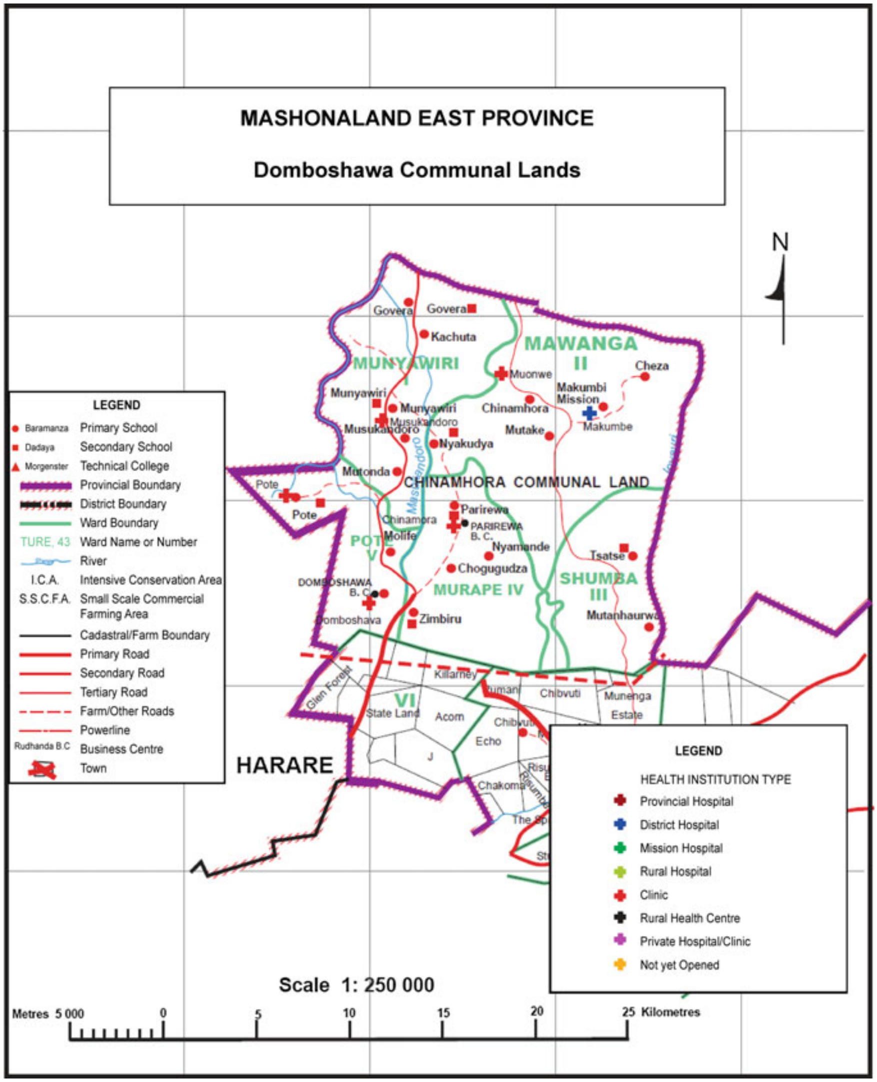


Fig. 1 Domboshawa communal lands. *Source* Surveyor General: June 2014

7 Discussion

7.1 Climate Change and Indigenous Communities in Domboshawa

The Domboshawa study shows that weather patterns are influenced by the wind, the stars, and animal and plant behaviour, as well as by the availability of wild fruit, cloud formation, birds, insects and wind direction prior to the rainy season. In spite of complicated 21st century methods of determining weather patterns, this article examines the importance of indigenous knowledge in determining and understanding weather patterns and the effect of weather patterns on farmers. Samples of some LTK forecasting techniques used in Domboshawa are given below (Tables 2 and 3).

7.2 Convergence Between Indigenous and Scientific Approaches

In Domboshawa there was convergence between both western science and LTK regarding what was evident on the ground. All respondents noted that water was becoming increasingly scarce and that there was an increase in the outbreak of diseases during floods. As a result of these environmental changes, there has been an increase in migration, although there is positive net migration due to the proximity of Domboshawa to Harare.

7.3 Typologies of Shona Indigenous Weather Forecasting

One of the indigenous rainfall prediction indicators that the farmers in Domboshawa use is the density of spider webs in their area. Many spider webs

Table 2 Domboshawa farmers' indigenous views on climate variability and change

• They no longer grow the crops they used to grow in the past
• Seasonal fruits no longer grow due to the effect of climate change, crop failures
• Relocation due to rainfall
• Dry and hot summers instead of wet and cold summers
• Temperature fluctuation
• Rainfall changes
• Reduced water levels

Source Field Data (May 2014)

Table 3 Scientific views of climate change

• Changes in temperatures (temperatures are increasing)
• Variability of rainfall
• Reduced water levels
• Ecosystem distressed and some species vanishing
• Change in farming practices
• Yield is dropping drastically
• Seasonal variations

Source Field Data (May 2014)

signify a very wet season, and the circular halo around the moon (known as *dziva* in the local Shona) is used to predict the wetness of that particular period of the season. Additional indicators include animal and plant behaviour, as well as wild fruit availability and wind direction prior to the rainy season. Though these indicators are local, they definitely show some level of dynamism and mixing of western science and LTK.

7.3.1 Derivation of Weather Forecasts from Bird Indicators

This refers to a bird whose behaviour is studied to derive a weather forecast. For bird indicators, please refer to Table 4.

Table 4 LTK interpretations of bird indicators

Behavioural sign	Forecast
Ducks	
1. Flapping wings frequently	Rains expected soon
2. Moving about restlessly	Dry spell expected
Swallows	
1. Flying haphazardly in large numbers	Imminent rains
2. Few and flying at great height	Dry spell expected
Black crow	
Crowing very early in the morning	A very hot afternoon expected
Migratory stock	
Presence in large numbers	Sign of good, warm rain season
Tinker bird	
Singing	Hot days expected

Source Field Data (May 2014)

7.3.2 Derivation of Weather Forecasts from Creatures or Animals

This refers to either a creature or animal whose behaviour is observed with the intention of generating a weather forecast. One of the indigenous rainfall prediction indicators that the farmers in Domboshawa use is the density of spider webs in their locality, with the presence of many spider webs being an indication of a very wet season. Hasty spiders struggling to get indoors or into hiding places are an indication of the beginning of Munhuruka rains. (Common rain names in Zimbabwe include *gukurahundi,* which washes away chaff; *mvumiramutondo,* which facilitates the blooming of trees; and *munhuruka,* which signals the beginning of the rainy and cropping season). All the respondents said they are quite aware of these rains and their significance. Usually land is prepared after munhuruka rains as argued by 65% of the respondents. For other animal indicators, please refer to Table 5.

7.3.3 Derivation of Weather Forecasts from Vegetation

This refers to a condition or to the prevailing characteristics of specific vegetation, which are used to derive a weather forecast. Wild fruits and abundance of fruits

Table 5 LTK interpretations from creatures or animals

Behavioural sign	Forecast
Frogs	
1. Croaking profusely	Signifies rains
2. Producing sharp shrills	Drizzle expected
3. Bull frog croaking with high tone	Rains the next day
Termites	
Stockpiling grass	Guti/rainy weather
Ants	
Appearing in large numbers	Sign of heavy rains
Cattle	
1. Sniffing the air with heads raised up	Expect immediate rains
2. Bellowing on dry riverbeds	Rains expected soon
Fish	
Jumping into the air frequently	Rains are about to come
Goats	
Bearing lots of kids	Sign of hot and wet season
Grasshoppers	
Appearing in larger numbers	Rains expected soon
Armyworm	
Large numbers	A dry spell expected

Source Field Data (May 2014)

Table 6 Derivation of weather forecasts from vegetation

Behavioral sign	Forecast
Wild loquart (*Uapaca kirkiana*)	
1. Abundant fruits	Good rainfall expected
2. Abundant fruits	Chances of drought
Fig tree (*Fiscus carica*)	
1. Plenty of fruits	A good rain season
2. Shooting	Rains are near
3. Shading leaves	Rains close by
Aloe Tree	
1. Blooming	Rains expected in 48 h
2. Producing green or red flowers	Signifies a drought
Julbernardia globiflora (*Munhondo*)	
1. Lots of spring foliage	Good rainfall season expected
2. Blooming in August	Early rains
3. Late blooming	Drought expected
Parinari curatellifolia (*Hacha*)	
1. Abundant fruits	A good rain season
2. Abundant fruits	Drought expected

Source Field Data (May 2014)

such as parinari curatellifolia (hacha), uapaca kirkiana (mazhanje) and nhunguru indicates a good rainfall season. Sixty two percent of the respondents argue that they used vegetation to derive weather forecasts. For other vegetation indicators, refer to Table 6.

7.3.4 Terrestrial Objects

One of the celestial bodies that the Shona of Domboshawa have used to predict rainfall conditions is the sun. There are many associations with the sun in terms of rainfall and temperature patterns (Shoko 2012). When the rainy season is about to begin, the sun does not heat people's heads directly; in such cases people notice that the sun is coated by *gore* (fog or mist). Shona people believe that when the *gore* is small then rainfall will be minimal as 64% of the respondents said When the *gore* is large there will be more rainfall. During the rainy season, when the day is hot, people expect rains either that very day or within two days. This inference is made in light of the day's excess of heat. Conversely, when it is cold and rainy people regard it as a sign of a lack of rain. The Shona people also use the moon to forecast weather patterns. The moon is used to predict the imminence and intensity of the rainy season. There is more rainfall when the moon does not appear for a long time

Table 7 LTK interpretations of terrestrial objects

Sun	
1. Presence of halo around the sun	Heavy rains are expected
2. Very hot in October and September	Rains are expected soon
3. The occurrence of an eclipse enhances chances of a good rainfall season	Enhanced chances of good rainfall
Moon	
1. A moon with tilted orientation	Drought expected
2. A moon with normal orientation	Rains expected soon
3. Full moon (Jenaguru)	Rains unlikely
4. Halo around the moon	Abundant rains expected
5. Appearance of 1st quarter and last quarter	Good chances of rain exist
6. No moon (Mhindo)	Chances of rain are enhanced
Stars	
1. Few stars appearing	Rains about to come
2. Star for good rainfall (Maguta) bigger than star for drought (manzara)	A good rainfall season expected and vice versa
3. Drought star (Manzara) appearing with star for good rainfall (Maguta) missing	Drought is expected and vice versa
4. Big Drought Star (Manzara) on the eastern side	Drought expected
5. Big Star for good rainfall (Maguta) on the western side	A good rainfall season expected
6. Plenty of falling stars	Drought expected

Source Field Data (May 2014)

during the night. When the moon appears with a ring around it, it is a sign that the rainy period is impending. The Shona people believe that the size of the ring coating the moon determines the amount of rain to be enjoyed that season. The bigger the ring, the more rainfall that season, and likewise the reverse is true. They also look at the circular halo around the moon; known as *dziva*, to predict the wetness of that particular period of the season. All in all 72% of the respondents said that they use terrestrial objects to predict the weather (please refer to Table 7).

7.3.5 Wind

Although these indicators can be said to be indigenous, they certainly show some level of dynamism and integration with western science, which has also tapped into these indicators and uses wind direction to predict rainfall patterns. More than 50% of the respondents indicated that they used the wind to interpret the weather. Please Refer to Table 8 for other indicators.

Table 8 LTK interpretations of wind indicators

Behavioral sign	Forecast
Wind	
1. Northerly becoming southeasterly	Rains are expected soon
2. The presence of prevailing southeasterly to easterly winds	Drizzly weather expected soon
3. The dominance of a westerly wind season	Enhanced chances of a good rainfall
4. Northerly to northwesterly winds	Rainfall expected in about three days
5. Very strong winds during a threatening rainfall event	Disturbs good rains
6. The presence of a prevailing easterly wind for a long time	Drought expected
7. Dry southerly winds in summer	A dry spell expected
8. Northerly winds in summer	Rainfall expected within a few days
9. The prevalence of whirlwinds in August	Signifies early rains

Source Field Data (May 2014)

7.3.6 Weather Conditions

Domboshawa residents are able to read the weather conditions of their day-to-day living and about 69% of the respondents gave behavioral indicators used to interpret weather as exemplified by Table 9.

7.4 Assessment of Climate Variability and Weather Signals in Domboshawa

Residents of the area also look at the circular halo around the moon, known as *dzivaremvura (halo)*, to predict the possibility of rainfall in the coming season and the wetness of that particular period of the season. This is not only peculiar to Domboshawa but this scenario is evident in other parts of Zimbabwe such as Mberengwa (Shoko and Shoko 2011). Other indicators include animal and plant behaviour, as well as wild fruit availability and wind direction prior to the rainy season as alluded to by 82% of the respondents. However, these indicators appear to be dynamic and related to those of western science, which has also tapped into these indicators and uses wind direction to predict rainfall patterns. Overreliance on western science, however, seems to be one of the biggest challenges threatening the sustainability of indigenous knowledge as knowledge dissemination is through the radio a.

Table 9 LTK interpretations for weather conditions

Behavioural sign	Forecast
Weather Condition(s)	
1. Hazy weather from September to early November	A good rainfall season expected
2. Haze in August	Heralds the early onset of the hot season
3. Appearance of mist on Domboshawa	Rains expected in one to two days' time
4. The occurrence of mist during the morning halo around the moon	A hot afternoon is expected
5. Presence of morning dew	No rains expected for the next 24 h
6. Absence of morning dew	Convective rainfall is favourable
7. Very hot weather from September to October	Good rainfall season expected
8. Lightning in the far north in October	Heralds the onset of the rainfall season
9. Rainbow appearing just before a rainfall event	Failure of the rainfall event predicted
10. Very hot and humid conditions in summer	Signify good chances of thunderstorms
11. Lightning from the west in summer	No immediate rains expected
12. Appearance of cirrus clouds	Perfect conditions for precipitation
13. Extended cold winter	Signifies drought to come
14. Warmer than normal winter	Drought expected the coming season

Source Field Data (May 2014)

7.5 Challenges Related to LTK and Climate Change in Domboshawa

As discussed earlier, the main problem with LTK is that it is not recorded or documented and therefore the data tend to be fragmented. Upon the deaths of people who possess valuable knowledge, the older generation i.e. those above 65 years the knowledge dies as well. The local community does not have the capacity for documenting LTK so that it can be passed from one generation to another and therefore does not become extinct. Data availability and exchange does not normally occur in the locality due to the lack of capacity and will to document such information. People cope and adapt to climate variability and change in a number of ways. There is also the need to document those coping mechanisms that are not necessarily related to agriculture, but for this to be accomplished, information should be available and those who have it should be willing to share. Due to an increasing dearth of social capital in Domboshawa, forums that were established years ago have been destroyed. However, with the increasing role of social media, social capital could be harnessed to disseminate information on LTK. The government is not allocating enough funds to disaster management and planning. Funds may arrive only after the disaster has already come, and LTK may not have assisted farmers sufficiently. Hence, there is a need to integrate LTK and meteorological information.

7.6 LTK's Interface with Science

LTK enables farmers to participate as agents as well as consumers in programs that use modern climate science to plan for and adapt to climate variability and climate change. Who should provide weather information? Whose reality counts? That of the few at the centre of power (elite) and that of the many at the periphery (smallholder farmers)—both are important as explained by 69% of the farmers in Domboshawa. For full participation of the latter, words such as participation itself, ownership and component are quite critical. Hence, we should challenge ourselves personally and professionally as well as institutionally so that reality counts, i.e., weather information should be produced by or with farmers, as local communities are experts on their own reality (Chambers 1996). As of now that local knowledge is not documented at all.

LTK is related to climate science on two time scales: it facilitates communication between indigenous and modern scientific knowledge in the domain of climate variability (Risiro et al. 2012). This arrangement predisposes farmers to be open to scientific forecasts distributed by the MSD and by the media because they already accept a variety of components of knowledge and evaluate these components as the season progresses. Hence, there is a need for the marriage of LTK and scientific forecasts. Meteorologists will therefore be in a position to design forecasts that are relevant and usable (Nyong et al. 2007). Forecasts could show historical patterns, weather observations and regional information, corresponding to sources of information that meteorologists use. LTK is highly social in nature, thus forecasts could be disseminated through innovative forms of forecast dissemination that centre on social interaction, e.g., Facebook and Whatsup, to enhance communication, this response was said by 85% of the farmers. Farmers should therefore be seen as active players in the production, transmission and use of information.

8 Conclusion

Over-reliance on western science, as well as the emerging group of young people who view anything traditional as backward, seem to be the biggest challenges threatening the sustainability of indigenous knowledge in Zimbabwe especially in Domboshawa. On average 71% of the respondents noted that they have used IKS in the past two years to interpret the weather. I therefore call for the marriage of local knowledge and modern science because applying them in isolation might eliminate the complementarities that could help farmers succeed. This is worsened by the absence of a documenting culture among Zimbabweans. For millennia, the locals have depended on folklore passed from older to younger generations; most of this was through word of mouth. Meanwhile, folklore is quickly fading away as grandparents and grandchildren are scattered all over the world looking for better opportunities. Exposure to new knowledge and cultures in other countries might be contributing to the treatment of local knowledge as primitive and out of touch with civilization. Few people, therefore, look at IKS as integral, and some have only considered using it in times of adversity. Local knowledge is not only important to farming; it is also critical to social, cultural, economic and political development. The lack of a documentation culture is striking when one considers how many publications have been written about Zimbabwe's political leadership by people from outside Zimbabwe. Local voices are usually expressed through the voices of foreign researchers, and our work thus usually goes undocumented and unrecorded.

9 Recommendations

There is a need to utilise indigenous knowledge in weather forecasting to supplement conventional weather forecasts from the Meteorological Services Department (MSD). In view of the responses from the respondents, the following recommendations are made:

- Most rural communities are still faithful to LTK for climate risk management, even when most agree that the patterns of the local climate seem to be changing. There is a need to localise climate change discourse so that that villagers can understand what is occurring. There is very little literature on climate change in Zimbabwe; as a result, studies are dominated by examples from Western countries, which are not relevant to the Zimbabwean situation.
- There is an urgent need to integrate indigenous climate risk reduction strategies with western climate information, to provide the local communities with new tools for coping with current climate extremes, and to enable communities to adapt to future climate changes. Synchronization of indigenous weather systems and the conventional meteorological forecasts—to produce a product that is a hybrid of the two forecasting systems is essential in Domboshawa.
- Though indigenous knowledge systems form a strong base of knowledge for Zimbabwean society, they are still shunned due to lack of institutional support. Emphasis should be on developing indigenous knowledge systems, documenting this unique knowledge, and integrating it into mainstream knowledge. In Zimbabwe, there is little documentation of this knowledge, yet it is a viable alternative knowledge base. Policy should be put in place through provision of human and financial resources to support IKS within communities. Zimbabwe does not have a specific policy on IKS.

- There is a high risk of extinction of indigenous knowledge if it is not documented. To avoid this loss, research should be done on the various methods of IKS and should document the effective methods for use by the future generations, especially regarding climate variability and change. Therefore, skills to identify, collect, and develop indigenous knowledge into contemporary usable formats are needed to ensure the sustainability of LTK in the Zimbabwean context.

References

Albuquerque UP, da Cunha LVCF, Lucena RFP, Alves RRN (Eds) (2014) Methods and techniques in Ethnobiology and ethnoecology. Humana Press, New York

Ashcroft B, Griffiths G, Tiffin H (1995) The Post-colonial Studies Reader. Routledge, London

Berkes F, Jolly D (2001) Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conserv Ecol 5(8). http://www.consecol.org/vol5/iss2/art8

Berman R, Quinn C, Paavola J (2012) The role of institutions in the transformation of coping capacity to sustainable adaptive capacity. Environ Dev (2):86–100

Chambers R (1996) Who's reality counts? Putting the first Last. Intermediate Technology, London

Chenje M, Sola I, Paleczny D (1998) The state of Zimbabwe's environment. Government Printer, Harare

Dewalt BR (1994) Using indigenous knowledge to improve agriculture and natural resource management. Hum Organ 53(2):123–131

Goromonzi Rural District Council (1996) Goromonzi Rural District Council Economic survey Report. Ruwa, Goromonzi

Grenier L (1998) Working with indigenous knowledge: a guide for researchers. IDRC, Canada

Huntington HP (2000) Using traditional ecological knowledge in science: methods and applications. Ecol Appl 10:1270–1274. doi:10.1890/1051-0761(2000)010[1270:UTEKIS]2.0.CO;2

International Council for Science (2002) ICSU Series on science for sustainable development no 4: science traditional knowledge and sustainable development, p 24

Kumar R (2010) Research methodology: a step-by-step guide for beginners. Sage Publications, Thousand Oaks, California

Makwara EC (2013) Indigenous knowledge systems and modern weather forecasting: exploring the linkages. J Agric Sustain 2(1): 98–141

Mapara J (2009) Indigenous knowledge systems in Zimbabwe: juxtaposing postcolonial theory. J Pan Afr Stud 3(1)

Mararike CG (1999) Survival strategies in rural Zimbabwe: the role of assets, indigenous knowledge, and organisations. Mond Books, Harare

Mashonaland East Provincial Census Report (2012) ZimStat, Zimbabwe National Statistical Agency, Harare, Zimbabwe

Meteorological Services Department (2012) 2012 Seasonal forecast. Meteorological Services Department, Harare, Zimbabwe

Nyong A, Adesina F, Osman E (2007) The value of indigenous knowledge in climate change mitigation and adaptation strategies in the African Sahel. Mitig Adapt Strateg Glob Chang 12:787–797

Risiro JD, Mashoko D, Tshuma T, Rurinda E (2012) Weather forecasting and indigenous knowledge systems in Chimanimani district of Manicaland, Zimbabwe. J Emerg Trends Educ Res Policy Stud 3(4):561–566

Shoko K (2012) Indigenous weather forecasting systems: a case study of the biotic weather forecasting indicators for wards 12 and 13 in Mberengwa district Zimbabwe. J Sustain Dev 14 (2): 92–114

Shoko K, Shoko N (2011) A comparative analysis of perception levels of accuracy for indigenous weather forecasts and meteorological forecasts: the case of wards 13 and 15, Mberengwa district, Zimbabwe. The Dyke 5(1):174–188

Vincent V, Thomas RG (1960) An agricultural survey of Southern Rhodesia: Part I: Agro-ecological survey. Government Printers, and Salisbury

Tatira L (2000) The role of Zviera in Socialisation. In E Chiwome, Z Mguni, Z, Furusa M (eds) Indigenous knowledge in Africa and Diaspora communities. University of Zimbabwe Publications, Harare, pp 146–151

Thrupp LA (1998) Legitimizing local knowledge: from displacement to empowerment for third world people. Agric Hum Values (Summer issue): 13–24

Viswanathan S (2005) Competing across technology-differentiated channels: the impact of network externalities and switching costs. Manag Sci 51(3):483–496

Unganai LS (1996) Historic and future climate in Zimbabwe. Climate research 6 137-145. Drought Monitoring Centre. Belvedere, Harare, Zimbabwe

UNEP (2000) Global environment outlook, 2000. Nairobi, Kenya

Climate Change Communication in Nepal

Anup K. C.

1 Climate Change in Nepal

Climate change is a global issue which had occurred from historical past, observed in present time and will be continued in the future due to the change in long term weather phenomena (GoN 2011; Anup and Ghimire 2015). It has a growing concern in Nepal due to its adverse impacts on different sector including agriculture, hydropower and tourism (Sharma 2009). Along with Nepal, other economically poor Least Developed Countries (LDC) are vulnerable to climate change (MoSTE 2015d). Due to its high altitudinal variation, geology, unique ecological system, rugged topography, nature dependent livelihood and poverty, Nepal is highly vulnerable to climate change (FAO 2010; Gurung and Bhandari 2009; Rai and Gurung 2005). It is also intensified by geographical location, social condition, political influence, lack of skilled manpower, illiteracy and economic prosperity (Gurung and Bhandari 2009; Anup et al. 2013).

Nepal has diverse climate, biological resources and agro-climatic zone from subtropical to the alpine and tundra due to the high altitudinal range of 60 m from south to 8848 m in the north from average mean sea level (ADB 2015; Anup 2015). There is occurrence of summer monsoon rain from June to September in Nepal covering about 80% of the annual precipitation (FAO 2010; GWPNepal 2015). Nepal has less than 0.4% of the world's total population and contributes about 0.025% of annual greenhouse gas (GHG) emissions which is very negligible as compared to those of developed countries (MOE 2010; Rai and Gurung 2005).

The original version of this chapter was revised: Author name has been changed. The erratum to this chapter is available at https://doi.org/10.1007/978-3-319-70066-3_27

Anup K. C. (✉)
Department of Environmental Science, Tribhuvan University, Amrit Campus, Thamel, Kathmandu, Nepal
e-mail: kcanup04@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_2

The temperature of Nepal is rising at a faster rate than the global temperature (Gurung and Bhandari 2009; MoSTE 2015d). There is average annual increase in temperature of 0.06 °C per year with high rise in the Himalayas (FAO 2010; MoSTE 2015b; Rai and Gurung 2005). Temperature projections estimated the rise of 1.4 °C by 2030, 2.8 °C by 2060 and 4.7 °C by 2090 (GWPNepal 2015; NCVST 2009). There are more frequent warmer days and less frequent cooler nights observed throughout Nepal (FAO 2010; Anup 2015). Annual maximum temperature is in increasing trend with hot summer days while minimum temperature is in decreasing trend with cool winter days (Anup and Thapa Parajuli 2014; MoSTE 2015b). Temperature rise is higher in far-western Nepal than other regions (FAO 2010).

Precipitation projections estimated increase in rainfall amount, heavy rainfall events and droughts (GWPNepal 2014a; NCVST 2009). There is decreasing trend of rainfall in central and western Terai while there is increasing trend of rainy days and rainfall amount in western and northern hills and mountains in monsoon season (FAO 2010). High intense rainfall as a result of climate change causes water induced disaster such as floods, landslides and soil erosion (FAO 2010; Anup et al. 2013). Temperature rise is increasing snowmelt and glacier retreat by changing hydrological pattern and increasing glacial lake outburst floods (GLOFs) (ADB 2015; FAO 2010).

Increase in temperature, high intense rainfall, unfavorable weather pattern, rapid snow melt, landslides, floods and glacial lake outburst floods were observed in higher mountains (CCNN 2011; MoSTE 2015b). Climate change had altered ecosystem functions and services, crop production cycles and rainfall patterns; increased flash floods events, longer cycles of droughts and heavy floods events (GWPNepal 2015; MoSTE 2015b). Nepal is fourth most vulnerable among 170 countries according to global Climate Change Vulnerability Index (CCVI) (CCNN 2011; MoSTE 2015b). As, people of Nepal are highly dependent on natural resources and agriculture, slight changes in temperature and rainfall pattern makes people more vulnerable to climate change (GWPNepal 2014a; Rai and Gurung 2005).

Nepal is highly dependent on agriculture contributing more than 30% to gross domestic product (GDP) and supplementing livelihood of more than 80% people (CCNN 2011; MoPE 2004). Dry spells of rain and draughts causes negative impacts on agriculture, livestock, human comfort and livelihood (ADB 2015; FAO 2010). The poor people, who are directly dependent on nature and rain-fed agriculture are unable to cope with this issue (Gurung and Bhandari 2009; GWPNepal 2015). Decrease in frequency of snow fall and snow cover in mountain region affects agriculture, livestock and livelihood of local people (Anup and Ghimire 2015; Anup and Thapa Parajuli 2014). Climate change had caused decrease in ground water level and increase in temperature resulting in low agricultural production (IDE 2015). Rise in temperature increases evapotranspiration rates while change in precipitation increases flash floods, storms and landslides. Climate change can delay, disrupt, damage and bring failure to infrastructure development (MoSTE 2015a).

As climate change had caused adverse impacts on different sectors in Nepal, there is a need of awareness programmes to the affected people about climate change, its impact, and mitigation and adaptation measures. There is a need of detailed review to assess the situation of climate change communication in Nepal which could be helpful in developing new researches, projects and programmes for effective communication in the future. The activities performed by different organizations towards climate change communication, mitigation and adaptation need to be reviewed for developing effective programmes for climate change awareness in different areas of Nepal.

By setting an objective to assess the role of organizations in climate change communication in Nepal, this paper was prepared through detailed literature review. There were very less peer reviewed journal papers and reports published towards climate change communication in Nepal. The paper was developed without the review of adequate peer reviewed journals. Activities performed by different organization towards climate change were taken from their published annual reports and websites. It was really a challenge to gather adequate information towards status of climate change communication in Nepal.

1.1 Methodology

This paper was prepared through literature review of the researches and publications in climate change issues in Nepal. In the beginning; research reports, annual reports, technical reports and journal papers related to climate change were collected from different websites and libraries. Collected documents were reviewed to assess the role of organizations and researchers in climate change awareness, mitigation and adaptation. Necessary climate change information suitable to the objective of this paper was compiled and prepared in the form of paper. It was observed that different tools and techniques were applied by different organizations for climate change communication, mitigation and adaptation in Nepal.

1.2 Climate Change Communication in Nepal

Climate change communication is necessary to aware local people towards anthropogenic causes of climate change, its impacts and measures to adapt from it. There is an urgent need of collaborative and effective actions in local, national and international level to address its impacts, and enhance climate resilience of the people and country (MoE 2012). Educational programmes and public awareness activities were organized by different organizations using different resources and techniques in Nepal. These organizations had implemented different methodologies for effective climate change communication in Nepal.

1.3 Role of Governmental Sector in Climate Change Communication

There is a great role of government towards climate change communication in Nepal. Government of Nepal is in strong position towards necessary policy formulation process but it is weak in implementation of its policies.

For climate change communication in Nepal, Ministry of Population and Environment (MOPE) guides other ministries and departments (MoPE 2016). It is the main Centre of United Nations Framework Convention on Climate Change (UNFCCC) in Nepal. It has involved its Climate Change Management Division and Environment Division for prioritizing climate change activities (Maharjan 2014; MoSTE 2015e). Nepal had been involved in the climate change regime for over two decades since 1992, and had participated in many climate change intergovernmental meetings (CEN 2012). Multi-stakeholder Climate Change Initiatives Coordination Committee (MCCICC) was formed as a key national forum for regular consultation of climate change policies, plans and projects by replacing Climate Change Network (CCN) (CEN 2012; GoN 2011).

Public awareness programmes were initiated by the government and non-government sector; and these activities were increased with time after 2006 (CCNN 2011; GoN 2011). As being a Party to the Convention, Nepal had prepared and shared Initial National Communication in 2004 (CEN 2012; GoN 2011). Climate change was also prioritized in 2003 Sustainable Development Agenda and 2001 Millennium Development Goals. From 2005 to 2007, Nepal had prepared action plan for enhancing climate change capacity and had implemented projects for managing climate change and the environment (GoN 2011).

Nepal had received funding to prepare Second National Communication (SNC), Pilot Programme for Climate Resilience (PPCR), and Reducing Emissions from Deforestation and Forest Degradation (REDD) readiness activities between 2007 and 2009 (CEN 2012). In July 2009, Climate Change Council was formed as the highest body under the Chairmanship of Prime Minister for policy formulation and international negotiations. Cabinet meeting of GoN was organized near the base camp of the Mount Everest before CoP 15 for climate change communication in national and global level (GoN 2011; Maharjan 2014).

As vulnerability of Nepal towards climate change, climate risks and uncertainties are increasing; new knowledge and capacity towards climate change mitigation and adaptation need to be developed. Government of Nepal (GoN) had initiated different activities to increase institutional capacity of social and economic sectors to enhance resilience of population, and reduce the vulnerability (MoSTE 2015b). Climate Change Policy was developed in 2011 in Nepal to mitigate and adapt to the negative impacts of climate change, focus on low-carbon economy and socio-economic development (MoE 2011). Nepal Climate Change Development Portal was set up as a main platform for sharing climate change information. Nepal Academy of Science and Technology (NAST) had established Nepal Climate Change Knowledge Management Centre (NCCKMC) in partnership with Ministry, for climate change knowledge generation, collection and dissemination (CCNN 2011).

Pilot Programme for Climate Resilience (PPCR) had started in Nepal along with the National Adaptation Programme of Action (NAPA). It targets in ministerial level for coordination and planning of adaptation in development plans in first phase and implementations of the plans and programmes in the second phase (CCNN 2011). Similarly, GoN had prepared and endorsed National Framework on Local Adaptation Plan for Action (LAPA) in November 2011 according to NAPA priorities with local level participation (Maharjan 2014). LAPA was piloted in Ilam, Udaypur, Nawalparasi, Kapilvastu, Kaski, Dadeldhura, Pyuthan, Rukum, Achham, and Kalikot district of Nepal. During LAPA formulation; public interactions, workshops and seminars for sensitization towards climate change was organized in local and district levels. Agriculture, forestry, health, water and sanitation have been prioritized with special focus on education, local infrastructure, disasters and other environmental sectors (MoE 2011).

Also, local level adaptation projects by non-governmental organizations (NGOs) was taking place in different regions of Nepal (FAO 2010). Nepal had received climate change fund from convention regime, and outside convention from different countries such as; United Kingdom, Japan, European Union, Norway and Germany through different NGOs (Maharjan 2014). Nepal Climate Change Support Programme (NCCSP), Strategic Programme for Climate Resilience (SPCR), and Hariyo Ban Programme were the other important projects being implemented for climate change communication and adaptation to the vulnerable people of Nepal (Maharjan 2014).

There are 7 climate change projects running in response to NAPA and LAPA. MOPE had prepared methodology and guidelines for climate risk screening with the help of 56 Vulnerability Assessments and 56 Adaptation Plans drafts. Vulnerability Assessment and Adaptation Planning Guideline and Risk Management Framework were in the publication process. Ministry of Agriculture Development (MOAD) had implemented National Climate Change Policy 2011 and introduced climate change in National Land Use Policy (2012) and Industrial Policy (2011). Similarly, Department of Soil Conservation and Watershed Management, Department of Roads, Department of Hydrology and Meteorology, Department of Local Infrastructure Development and Agricultural Roads, Department of Water Supply and Sanitation, Ministry of Federal Affairs and Local Development (MOFALD), Department of Water Induced Disaster Prevention, Department of Irrigation, Department of Forestry and Department of Urban Planning and Building Construction had also given emphasis on climate change communication in their planning, policy, project and programme level (MoSTE 2015e).

Other governmental institutions such as Alternative Energy Promotion Center (AEPC) and Reducing Emissions from Deforestation and Forest Degradation (REDD)-Forestry and Climate Change Cell are working towards climate change communication and mitigation (Maharjan 2014; Sharma 2009). MOSTE, MOAD and MOFALD had set up library to collect and provide information related to climate change in their Climate Change Resource Centre. Trainings and workshops were also organized in regular interval for their technical staff in climate change issues (MoSTE 2015e).

Nepal had signed Paris Agreement along with 174 countries at the United Nations Headquarters in New York to show commitment towards reduction of GHG emissions. To make cities climate resistant, balance and sustainable; ten new towns were proposed in all five development region across mid hill highway area. Cycling was also promoted as a clean transport sector by the government to reduce GHGs emission and increase climate change awareness. Awareness raising programmes on climate change impacts, mitigation and adaptation were conducted by Ministry of Population and Environment in different region of Nepal (MoPE 2016).

Mainstreaming Climate Change Risk Management in Development (MCCRMD) of PPCR had planned to prepare Climate Change Adaptation (CCA) information tool and identify indigenous CCA practices of women and disadvantaged groups. For this, study was carried out to identify indigenous knowledge and local practices; integrate knowledge in policies and plans; and support development works in climate-sensitive sectors in Nepal (MoSTE 2015b). The identified indigenous local knowledge and practices (ILKP) are useful in climate change adaptation and natural resource management in changing environmental scenario. They need to be replicated in different areas of Nepal with the help of institutions of female and disadvantaged groups (MoSTE 2015b). With an objective to enhance governmental body's capacity and share information about climate change, its impact and climatic risk management; a project was run jointly by GoN and Asian Development Bank (ADB). It had expectation to increase climate change resilience in Nepal; and help in developing guidelines, framework, policies, projects and programmes for infrastructure development (ICEM 2015).

2 Role of Non-governmental Sector in Climate Change Communication

Different non-governmental organizations were involved in climate change awareness, mitigation and adaptation in Nepal. To receive climate change fund, most of the organizations were prioritizing climate change as their major agenda. They were focusing in their respective project area but were unable to reach every corner of the country for climate change communication.

First of all, English language is necessary to be translated into Nepali for proper dissemination in schools, colleges, government offices and libraries. Information related to climate change issues was distributed in the form of pamphlets and booklets, and message was circulated through radio and televisions media on special occasions. Involvement of local people in plantation, cleanliness, workshops and seminars on climate change issues was promoted by different local governmental and non-governmental organizations (MoPE 2004). To generate climate change awareness and help in climate change mitigation and adaptation; climate change vulnerability impact analysis was carried out. Jugedi Khola watershed in Chitwan district of Central Nepal was selected for the implementation of the project on the basis of severity and vulnerability to climate-induced disasters and priority of District Development Committee (DDC) (Gurung and Bhandari 2009).

Clean Energy Nepal (CEN) had prepared an attractive flipchart on the topic, "Climate change, its impacts and solutions" to raise climate change awareness among students and teachers in the school, and youth and elderly people in the community. It was prepared to enhance climate change discussion in a group with the support of OXFAM-Nepal. The flip chart was prepared to assist the climate change mobilisers in the field where there is no electricity and multimedia. It contains information on weather, climate, greenhouse gases, global warming, climate change, impacts of climate change in Nepal, mitigation measures, adaptation measures and international attempts for mitigation of GHG emissions (Acharya et al. 2011).

With an aim to identify local adaptation measures, its opportunities, constraints and innovative ways of enhancing adaptive capacity in Nepal, Regmi and Bhandari (2013) carried out a research with the help of literature review and case studies. Content analysis focusing on climate change responses of two national documents, NAPA and SPCR was carried out. Also, 17 policy makers and 26 practitioners working on climate change issues at the national and local level were purposively selected for semi structured interview. The case study was carried out in two pilot Village Development Committees (VDCs) of LAPA and Community Adaptation Planning (CAP) implementation of Pyuthan district.

Semi structured interview was carried randomly in 120 households of 2 VDCs (60 members from each VDC), and six focus group discussions was carried on the basis of gender and ethnicity with Community Forestry User Group (CFUG) members, executive members of Village Forest Coordination Committee (VFCC), project staffs and local government officials. To assess the risk of climate change and capacity to adapt to climate change impacts, technical assistance was provided by ADB. National and local consultations on issues identified and prioritized by NAPA was proposed with local people, NGOs, government, academic institutions and development partners (ADB 2015).

Eight districts were selected for integrating climate change risk management on water supply and sanitation, roads and urban development, and irrigation and flood protection. For each infrastructure in every district, vulnerability assessment and adaptation planning was carried out to train government officials. Priority was given towards research, training and educational activities to enhance awareness on climate change of university and school level teachers, students, researchers, planners and local governmental staffs (ADB 2015).

To assess different indigenous practices and its role in climate change adaptation, primary data and information was collected from key informant interview and household survey while secondary information was collected through review of literatures, national and district level stakeholder workshops and focus group discussions (FGDs). It was observed that local indigenous people who have less access to drinking water and irrigation, who lacks social security, and whose livelihoods depend on rain fed agriculture and wage labor were affected adversely by climate change (MoSTE 2015c).

To enhance climate smart agriculture (CSA), Local Initiatives for Biodiversity Research and Development (LI-BIRD) started a research project in partnership with the Climate and Development Knowledge Network (CDKN). The project aims to identify and recommend climate smart technology for different agro-ecological regions of Nepal and enhance capacity of governmental staffs, women and poor farmers for implementation of climate smart village approach. Research to initiate climate smart villages (CSV) was started in 7 Terai districts and mid hill districts to combine weather, climate, water, nutrients, knowledge and carbon smart farming technologies. They have prepared 9 LAPAs in Dailekh, Jajarkot and Jumla district with the support of second phase of NCCSP. Climate Diary was established in Kaski and Parbat district to document daily temperature, rainfall, extreme natural events and important socio economic events (LI-BIRD 2016).

Jalsrot Vikas Sansthan (JVS)/Global Water Partnership (GWP) Nepal had collected information on indigenous technologies and practices related to climate change adaptation measures being applied by Nepalese farmers in agriculture. Indigenous practices were adopted by local farmers to adapt towards changing climatic condition which need to be modified with new technologies. Farmers have traditionally protected seed and seedbed, harvested water, used organic manure, modified cropping pattern, used flood resistant and drought resistant techniques, re-sowed rice seeds and used common nursery for the preparation of rice seedbed to cope with climate change (GWPNepal 2014b).

International Development Enterprises (iDE), Rupantaran and Resource Identification and Management Society Nepal (RIMS-Nepal) are running Initiative for Climate Change Adaptation (ICCA) project to develop climate change adaptation policies and improve food security of farmers. They had focused on changing crop pattern and encouraging use of biogas and solar energy. They had a plan to diversify and improve resilience of poor and vulnerable communities through income generation, enterprise development, sustainable management of non-timber forest products (NTFPs) and production of high-value vegetable crops, coffee, and essential oils. The project plans to enhance capacity of local governmental bodies towards climate change, and develop and implement local adaptation plans. It had helped to aware community members on climate change and alternative livelihood options. To provide information on climate change and alternative farming techniques, it had established Community Climate Resource Centres and community libraries. It had helped farmers to adapt to climate change through water storage, ground water recharge, soil erosion prevention, community-managed multiple water use systems, micro-irrigation, integrated pest management and nursery bed raising (IDE 2015).

World Wide Fund for Nature (WWF) Nepal plans to implement adaptation and mitigation strategies to build the climate change resilience of vulnerable ecosystems and communities by focusing on energy and food security. It aims to promote knowledge of climate change through research studies; campaigns to strengthen policy and awareness; and adaptation projects to build resilience of local communities and ecosystems. It will train and work with local scientists to understand climate change issues (WWFNepal 2016). In the past, WWF Nepal had helped in increasing awareness on climate change impacts, identifying vulnerabilities, implementing adaptation measures, supporting climate change negotiation, raising climate change awareness and promoting low carbon development in Nepal (WWFNepal 2013).

WWF Nepal had provided technical inputs in drafting Emissions Reduction Project Document (ERPD) in the Terai Arc Landscape (TAL) of Nepal. It had helped in installing 7500 biogas plants in 2012 and 1911 biogas plants in Phase-II Gold Standard Biogas Program (2013–2020) in Nepal's TAL. Implementation of community and local adaptation plan by WWF Nepal had helped 1200 households in TAL, Sacred Himalayan Landscape (SHL) and Chitwan Annapurna Landscape (CHAL). It had provided improved access of water to 4000 households in Indrawati and Dudhkoshi sub-basins. It had organized earth hour event in World Heritage Site to aware many thousand youth towards climate change in Nepal (WWFNepal 2015).

WWF Nepal initiated a project to address climate change vulnerability in the Churia range under Global Environment Facility (GEF) (WWFNepal 2014). It had applied integrated approach to combine food, water and energy security to adapt from the impacts of climate change. A local level learning workshop was organized in Langtang National Park Buffer Zone in SHL to provide awareness related to climate change, its impacts and adaptation measures. It had contributed in forest carbon inventory in the TAL and supported government to draft the ERPIN. WWF Nepal conducted vulnerability assessments (VA) in seven sites (3 in TAL and 4 in SHL) and in CHAL to identify necessary adaptation actions. VA supports preparation of CAPA. WWF Nepal is supporting to enhance capacity of 333 local resource persons and youth in forest carbon inventory and REDD+ issues in TAL, SHL and CHAL. WWF Nepal focuses on water smart communities in rainwater harvesting, runoff water collection and spring source conservation (WWFNepal 2013).

Practical Action had supported in climate change adaptation, climate change policy formulation, low carbon growth and low cost technology with the help of its 16 projects. With the support of community, it had installed a meteorological station in Chitwan and had organized trainings, workshops and exposure tours for climate change communication (PracticalAction 2016). To address climate change issue, Practical Action in collaboration with WWF, IUCN, CECI and NAVIN had developed tools and methodologies of vulnerability assessment for DDCs and VDCs. It had helped in generating wind and solar hybrid energy for lighting, television and mobile charging in Nawalparasi district (PracticalAction 2011).

Action Aid Nepal had organized climate change consultations, promoted Climate Resilient sustainable Agriculture (CRsA) and helped in collective farming, organic farming and community seed bank as a response to climate change. It had translated CRsA handbook in Nepali language with examples of Nepalese farmers and Nepalese agriculture to help Nepalese farmers (ActionAidNepal 2014).

Clean Energy Nepal (CEN) had regularly conducted researches, conferences, workshops, seminars, roundtable discussions and awareness activities related to climate change issues in local, national and international level. It had helped in the formation of Nepalese Youth for Climate Action network, NGO Network on climate change (NGONCC), Climate Action Network and Clean Air Network Nepal for awareness raising, knowledge generation, technology transfer and policy advocacy in climate change issues. It had organized training camp on climate change awareness to equip journalist with climate change skills in print, audio and visual media. It had been regularly organizing green discussion series and pre COP and post COP consultations to communicate international climate change negotiations to policy makers, researchers and students. Before COP 19, CEN had prepared a resource kit for Nepali negotiators to provide information on UNFCCC conferences and meetings procedures, history of UNFCCC negotiations and decisions of previous negotiations (CEN 2014).

International Centre for Integrated Mountain Development (ICIMOD) had helped in setting climate smart technologies to increase climate resilience of rural communities. Atmosphere Initiative had been conducting regular research on black carbon and other pollutants. Climate change exhibition held in Kathmandu and Pokhara had gathered more than 90,000 visitors in a year. Also, few researches were conducted in snow hydrology, carbon stock assessment and other climate change perceptional studies (ICIMOD 2015). ICIMOD also conduct seminars, workshops, trainings and youth forums in regular interval for climate change communication.

NAST-NCCKMC had organized climate change awareness programmes in schools and DDCs of Terhathum, Sankhuwasabha and Dhankuta in eastern Nepal; Salyan, Rolpa, Surkhet and Pyuthan in mid-western Nepal; and Parsa in central Nepal. It had organized quiz and exhibition with the help of colorful posters in simple Nepali language. It had provided information on climate change science, impacts, and adaptation and mitigation measures to students and local people. Also NAST-NCCKMC had provided climate research grant to 25 young researchers in 2012 and climate experts in 2014, and had set up mobile climate change library in different places of Nepal (NAST-NCCKMC 2016).

National Trust for Nature Conservation (NTNC) organizes climate change sensitization workshops, ecotourism promotional activities, awareness generation programmes, and renewable energy support programmes in its Annapurna Conservation Area Project, Gaurishankar Conservation Area Project, Manaslu Conservation Area Project, Central Zoo, Biodiversity Conservation Centre, Bardia Conservation Program and Shuklaphanta Conservation Program in regular interval (NTNC 2015).

Central Department of Environmental Science (CDES) of Tribhuvan University (TU) is one of the pioneer educational institutions actively involved in climate change communication in Nepal. It had organized climate change related guest lectures and seminars in regular interval to its faculties and students. With the support of United Nation Development Programmes (UNDP)-Nepal; it had completed two projects, Ecosystem based Adaptation (EbA) Project and Strengthening Disaster Risk Management in Academia (SDRMA) Project. Recently, TU-CDES had organized awareness related programmes on climate change and disaster management in different region of Nepal with the support of these projects. It had organized seminars, workshops, round table discussions, trainings and policy consultations in Gorkha, Dhading, Panchase, Pokhara, Kushma, Syangja and Kathmandu. It had also encouraged students to conduct climate change researches in Panchase and other region of Nepal (TU-CDES 2015).

3 Challenges of Climate Change Communication in Nepal

There is a great challenge for climate change communication in Nepal due to its geographical variation, illiteracy, poverty, diverse language, and diverse culture and traditions (MoPE 2004). There is slight increase in climate change awareness of government and non-governmental organizations while public awareness is really a challenge, till the date (CCNN 2011). Women are more vulnerable to climate change than men due to their traditional roles in collection of water, firewood, fodder and other natural resources, and their contribution in agriculture and livestock management (ADB 2015; CCNN 2011). There is strong capacity of Government in formation of climate change policies and strategies while there is weak capacity in implementation of such policies and strategies (ADB 2015). Climate Change Policy (2011) of Nepal had focused less on adaptation and more towards low emission and low carbon development but Government of Nepal had developed NAPA and LAPA framework prioritizing adaptation according to the donor interests (Regmi and Bhandari 2013). Climate financing is difficult to track due to the lack of auditing and financial management system, different criteria of expenses and different sources of climate finance (Maharjan 2014).

Financial, technical and logistic support for climate change communication is not available equally in all the region of Nepal. If it is available in few areas, it is not sufficient for awareness of all the people. There is lack of local skilled manpower for climate change awareness who can implement climate change communication project in local language and in local context by using local resource. Climate change visiting expert would be less effective to spread awareness in village area on climate change issues due to the language problem. Also, geographical variation is disturbing to implement climate change communication projects in efficient way. Lack of transportation and communication facilities is also affecting communication of climate change from print, electronic and digital media.

3.1 Opportunities of Climate Change Communication in Nepal

There is need of strong communication and cooperation among least developed and mountainous countries to raise common problems and initiate common efforts related to global climate change and development issue. Research, sharing of traditional knowledge, information dissemination, public awareness, infrastructural development, institutional development and effective science-policy interface is necessary for increasing resilience of water, biodiversity, energy, food, natural resources and environment (Gurung and Bhandari 2009; MoE 2012). Poverty reduction, employment generation, economic growth, rural development, environmental conservation, gender equality, social inclusion and sustainable mountain development need to be prioritized (MoE 2012; MoPE 2004). Collaboration of government, community based organization, private sector, local people, civil society and youth need to be enhanced (FAO 2010; MoE 2012). It is necessary to focus on climate induced disaster risk reduction, preparation of climate resilient community, and diversification of livelihood options of local people (Gurung and Bhandari 2009).

As climate financing is a major challenge, 80% of climate change funds should be mobilized for climate change adaptation and mitigation in local level (Maharjan 2014). Food insecurity and food shortage issues in hill and mountain region of mid and far western Nepal should be addressed to minimize immediate hunger (FAO 2010). To minimize the adverse impact of climate change; government and local farmers should adopt micro-irrigation systems, diversify the livelihood options, and change the cropping pattern with respect to changing climatic scenario (IDE 2015). Line agencies and policy makers should identify and plan climatic scenario, hazard, disaster risk reduction approach, land use planning, watershed management, glacial and fluvial movement, ecosystem management, early warning system and agricultural development (FAO 2010).

Technological cooperation and indigenous practices among countries could help vulnerable household to better adapt to climate change (MoE 2012; Regmi and Bhandari 2013). Participation of local people in sharing their indigenous knowledge and capacity building programmes is important in enhancing climate change resilience and adaptation in natural resource management. As, indigenous practices do not receive due attention by government and development agencies, it needs to be incorporated in natural resource management system to promote ownership and sustainability (MoSTE 2015c).

For effective implementation of climate change communication projects, local skilled manpower should be given priority. Necessary trainings and skill development activities of the local manpower should be focused for increasing their level of understanding. Local manpower would effectively implement climate change communication and adaptation projects in his local language and local context by using local resources. Climate change mitigation and adaptation projects are possible to implement if there is sufficient information about climate change science, its impacts, and mitigation and adaptation measures. So, climate change communication programmes are most important in the beginning of project implementation. Sufficient financial, technical and logistic resources should be allocated for climate change communication.

4 Conclusions

Climate change is observed in Nepal in the form of rise in temperature; increase in rainfall amount, intensity and dry spells; unfavorable weather pattern; rapid snow melt; and increased occurrence of landslides and floods. It is one of vulnerable country in the world due to its high altitudinal variation, geology, unique ecological system, rugged topography, nature dependent livelihood and poverty. With an aim to assess the status of climate change communication in Nepal, this paper was prepared through literature review of research reports, annual reports, technical reports and journal papers related to climate change. It was observed that educational programmes and public awareness activities were conducted for climate change communication in Nepal. In governmental sector, Ministry of Population and Environment (MOPE) is leading climate change communication with the support of other ministries and departments. Adequate policies and legislative documents were prepared from government sector but they lack proper implementation. Different non-governmental organizations, community based organizations and academic institutions were helping towards climate change communication in Nepal. It makes a feeling that most of the organizations are prioritizing climate change as a main agenda in their respective project area but were unable to reach every corner of the country. There is a great challenge for climate change communication in Nepal due to its geographical variation, illiteracy, poverty, diverse language, and diverse culture and traditions. Researches, sharing of traditional knowledge, information dissemination, public awareness, infrastructural development, institutional development and effective science-policy interface are necessary for increasing climate change communication in Nepal.

References

Acharya S, Thapa R, Chapagain D (2011) Climate change, its impacts and solutions. Clean Energy Nepal, Kathmandu, Nepal

ActionAidNepal (2014) Reflections and Learnings 2014. Action Aid Nepal, Kathmandu, Nepal, p 88

ADB (2015) The Asian development bank and the climate investment funds country fact sheets. ADB Climate Change and Disaster Risk Management Division, Manila, Philippines

Anup KC (2015) Climate change and its impact on hydropower development in Nepal. Vidhyut 26 (1):25–29

Anup KC, Ghimire A (2015) High-altitude plants in era of climate change: a case of Nepal Himalayas. In Ozturk M, Hakeem KR, Faridah-Hanum I, Efe R (eds) Climate change impacts on high-altitude ecosystems, vol 1. Springer International Publishing, Switzerland, pp 177–189

Anup KC, Thapa Parajuli RB (2014) Climate change and its impact on tourism in the Manaslu conservation area, Nepal. Tour Plan Dev 13. doi: 10.1080/21568316.2014.933122

Anup KC, Bhandari G, Joshi GR, Aryal S (2013) Climate change mitigation potential from carbon sequestration of community forest in mid hill region of Nepal. Int J Environ Prot 3(7):33–40

CCNN (2011) Governance of climate change adaptation finance in Nepal. Climate Change Network Nepal, Kathmandu, Nepal

CEN (2012) Information note for COP18 to the UNFCCC and CMP8 to the Kyoto Protocol. Clean Energy Nepal, Kathmandu, Nepal
CEN (2014) Annual report of BS 2070/71 (AD 2013–14). Clean Energy Nepal, Kathmandu, Nepal, p 37
FAO (2010) Implications of climate change for agriculture and food security and adaptation priorities in Nepal Rome. Food and Agriculture Organization of the United Nations, Italy
GoN (2011) Climate change policy, 2011. Government of Nepal, Kathmandu, Nepal
Gurung GB, Bhandari D (2009) Integrated approach to climate change adaptation. J For Livelihood 8(1):90–99
GWPNepal (2014a) Climate vulnerability and gap assessment report on flood and drought (Lower Rapti River basin case study). GWP Nepal/Jalsrot Vikas Sanstha (JVS), Kathmandu, Nepal
GWPNepal (2014b) Traditional climate change adaptation practices by farmers in Nepal Kathmandu. Global Water Partnership Nepal/Jalsrot Vikas Sanstha (JVS), Nepal
GWPNepal (2015) Stocktaking: climate vulnerability on agricultural sector for national adaptation plan process. Jalsrot Vikas Sanstha (JVS)/GWP Nepal, Kathmandu, Nepal
ICEM (2015) TA 7984: mainstreaming climate change risk management in development identification of high risk projects. International Centre for Environmental Management, Hanoi, Vietnam
ICIMOD (2015) Annual report 2014. International Centre for Integrated Mountain Development, Kathmandu, Nepal, p 80
IDE (2015) Initiative for Climate Change Adaptation (ICCA) project. In: Enterprises ID (ed) Kathhmandu. Nepal, U.S. Agency for International Development
LI-BIRD (2016) LI-BIRD annual report 2014–15. Local Initiatives for Biodiversity Research and Development, Pokhara, Nepal
Maharjan M (2014) Climate change adaptation projects and major activities on climate financing in Nepal. Global Water Partnership (GWP) Nepal/Jalsrot Viksa Sanstha (JVS), Kathmandu, Nepal
MOE (2010) National adaptation programmeme of action to climate change. Ministry of Environment, Government of Nepal, Kathmandu, Nepal
MOE (2011) National framework on local adaptation plans for action. Government of Nepal Ministry of Environment, Babarmahal, Kathmandu, Nepal
MoE (2012) Kathmandu call for action. Paper presented at the international conference of mountain countries on climate change, Kathmandu, Nepal, 5–6 April 2012
MoPE (2004) Initial national communication to the conference of the parties of the united nations framework convention on climate change. Ministry of Population and Environment, Kathmandu, Nepal
MoPE (2016) Climate change division. http://www.mope.gov.np/index.php#. Retrieved 14 Sept 2016
MoSTE (2015a) Climate change sector profile for infrastructure design and vulnerability analysis. International Centre Environmental Management, Kathmandu, Nepal
MoSTE (2015b) Indigenous and local climate change adaptation practices in Nepal. Ministry of Science Technology and Environment, Government of Nepal, Kathmandu, Nepal
MoSTE (2015c) Indigenous and local knowledge and practices for climate resilience in Nepal. Mainstreaming Climate Change Risk Management in Development, Ministry of Science, Technology and Environment (MoSTE), Kathmandu, Nepal
MoSTE (2015d) National adaptation plan formulation process. Government of Nepal Ministry of Science, Technology and Environment Climate Change Management Division, Kathmandu, Nepal
MoSTE (2015e) Nepal Climate Change Program (CCP) Program Progress Report January 1–December 31, 2014. Ministry of Science, Technology and Environment, Kathmandu, Nepal
NAST-NCCKMC (2016) A report on climate change awareness program Shankhuwasabha, Dhankuta, Surkhet and Parsa District. Nepal Academy of Science and Technology-Nepal Climate Change Knowledge Management Center, Kathmandu, p 12

NCVST (2009) Vulnerability through the eyes of vulnerable: climate change induced uncertainties and Nepal's development predicaments. Institute for Social and Environmental Transition-Nepal (ISET-N), Kathmandu and Institute for Social and Environmental Transition (ISET), Boulder, Colorado

NTNC (2015) Annual report 2015. National Trust for Nature Conservation, Kathmandu, Nepal

PracticalAction (2011) Annual report 2010/11. Practical Action Nepal Office, Kathmandu, Nepal, p 40

PracticalAction (2016) Climate change. http://practicalaction.org/our-work-in-nepal#climate-change. Retrieved 14 Sept 2016

Rai SC, Gurung A (2005) Raising awareness of the impacts of climate change initial steps in shaping policy in Nepal. Mt Res Dev 25(4):316–320

Regmi BR, Bhandari D (2013) Climate change adaptation in Nepal: exploring ways to overcome the barriers. J For Livelihood 11(1):43–61

Sharma KP (2009) Climate change trends and impacts on livelihood of people Kathmandu. Jalsrot Vikas Sanstha/Nepal Water Partnership, Nepal

TU-CDES (2015) Project completion report submitted to ecosystem based adaptation in mountain ecosystem of Nepal. Tribhuvan University-Central Department of Environmental Science, Kathmandu, Nepal

WWFNepal (2013) WWF nepal annual report 2014. World Wide Fund for Nature Nepal, Kathmandu, Nepal

WWFNepal (2014) WWF nepal annual report 2014. World Wide Fund for Nature Nepal, Kathmandu, Nepal, p 28

WWFNepal (2015) WWF Nepal annual report 2015. World Wide Fund for Nature Nepal, Kathmandu, Nepal, p 52

WWFNepal (2016) Climate. http://www.wwfnepal.org/whatwedo/climate/. Retrieved 13 Sept 2016

Short Stories and Climate Change: An Application of Kolb's Experiential Learning Model

Evangelos Manolas

1 Introduction

Climate change fiction is now a recognizable literary phenomenon which has even acquired its own nickname: "Cli-fi". The term cli-fi was invented in 2007 by Taiwan-based blogger Dan Bloom ('Cli-fi' novels humanise the science of climate change—and leading authors are getting in on the act 2015).

The term became more widely known when Margaret Atwood championed it in a 2012 tweet, and at the same time introduced it to her 500,000 followers. The phrase "cli-fi" began to emerge as a new literary and cinema genre (Zajaczkowska 2015). In particular, Atwood has commented on cli-fi this way:

> There's a new term, cli-fi (for climate fiction, a play on sci-fi), that's being used to describe books in which an altered climate is part of the plot. Dystopic novels used to concentrate only on hideous political regimes, as in George Orwell's *Nineteen Eighty-Four*. Now, however, they're more likely to take place in a challenging landscape that no longer resembles the hospitable planet we've taken for granted (Atwood 2013).

Institutions of higher education have began to offer specialized courses on climate change fiction such as the one offered by the University of Oregon (Siperstein 2015). Some Universities such as Arizona State University even promote Climate Fiction Short Story Contests. The first such contest was materialized in 2015. For the 2016 contest more than 700 stories by authors between the ages of 10 and 75 from around the world submitted stories. Writers can submit up to three stories. It is worth mentioning the evaluation criteria used in the contest:

E. Manolas (✉)
Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, 193 Pantazidou Street, 68200 Orestiada, Greece
e-mail: emanolas@fmenr.duth.gr

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_3

1. The story should, in some way, envision the future of Earth and humanity as impacted by climate change.
2. The story should reflect—directly or indirectly—current scientific knowledge about future climate change, without prejudice to authors' artistic freedom to exaggerate and invent fictional worlds.
3. The story could illuminate and invite reflections on a climate-related challenge that individuals, communities, organizations or societies face today (e.g., daily decisions and behaviors, policy-making and politics, strategy and planning, moral responsibility to the future, investment in R&D or technologies, health, etc. …) (Arizona State University 2016).

However, even if other Universities offer no specialized courses or short story contests on climate fiction, nevertheless, reading and writing climate short fiction may be accommodated in general reading and writing short fiction courses such as the ones offered by New York University (Zoref 2014) and Massachusetts Institute of Technology (MIT 2016).

This chapter reviews the emergence of climate fiction as a literary phenomenon, discusses the importance of short stories as a teaching tool, presents David A. Kolb's experiential learning model and finally attempts to apply the model via the use of short stories which include some aspect of climate change in their plot. The application suggested is followed by some observations which will be useful to those who wish to use this method in their settings.

2 Climate Fiction

Mary Shelley's 19th Century *Frankenstein* (1818) explored man's fear of the monster of difference and change, George Orwell's *Nineteen Eighty Four* (1948) was a commentary on the dangers of totalitarianism, Aldus Huxley's *Brave New World* (1932) painted a supposed utopia built on stability through genetic manipulation at the expense of creative chaos, Ray Bradbury's *Fahrenheit 451* (1953) explored the control of humanity through imposed ignorance. Fiction of recent decades reflects concerns with technology, corporate deceit, overpopulation or global environmental problems.

Cli-fi as an evolving and potentially expansive genre may be seen as processing our, unavoidable under the circumstances, cultural distress. Cli-fi narratives, apocalyptic or post-apocalyptic but not necessarily so, reflect and possibly even safely *contain* our collective fears and anxieties, especially with regard to our chances for long-term survival. They explore how we will feel and function in a climatically changed world, they reveal our mistakes and they prepare us for different futures. To mention a few titles: Arthur Herzog's *Heat* (1976), George Turner's *The Sea and Summer* (1987), Michael Crichton's *State of Fear* (2004), Ian McEwan's *Solar* (2010), Barbara Kingsolver's *Flight Behaviour* (2012), Nathaniel Rich's *Odds Against Tomorrow* (2013), Margaret Atwood's *MaddAddam Trilogy*

(2013) and Cormac McCarthy's *The Road* (2006) ('Cli-fi' novels humanise the science of climate change—and leading authors are getting in on the act 2015; Robinson 2016).

Climate fiction also includes short stories, such as those in the book *I'm With the Bears: Short Stories from a Damaged Planet* (2011) edited by Mark Martin and introduced by Bill McKibben and in the book *Under the Weather: Stories About Climate Change* (2012) edited by Tony Bradman (Tuhus-Dubrow 2013; Siperstein 2014).

Some examples of short stories included in the above books: In the first one Helen Simpson's *Diary of an Interesting Year* is set in 2040 and is a diary account and possibly a most alarming vision of societal collapse as a result of climate destruction. Paolo Bacigalupi's *The Tamarisk Hunter* deals with the significance of water supply as a most important resource and attempts estimates on the lengths that people will go in order to have supplies (Masurel 2011). T.C. Boyle's *The Siskiyou* is about naive activists who put their feet in cement to close a road against all those who will cause destruction of a forest. Lydia Millet's *Zoogoing* follows with a businessman who likes getting too close with zoo creatures who without anyone knowing spends nights in zoos. The story shows what it means to be an endangered creature and about to become extinct (Publisher's Weekly 2011).

In the second book, in Candy Gourlay's *How to Build the Perfect Sandcastle*, a boy in the Philippines watches as the coral reefs protecting his island are dying as a result of a single-degree rise in ocean temperatures. In Francis McCrickard's *As Busy As …*, three children in Britain, Zambia, and the U.S. raise awareness about decreasing bee populations. And in Miriam Halahmy's *Tommo and the Bike Train*, a boy in flood-threatened Bangladesh mobilizes his classmates to reduce their carbon emissions by pedaling to school (Booklist Reviews 2011).

Munteanu (2014) puts forward the view that cli-fi can be useful if it provides direction and opportunities for resolution and triumph. Without these qualities it is nothing more than a disaster story, something to endure. Literature has always provided and can provide a powerful call for action and change, e.g. Harriet Beacher Stowe's *Uncle Tom's Cabin* helped transform American views about slavery (Gow 2012), Rachel Carson's *Silent Spring* contributed to the development of the American environmental movement of the 1960s (Munteanu 2014).

Referring to climate short fiction Ullrich (2015) points out that it has the capacity to inspire action and this can perhaps explain cli-fi's popularity. Cli-fi may present bleak visions of the future, but within such frightening prophecies there are real possibilities that we can still steer in a different direction. As Atwood pointed out "People need such stories, because however dark, a darkness with voices in it is better than a silent void" (Ullrich 2015).

It is possible that our biggest obstacle with regard to climate change and its consequences is our inability to envision a world in which we failed to act: "If climate fiction can improve our empathetic response to other characters, perhaps it can help us to empathize with the characters of our future selves, seemingly alone out there, toiling through a dismal, yet preventable conflict" (Moore 2016).

3 Why Short Stories?

Among literary forms, short-story, which is defined by Poe "as a narrative that can be read at one sitting of from one-half hour to two hours, and that is limited to "a certain unique or single effect," to which every detail is subordinate" (Abrams 2016), seems to be the most suitable one to use in educational settings.

The short story is fiction at its most intensive and compact—in the words of the Scottish writer, A.L. Kennedy, "small in a way that a bullet is small" (Kennedy 2009).

As a self-contained form, the short story is suitable for close reading and seminar discussion. Questions of style, imagery, structure and narrative strategy can be addressed through a single text. It is for this reason that short stories are often used in introductory modules, training students in textual analysis or illustrating key themes and terms (Cox 2011).

The idea is also compatible with Collie and Slater (1991) when they refer to four advantages of using short stories for language teachers:

> First, short stories are practical as their length is long enough to cover entirely in one or two class sessions. Second, short stories are not complicated for students to work with on their own. Third, short stories have a variety of choice for different interests and tastes. Finally, short stories can be used with all levels (beginner to advance), all ages (young learners to adults) and all classes (morning, afternoon, or evening classes) (Collie and Slater 1991).

Ruder (2010) who uses short stories in teaching economics points out that short stories are much shorter than full-length movies, they possess a beginning, middle, and end which excerpts do not, and they are more accessible to students than other literary forms such as poems. As such, short stories are very useful additions to economics courses where class preparation may also include a substantial amount of technical reading and other assignments. He quotes Oates who describes the short story as "a prose piece that is not a mere concatenation of events, as in a news account or an anecdote, but an intensification of meaning by way of events" (Oates 1992). He also notes that the intensity of a short story makes it possible for even a short reading to illustrate complex economic ideas (Ruder 2010).

The above thinking is just as useful for teaching complex issues such as climate change. For example, Leal Filho in discussing environmental literacy, environmental education and environmental communication has noted:

> In order properly to inform people about facts and figures on the environment information needs to be disseminated systematically and in a way in which it is easily understood by those for whom it is intended… The ultimate aim of environmental education and communication is to provide the public with information on the environment with two objectives: first to make them environmentally literate; second, to make them commit themselves to the cause of environmental protection and conservation (Leal Filho 1998).

4 Kolb's Experimential Learning Model

Building on earlier work by John Dewey and Kurt Levin, American researcher Kolb (1984) created a model which consists of four learning stages: concrete experience, reflective observation, abstract conceptualization and active experimentation.

In the first stage, *concrete experience*, the learner actively experiences an activity such as a laboratory session or field work. This stage may be seen as a precursor to systematic engagement with a situation or problem. The second stage, *reflective observation*, aims to understand the experience. In this stage, students view concrete experiences from a variety of angles and explain why and how they occurred. The third stage, *abstract conceptualization* observations and reflections are linked into a theory or concept. Here, the aim is to identify the general concept of which the concrete experience was one example. The fourth stage, *active experimentation* tests the theories and leads to new experiences. In this stage, students use what they learned in the abstract conceptualization stage in order to make predictions about the real world and then act on those predictions. Students' actions are a new concrete experience and the learning cycle begins anew.

The key to designing lessons which take students full cycle is to note that the second word in each of the four stages' names shows what the learner experiences. The learner begins by having an experience which involves him or her in a situation (experience) and then reflects on the experience from several perspectives (observation). From those reflections, the learner draws concepts or conclusions and formulates them into theories or models (conceptualization) that lead them to experiment or act (experimentation).

Kolb found that learners typically did not use all four learning stages equally, but preferred to focus on one or two of them. He identified four learning preferences, each of which shows learners being most comfortable in a different pair of learning stages. Based on responses to a set of questions called the Learning Style Inventory, Kolb described the four learner preference groups as divergers, assimilators, convergers, and accommodators. Understanding the preferences is fundamental for understanding how students may respond to lessons designed specifically for each stage.

Divergers prefer learning through concrete experience and reflective observation. They may be very good at viewing a situation or problem from many perspectives and developing imaginative solutions. Assimilators prefer abstract conceptualization and reflective observation. These individuals can often pull together very different observations into an explanation or theoretical model. Convergers learn best through abstract conceptualization and active experimentation. Their strength lies in the practical application of ideas. They tend to organize their thinking to use hypothetical-deductive reasoning to focus on specific problems. The dominant learning preferences of accommodators are concrete experience and active experimentation. Accommodators tend to be risk takers who thrive on action and new experiences.

Teaching techniques which provide opportunities for concrete experiences may be observations, experiments, simulations, fieldwork, storytelling, films, jokes, cartoons, newspaper articles, examples, taking a survey, role play or reading texts. Techniques which provide opportunities for reflective observation include journals, logs, discussion, brainstorming, thought questions and rhetorical questions. Listening to lectures, seeking out and critiquing models in texts or articles, generating hypotheses, concept maps, building models and construction analogies, papers and projects involve learners in abstract conceptualization. Case studies, simulations, fieldwork, projects, homework, conducting an experiment in the laboratory or in the field engage students in active experimentation (Kolb 1984; Brock 1999; Healey and Jenkins 2000; Kelly 2002).

5 An Application of Kolb's Experiential Learning Model

The reading and writing assignment which follows is an attempt to apply Kolb's experiential learning model while also serving as an alternative to traditional assignments such as writing a critique of someone's work.

Concrete experience This involves reading a short story related to climate change. The selected story comes as a result of a student meeting with the instructor in which appropriate possibilities are discussed. Examples include short stories from edited collections such as the ones mentioned earlier in this chapter. The meeting with the instructor may include good reading advice and skills in short story analysis.

Reflective observation The initial reading, a concrete experience, is intended to encourage students to think about the central message(s) of the story, the values and worldviews conveyed by the story, the emotions generated by the story, the questions the story raises, the incentives behind the actions of the characters involved in the story, the story's target audience. Students also identify and discuss points in the story which contradict each other as well as the techniques used in the story to support values and positions. They discuss any symbolism contained in the story. They also discuss points omitted in the story. In addition, they identify and analyze the strengths and weaknesses of the story.

Abstract conceptualization During this stage students read relevant sources which may include biographies, journal articles, published interviews with the author of their chosen short story, newspaper or periodical reviews on the story the selected. The above sources may include analyses of factors which influenced the reception by the public of their chosen story or the impact of the story on other stories or trends. These sources may also include academic papers on particular themes emphasized in the story they selected, e.g. coral reefs and climate change. Instructors may also use this opportunity to provide guidance for the next stage.

Active experimentation Writing their own review of the story they selected would constitute a realization of Kolb's last experiential learning stage, active experimentation. An even better idea would be to write a short story themselves.

Concrete experience Students read the short stories created.

Reflective observation This stage could include discussion of similarities and differences between the original story selected and the story they themselves created. It could also include discussion of how themes, problems and issues were addressed. Or it could involve looking at recurring themes. In general students could discuss what was learned from their involvement in the process and how they would respond in the future regarding the climate change challenges they encountered.

6 Discussion and Conclusion

Libraries should make sure they have copies of collections of short stories either in printed or electronic form.

How long the process discussed above may take until it is completed is something which depends on a multiplicity of factors, e.g. number of students, level of students, total available time (Manolas and Kehagias 2005).

In the above process carefully chosen experiences are supported by reflection, critical analysis and synthesis. Also, the student is required to take initiative, make decisions and be accountable for results. Throughout the process described above the student is actively engaged in asking questions, investigating, experimenting, solving problems, assuming responsibility, being creative and constructing meaning. Students are involved in many ways, i.e. intellectually, emotionally, socially, soulfully and/or physically. Relationships such as student to self and student to others are developed and nurtured and opportunities are provided for students to explore their own values and worldviews (Association for Experiential Education 2016).

The activity discussed in this paper provides opportunities for people to identify and overcome barriers to combat an important environmental problem, while simultaneously turning a class assignment into a life experience. At the same time, everyone gets personally involved, everyone gets the opportunity to critically and constructively review their effort, confirm and expand facilitating and limiting factors and identify areas of personal improvement, e.g. by using better existing competencies or developing new ones (Manolas and Littledyke 2010). In addition, the process discussed in this paper gives students opportunities to draw on and use historical, political, social, economic and scientific information on climate change as well as reflect on and discuss their perceptions and feelings about climate change and the future (Siperstein 2014).

The stages described contain different learning patterns by providing diverse modalities on how learning can occur. Also, students serve as models of improvement for one another while, at the same time such involvement increases each student's confidence regarding learning in both the cognitive and affective domains (Leal Filho et al. 2010).

The instructor's primary role has been to assist students select an appropriate experience, pose questions and problems, set boundaries, support students and facilitate the learning process (Association for Experiential Education 2016).

Given the potential of short stories in forming beliefs and behaviors the appearance of more stories should be welcome and so should the expansion of reading and writing short fiction in both formal and non-formal education.

References

Abrams MH (2016) A glossary of literary terms. http://www.ha-ka.dk/kf/short%20story%20characteristics.htm. Last accessed 16 May 2016

Arizona State University (2016) Climate fiction short story contest. https://climateimagination.asu.edu/clificontest/. Last accessed 20 May 2016

Association for Experiential Education (2016) What is experiential education? http://www.aee.org/index.php?option=com_content&view=article&id=110:what-isee&catid=20:other&Itemid=260. Last accessed 16 May 2016

Atwood M (2013) We must tackle climate change together. The Huffington Post, 12 Nov 2013. http://www.huffingtonpost.ca/margaret-atwood/atwood-climate-change_b_4256145.html. Last accessed 4 May 2016

Booklist Reviews (2011). January. Under the weather: stories about climate change http://catalog.youranswerplace.org/%28dnoom3jt5hk2fu45akyvgj55%29/NewCopyListing.aspx?QS0=&QS1=2&QS2=Short%20stories&QS3=1&QS4=2&QS5=0&QS6=99&QS7=0&QS8=9999&QS9=0&QS10=99&QS11=81776&QS12=1&QS13=1&QS14=778523&QS15=9781845079307#Annotations. Last accessed 6 Jun 2016

Brock KL (1999) Enlivening Political Science courses with Kolb's learning preference model. Political Science and Politics. http://www.findarticles.com/cf_0/ m2139/2_32/54895453/print.jhtml. Last accessed 10 Feb 2002

'Cli-fi' novels humanise the science of climate change—and leading authors are getting in on the act (2015) November 26. http://theconversation.com/cli-fi-novels-humanise-the-science-of-climate-change-and-leading-authors-are-getting-in-on-the-act-51270. Last accessed 12 May 2016

Collie J, Slater S (1991) Literature in the language classroom, 5th edn. Cambridge University Press, Glasgow

Cox A (2011) Introduction. In: Cox A (ed) Teaching the short story. Palgrave Macmillan, Basingstoke

Gow K (2012) How fiction impacts fact: the social impact of books. Fast Company, July 12. http://www.fastcompany.com/1842370/how-fiction-impacts-fact-social-impact-books. Last accessed 3 May 2016

Healey M, Jenkins A (2000) Kolb's experiential learning theory and its application in Geography in higher education. J Geogr 99(5):185–195

Kelly C (2002) David Kolb, The theory of experiential learning and ESL. February 11. http://www.aitech.ac.jp/~iteslj/Articles/Kelly-Experiential/. Last accessed 11 Feb 2002

Kennedy AL (2009) Small in a way that a bullet is small. In: Cox A (ed) The short story. Cambridge Scholars, Newcastle

Kolb DA (1984) Experiential learning: experience as the source of learning and development. Prentice-Hall, Englewood Cliffs

Leal Filho W (1998) Environmental education and communication: complementary tools for environmental management. In: Nath B, Hens L, Compton P, Devuyst D (eds) Environmental management in practice, vol I. Routledge, London

Leal Filho W, Pace P, Manolas E (2010) The contribution of education towards meeting the challenges of climate change. J Balt Sci Educ 9(2):142–155

Manolas EI, Kehagias TI (2005) Kolb's experiential learning model: enlivening Physics courses in primary education. In: Michaelides PG, Margetousaki A (eds) Proceedings of the 2nd International Conference on Hands-on Science. Rethymno, pp 286–289, 13–16 July

Manolas E, Littledyke M (2010) Enriching understanding and promoting responsible behaviour to combat climate change: a case study involving the use of Kolb's experiential learning model, In: Kalogiannakis M, Stavrou D, Michaelidis P (eds) Proceedings of the 7th International Conference on Hands-on Science. Rethymno, pp 131–137, 25–31 July

Masurel P (2011) I'm with the bears: short stories from a damaged planet. The short review. http://www.theshortreview.com/reviews/ImWiththeBearsShortStoriesfromaDamagedPlanet.htm

MIT (2016) Writing and reading short stories syllabus. http://ocw.mit.edu/courses/comparative-media-studies-writing/21w-755-writing-and-reading-short-stories-spring-2012/Syllabus/. Last accessed 11 May 2016

Moore R (2016) Climate fiction provides a window into our future—and ourselves. NRDC. February 1. https://www.nrdc.org/experts/rob-moore/climate-fiction-provides-window-our-future-and-ourselves. Last accessed 12 May 2016

Munteanu N (2014) Can environmental SF help save our planet? Amazing stories, February 27. http://amazingstoriesmag.com/2014/02/can-environmental-sf-help-save-planet/. Last accessed 28 Apr 2016

Oates JC (ed) (1992) The Oxford book of American short stories. The Oxford University Press, New York

Publishers Weekly (2011) I'm with the bears: short stories from a damaged planet. 14 November. http://www.publishersweekly.com/978-1-84467-744-3

Robinson A (2016) Highlighting the mistakes we are making: on the uses of climate change fiction. http://www.wheelercentre.com/notes/highlighting-the-mistakes-we-are-making-on-the-uses-of-climate-change-fiction. Last accessed 11 May 2016

Ruder PJ (2010) Teaching economics with short stories. AJEE 7(1):20–30

Siperstein S (2014) Climate change fiction: radical hope from an emerging genre. Ecofiction.com "wild words and worlds", September 25. http://eco-fiction.com/climate-change-fiction-radical-hope-from-an-emerging-genre/. Last accessed 25 Apr 2016

Siperstein S (2015) ENG 104: climate change fiction. https://blogs.uoregon.edu/eng104/syllabus/. Last accessed 11 May 2016

Tuhus-Dubrow R (2013) Cli-Fi: birth of a genre. Dissent. https://www.dissentmagazine.org/article/cli-fi-birth-of-a-genre. Last accessed 25 Apr 2016

Ullrich JK (2015) Climate fiction: can books save the planet? The Atlantic, August 2014. http://www.theatlantic.com/entertainment/archive/2015/08/climate-fiction-margaret-atwood-literature/400112/. Last accessed 6 May 2016

Zajaczkowska J (2015) Cli-fi: cinematic visions of climate change. http://www.contributoria.com/issue/2015-09/55a116d01d70d5336c000002/. Last accessed 4 May 2016

Zoref C (2014) Reading and writing the short story. New York University. http://gallatin.nyu.edu/content/dam/gallatin/documents/syllabi/2014/FA/WRTNG-UG1540.pdf. Last accessed 11 May 2016

Author Biography

Evangelos Manolas was born in Naxos, Greece, in 1961. He has received a Bachelor of Arts in Sociology from the University of Essex (1983), a Master of Arts in International Relations from the University of Kent at Canterbury (1985) and a Philosophy Doctorate from the University of Aberdeen (1989). He is Associate Professor of Sociology and Environmental-Forest Education in the Department of Forestry and Management of the Environment and Natural Resources, School of Agricultural and Forestry Sciences, Democritus University of Thrace, Orestiada, Greece.

Role of the Media in Climate Change Communication in the Northwest Region of Cameroon

Suiven John Paul Tume, Mbilam Samson Jumbam, Ndze Albert Nsoseka, Ngoran Divine Nyarka, Lawong Judith Yenla and Njodzeka Gilbert Njodzeka

1 Introduction: Some Facts About the Northwest Region of Cameroon

The Northwest Region is the third most populated region in Cameroon. It is located between 6° 20′ N–6° 33′ N and 10° 30′ E–10° 50′ E coordinates, with a surface area of about 17,300 km^2. The capital city is Bamenda. The region saw an increase in its population from about 1.2 million in 1987 to an estimate of 1.8 million in 2010 (Ngonga and Tume 2015). The population density of 99.12 pers./km^2 is higher than the national average of 22.6 pers./km^2. The urban growth rate is 7.95%, higher than the national average of 5.6%, while the rural growth rate is approximated at 1.16% (Lambi 2001). The region was created in 1972 with five administrative divisions—Bui, Donga-Mantung, Menchum, Mezam and Momo. Today, it has seven divisions

S. J. P. Tume (✉) · N. G. Njodzeka
Green Care Association, Shisong, P.O. Box 141, Kumbo, Northwest Region, Cameroon
e-mail: wantume@gmail.com

N. G. Njodzeka
e-mail: greencare@ymail.com

M. S. Jumbam
Faculty of Educational Sciences, University of Oslo-Norway, Oslo, Norway
e-mail: mbilamsamson@yahoo.com

N. A. Nsoseka
Kailan Foundation, Kumbo, Cameroon
e-mail: nsosekaalbert@gmail.com

N. D. Nyarka
Century College, St. Paul, MN, USA
e-mail: ngorandivine@yahoo.com

L. J. Yenla
Local Government Training Centre, Buea, P.O. Box 6, Buea, Southwest Region, Cameroon
e-mail: juyenla@yahoo.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_4

Fig. 1 Location of the Northwest Region of Cameroon. *Source* Wikipedia

(Fig. 1). The additions are Boyo—carved out of the Menchum and Ngoketunjia, split off from Mezam. Each division is further separated into sub-divisions. The basic unit of local government is the council. There are thirty-two councils in the region.

The Northwest Region of Cameroon is a part of the mountainous grassland savanna zone of Central and West Africa with the '*Aw*' climate type (tropical grassland). The high altitude farming zones with volcanic soils are rich in organic matter with an annual average rainfall of about 2500 mm. The area has great potentials for intensive agriculture (Molua and Lambi 2007). The government, Non-Governmental Organizations (NGOs), the media and socio-cultural groups have taken up initiatives to sensitise the population in the fight against climate change. For an ordinary farmer who lives in a rural area and for most people in town, the issue of climate change is not a strange phenomenon. The people relate their visible experiences of changing weather patterns to global warming. This makes them more engaged with the media in discussions that enable them to make sense of the perceived and visible changes. The fact that people speak about global warming all the times means that there is a new message circulating in society that changes the way people perceive the world and their relationship with the environment.

Cash flows from international donor organisations for many NGOs in the Northwest Region of Cameroon have shifted their policies to work on climate change related issues. Part of these projects are sensitisation and awareness campaigns in which people are discouraged from burning their land and cutting down trees (de Wit 2011). Moreover, at the grassroots level, planting trees has become an imperative in the call for thinking globally and acting locally. However, NGOs do not operate in isolation but rather jointly implement their activities. In November 2009, an association called Cameroon Traditional Rulers Against Climate Change (CAMTRACC) was launched. Inspired by the FAO of the United Nations, traditional rulers of the Northwest Region united to form a solid front at the grassroots level to fight against climate change.

2 Method of Study

In order to ascertain the role of the media in climate change communication, an ethical clearance was obtained from the Regional Delegation of Communication for the Northwest Region of Cameroon to survey media outlets. The instrument used was a questionnaire. A total of 28 media outlets composed of 25 radio stations and 3 newspapers were surveyed. The media outlets were asked to identify themselves by name, type (radio, television or print) and location town. They were also asked to specify their programs on climate as well as other programmes related to the environment. Again, the media outlets were asked how do you engage the public in communicating climate change issues and if the public receptive to climate change issues. Since climate change is linked to several aspects of the environment, another question was directed towards international environmental-related days. An additional question was on the use of social media in disseminating climate change information. The last question was on manifestations of climate change around the local environment. The responses were expressed as percentages and presented in tables. Some of the radio stations are not fully aware of all international days related to climate and the environment. This study therefore, is a sensitisation and outreach activity to inform them. A copy of the questionnaire was retained at each media house to keep them alert of all international days so that they can conduct more investigative journalism for objective reporting and raise more public awareness.

3 Drivers of Climate Change in the Northwest Region of Cameroon

Human activity has caused a variety of changes in different forcing agents in the atmosphere and land surface. A large number of greenhouse gases have increased over time from anthropogenic origin. Atmospheric aerosols have diverse and complex influences on the climate. Human activity has modified the land cover and changed the surface albedo. Some of the gases and aerosols are directly emitted to the atmosphere whereas others are secondary products from chemical reactions of emitted species. The lifetimes of these different forcing agents vary substantially (Myhre et al. 2013). Anthropogenic land cover change has a direct impact on the Earth radiation budget through a change in the surface albedo. It also impacts the climate through modifications in the surface roughness, latent heat flux and river runoff.

The landscape of the Northwest Region of Cameroon is dominated with remnants of gallery forests under the threat of overgrazing and unsustainable agricultural practices. These stunted highland vegetation is very resistant to prolonged droughts. Slash and burn farming method the destruction of soil organic matter which often leads to bush fires during the dry season. Bushfires can cause severe consequences for the environment including loss of vegetation and wildlife. These fires also cause changes to the atmosphere such as increased levels of CO_2 in the air through large volumes of smoke and ash and localised change in weather. The impact of bushfires on the people of the region is devastating. Some of the affects are lasting health problems, poverty resulting from loss of livelihood, rural exodus, social displacements in families, intra-and inter-community conflicts from competition over scarce natural resources and many other negative effects such as insufficient pasture for cattle. Cattle grazing is not only an environmental unfriendly activity in the Northwest Region of Cameroon. It triggers more pressure on stunted vegetation. Animals also destroy food crops, thereby intensifying farmer-grazier conflicts. This makes the Northwest Region of Cameroon highly vulnerable to climate change like most areas in sub-Sahara Africa.

Climate change-related impacts in the Northwest Region of Cameroon include temperature fluctuations from year to year, desiccation of natural habitats and more frequent droughts and floods. Such changes have a negative impact on agricultural production and food security. Similarly, the sustainability of some rural infrastructure would also be negatively impacted by climate change. The health of people in the area could be worsened by climate variability (drying up of water resources and flooding are closely related to an increase in water-borne diseases such as cholera).

Another driver of climate change in the Northwest Region of Cameroon is the '*water vampires*'—eucalyptus trees which many consider as '*environmental terrorists*'. Eucalyptus plantations have replaced the indigenous trees. They are used for fuel wood and electric and telecom transmission poles in Cameroon and beyond. Following the slumping of coffee prices in the 1980s, coffee plantations were cut down in favour of eucalyptus. The eucalyptus also provides revenue for plantation owners and municipal councils at the detriment of water resources and the environment. Other extremes of climate change in the Northwest Region are urban flooding in Bamenda, landslides, mudflows and rock falls emanating from heavy rainfall. Some of these local realities have been the erratic rainfall, especially the onset of rain at the beginning of the wet season and prolonged dry seasons. These variations in the climate have greatly disrupted the agricultural calendar. These climatic variations also have negative with multiplier effects like drying up of some annual springs, frequent droughts during the rainy season, increasing local temperatures, poor harvests of staple crops like maize, beans and Irish potatoes, incessant water crisis throughout the year, reduction in volumes of rivers, springs and other water bodies. These alterations constitute the climate change messages that these media houses broadcast.

Since 2012, Cameroon has a National Climate Change Action Plan (NCCAP) aimed at building the capacity of socio-economic actors to adjust to climate change (UNDP 2009; African Development Fund 2013; Egan 2013). A series of adaptation measures include:

- assessment of risk and vulnerability studies to identify the best intervention strategies
- sensitisation and training of traditional rulers (Fons, Chiefs, Aldors), mayors of municipal councils and farmers on environmental protection and climate change adaptation
- knowledge building on climate change adaptation by training many stakeholders
- promotion of improved stoves to ease pressure on wood resources
- increase in the proportion of reforestation of watersheds through analogue forestry
- rangeland improvement activities to reduce bush fires and consequently scale down greenhouse gas emissions.

4 Role of the Media in Climate Change Communication

The Fifth Assessment Report (AR5) of the Intergovernmental Panel on Climate Change (IPCC) is widely recognised by academics, journalists, communications experts, governments and civil society organizations to have marked strides in the approach the IPCC communicates its agenda (IPCC 2016). The communication of AR5 saw both greater professionalism at all stages of the process and greater breadth and diversity in the subsequent outreach accomplishments. The results of this can best be seen in the Paris Agreement of the United Nations Framework Convention on Climate Change (UNFCCC) reached at the Conference of Parties in December 2015 (COP-21). This agreement is based on assessments that the IPCC communicated to negotiators through the Structured Expert Dialogue and UNFCCC meetings. The IPCC has also experienced growing calls from policymakers and other users to do more with its communications. Some improvements to IPCC communications came not from the communications team but from the authors of AR5—the use of headlines statements in the Working Groups I, II & III contribution to AR5 and the Synthesis Reports. Other improvements for AR5 included:

- Responding to media questions before completion of the reports
- Media workshops to clarify the workings of the IPCC and how it produces assessments
- Making IPCC communications more professional by working with external communications specialists
- Media training for bureau members and authors
- Systematic planning of interviews with a range of authors, both face-to-face and remotely
- Arranging facilities for broadcasters
- Production of scientifically rigorous but compelling videos, overseen by the working group co-chairs and IPCC Chair
- Ambitious programme of outreach activities all over the world
- Cooperation with third parties producing versions of the report targeting specific sectors in specific regions
- Use of social media to publicise IPCC findings and outreach activities.

This gives the IPCC a strong foundation to build on for its future climate change communications.

In line with the IPCC, Change Communications, a not-for-profit and non-political organisation trained twenty community radio journalists from ten stations in the Northwest Region of Cameroon on the basic concepts of climate change and techniques of reporting it in March 2016. At the end of their training which held in Bamenda, they were expected to produce carefully tailored programs and professionally sound news reports on climate change issues in their respective localities. There is evidence that the information and messages contained in the programs produced so far are timely and useful for the public. Media houses in the Northwest Region of Cameroon produce a variety of climate-focused programs (71.42%) and other environmental-related programs (67.85%) (Table 1).

The public is receptive of these programs, though there is limited use of social media to fully engage the youth in climate change communication. Other stakeholders involved in the training of journalists on climate and environmental reporting in Cameroon include Media Synergy for the Promotion of Biodiversity Conservation and Community Development against Climate Change-Cameroon

Table 1 Climate—environmental focused programs in Northwest Cameroon

Item	Responses	
	% Yes	% No
Daily weather forecast	03.57	96.43
Climate-focused programs	71.42	28.58
Other environmental-related programs	67.85	32.15
Public perception of climate change messages	100.0	00.00
Use of social media to communicate climate change	42.85	57.15

Source Fieldwork, May–July 2016

(MECCOD), Ndop; Earth Journalism Network, Washington DC; Pan-African Parliamentarians Network on Climate Change; Climate Change Radio Network-Bamenda as well as the Pan-African Climate Justice Alliance (PACJA) amongst others.

The media houses in the Northwest Region of Cameroon have interactive programs on climate change and other environmental issues. During such live broadcasts, the public is engaged through phone-in and text messages to contribute to the issues at stake as well as to ask questions and get clarifications from the resource persons in the studios. This is an indication that the public is very receptive to climate change messages (Table 1). The radio stations broadcast a variety of climate and environmental related programs (Table 2). They have more than one climate and environmental related programs. The most popular of the programs is '*You and the Environment*'.

'*You and the Environment*' is aired by Stone FM Community Radio Ndop (Ngokentugia Division), Voice of Moghamo Batibo (Momo Division), Savannah Frontier Radio Ndu (Donga-Mantung Division), Radio Hot Cocoa Bamenda (Mezam Division), City Community Radio Kumbo (Bui Division) and Cameroon Baptist Radio Bamenda (Mezam Division). In addition, three radio stations—Cameroon Baptist Convention Radio Bamenda, City Community Radio Kumbo and Afoni Community Radio Tatum indicated that this program handles a variety of issues including climate change. Two stations—Savanna Frontier Network Nkambe and Savannah Frontier Radio Ndu, both in Donga-Mantung Division transmit programs entitled '*Climate Change*'.

Three newspapers—The GrassLander in Kumbo (Bui Division), The Eye (Mezam Division) and Eden Newspaper (Regional Bureau, Bamenda, Mezam Division) that participated in this investigation run columns—'*Environment and Agriculture*'; '*Climate Messenger*' and '*Green Corner*' respectively. The GrassLander also runs a '*Students*' *Corner*' where secondary students report activities of their schools' environmental clubs.

Other programs include '*Environmental Issues*' by Afoni Community Radio Tatum (Bui Division); '*Emergence*' through Renaissance Community Radio Ndu (Donga-Mantung Division); '*Our Environment*' via Donga-Mantung Community Radio Nkambe (Donga-Mantung Division); '*Environmental Education*' by Jakiri Community Radio (Bui Division); '*Farmers*' *Corner*' by Stone FM community Radio Ndop, Donga-Mantung Community Radio, Savanna Frontier Radio Network Nkambe, Savannah Frontier Radio Ndu and Renaissance Community Radio Ndu. '*The Green Environment*' is broadcast by Abakwa FM Bamenda (Mezam Division). *Reflections on Pope Francis*' *Laudato Si*' is a broadcast of the two Catholic radio stations—Radio Evangelium Bamenda (Mezam Division) and Radio Evangelium Kumbo (Bui Division). Three stations air programs on environmental conservation. These are '*Environmental Conservation*', '*Conserve Kilum Forest*' and '*Environmental Protection*' by Ndefcam Radio Bamenda (Mezam Division), Oku Rural Radio and Bui Community Radio (Bui Division) respectively.

Table 2 Climate—environment-related programs on the media in Northwest Cameroon

Media house	Climate program	Environment program
CRTV Northwest, Bamenda	Nature	Nature
Santa Meteo Radio	Climate and environmental slots	Climate and environmental slots
Ndefcam Radio, Bamenda	Environmental conservation	Environmental conservation
Cameroon Baptist Radio, Bamenda	You and the environment	You and the environment
Rush FM Radio, Bamenda	Daily weather forecast	–
Belo Community Radio	Water forum	My community and I, famine corner
Bui Community Radio, Kumbo	Environmental protection	Bui development forum
The GrassLander Newspaper, Kumbo	Environment and agriculture	Students' corner
Oku Rural Radio	Focus on our environment for our tomorrow	Conserve Kilum forest
City Community Radio, Kumbo	You and the environment	You and the environment
Afoni Community Radio, Tatum	Environmental issues	Environmental issues
Savannah Frontier Radio, Ndu	Climate change, you and your environment	Agriculture-our calling
Renaissance Community Radio, Ndu	Emergence	Apiculture, gardening, organic manure
Voice of Moghamo, Batibo	You and the environment	Water is life
Savanna Frontier Radio Network, Nkambe	Climate change	Farmers' corner
Donga-Mantung Community Radio, Nkambe	Our environment	Farmers' show
Radio Evangelium, Kumbo	Reflections on Pope Francis' *Laudato Si*'	Agricultural Training Program (ATP)
Jakiri Community Radio	Environmental Education	Farmers' corner
Stone FM Community Radio, Ndop	You and your environment,	Hygiene and sanitation, women and changing world, farmers' corner
Abakwa FM, Bamenda	The green environment	The green environment
Radio Hot Cocoa, Bamenda	You and the environment	You and the environment
Radio Evangelium, Bamenda	Reflections on Pope Francis' *Laudato Si*'	–

(continued)

Table 2 (continued)

Media house	Climate program	Environment program
The Eye	Climate messenger	Climate messenger
Eden Newspaper	Green corner	Green corner
Foundation Radio, Bamenda	–	–
Rainbow Radio, Mbengwi	–	–
Sky Sports Community Radio, Bamenda	–	–
Sky FM, Ndu	–	–

Source Fieldwork, May–July 2016

The regional radio station of the Cameroon Radio Television (CRTV) Northwest runs a weekly program—'*Nature*'. This program handles a cross section of environmental issues such as climate change, water resources, environmental impact assessment and urban waste disposal in the city of Bamenda amongst others. This is a weekly live-studio broadcast with resource persons to handle the themes for each program. The presenter of the program in collaboration with the Regional Delegations of Agriculture and Rural Development, Environment, Nature Protection and Sustainable Development carry out field investigations across the entire region on climate change vulnerability, mitigation and adaptation. CRTV Northwest also prepares and broadcast special packages for the following international days because they relate to climate and the environment: world water day, world meteorology day, earth day, international day for biological diversity, world environment day, world day to combat desertification and droughts, international day for the preservation of the ozone layer, world tourism day, world habitat day, international day for natural disaster reduction, world food day, world cities day, international day for prevention of the exploitation of the environment in armed conflicts and international mountains day. Although not all radio stations run programs on climate and the environment, they still have news items on these themes, especially during international days like world water day, earth day, world food day and others.

The media houses also assign their staff to carry out field investigations of some physical evidences of the changing climate. Some of these field investigations include degraded watersheds, drying water bodies, recurrent droughts in agricultural lands, especially at *hollow frontiers* (fertile agricultural lands where farmers move seasonally), unsustainable agricultural practices as well as other anthropogenic-driven environmental changes. In order to effectively pass across the messages, use is made of local languages and Pidgin English to communicate the effects of climate change based on local realities. The outcome of these field investigations culminate in the production of radio documentaries on local vulnerabilities and indigenous adaptations to climate change.

5 Limitations to Climate Change Communication

Climate change is a challenging issue to convey because the long-term average changes set in slowly and imperceptible (Moser and Dilling 2011). Changes in medium-term and long-run have emerged only recently from the daily, seasonal and inter-annual variations. In the same way, not all media houses in the Northwest Region of Cameroon are taking climate and environmental issues seriously. Some of these radio stations were hesitant to participate in the study with the argument that climate change is caused by industrial emissions in the developed countries.

Others who participated in the survey do not run any programs on climate change because of inadequate resource persons to tackle the subject and their inability to hire specialists in climate and environmental issues. These include Sky Sports Community Radio Bamenda, Rainbow Radio Mbengwi, Sky FM Ndu and Foundation Radio Bamenda (Table 2). Again, the general reporting on climate and environmental issues is inadequate (Table 3). Apart from world water day, world environment day and world food day, the rest of the international days related to climate and the environment are under-reported. One reason for this is that the media outlets do not know the dates which these international days are commemorated.

Table 3 Reporting climate and environmental international days

International day	Date	Freq	%
World water day	March 22	28	100.0
World meteorology day	March 23	03	10.71
Earth day	April 22	13	46.42
International day for biological diversity	May 22	06	21.42
World environment day	June 5	21	75.00
World oceans day	June 8	01	03.57
World day to combat desertification and droughts	June 17	11	39.28
International day for the preservation of the ozone layer	September 17	08	28.57
World tourism day	September 27	09	32.17
World habitat day	October 3	10	35.71
International day for natural disaster reduction	October 12	09	32.17
World food day	October 16	16	57.14
World cities day	October 31	04	14.28
International day for prevention of the exploitation of the environment in armed conflicts	November 6	08	28.57
International mountains day	December 11	03	10.71

Source Frequencies and percentages computed from field data (May–July 2016)

Some of the radio stations are not living up to expectation for the purpose for which they were created. For instance, Santa Meteo Radio (Mezam Division) does not broadcast daily weather forecast. They do not also know the date which world meteorology day is commemorated. However, they have news items on the risks of climate change from time to time. Santa Meteo Radio is only aware of world water day, international day for the preservation of the ozone layer and world food day.

Another shortcoming of the media houses is the mastery of the concept of climate change. A significant proportion of the staff in these media houses have limited knowledge of the science of climate and environmental change. Thus, there is need for capacity building and training. Other factors, especially policy options and resistance to change from indigenous communities come into play. Thus, for communication to be effective in leading to active engagement, it must be supported by policy, economic and change of mind-set of the people that will pave the way for the concerns and good intentions to be achieved.

6 Conclusions

Climate change communication is gaining grounds in the Northwest Region of Cameroon. All the media houses surveyed in this study are fully aware of the vulnerabilities and direct impacts of climate change around their local environment. Faced with these evidences, climate communicators have been engaging the public in the fight against climate change. First, they attempt to increase public understanding of the prevailing climatic and environmental conditions and provide more information on the assumption that knowledge is the major stumbling block to action. Second, they resort to fear tactics to motivate positive action, but often, this achieves the opposite effect. Third, they base climate change communication on the credibility of the authorities like the IPCC and other climate scientists. The local media insists and make it clear that their reporting is based on scientific framing of climate change as the most convincing story, irrespective of the differences among audiences. Finally, the local media in the Northwest Region of Cameroon try to reach the masses through traditional communication channels. Communication on climate change is only part of the picture. Raising awareness and discussing issues does not directly result in behaviour change or policy action.

Future Prospects There is need for more interactive radio programs on climate and the environment especially for the media houses that do not air such programs. Journalists need more capacity building and training on climate change and environmental reporting. Journalism clubs should be encouraged in schools where students can disseminate environmental issues to their peers. Radio quizzes should aired during all climate and environment related international days. Socio-cultural, religious gatherings like churches should be used as communication channels on the dangers of unsustainable activities like poor agricultural methods. During international days, sketches and poems should be used as a means to get across climate change messages. Hands-on-the ground projects like tree planting should be encouraged through communities and NGOs. Traditional address systems (*Town Cryer*) should be used to sensitize the rural populations on the dangers of their activities like overgrazing, slash and burn farming and bush fires. Newspapers have a duty to dedicate columns for climate and the environment. Use of local languages to reiterate causes of climate change, vulnerability and adaptation should be aired frequently through radio stations. Posters in public spaces on the dangers of climate should take precedence. Sensitisation and workshops at grassroots should be encouraged. The youth should be fully engaged in climate change communication through popular social media and community forums.

Acknowledgements We wish to thank Dr. Louise-Marie Bégné, (Regional Delegate of Communication for the Northwest Region of Cameroon) and Mr. Gilbert Fonyuy, (Regional Chief of Public Communication for the Northwest Region of Cameroon) who issued us an ethical clearance to collect data from media houses. We also acknowledge the media outlets that participated in this survey.

References

African Development Fund (2013) Grassfield, Rural Infrastructure And Participatory Development Support Project, Phase II. Grassfield Decentralized and Rural Development Project II. GP-DERUDEP II, Bamenda, p 9

de Wit S (2011) Global warning: an ethnography of the encounter of global and local climate change, discourses in the Bamenda Grassfields, Cameroon. African Studies Centre, Leiden, p 139

Egan A (2013) Knowledge management strategy on climate change adaptation for Cameroon. Ministry of the Environment, Protection of Nature and Sustainable Development, Yaoundé, Cameroon, pp 17–19

Intergovernmental Panel on Climate Change (IPCC) (2016) Meeting report of the intergovernmental panel on climate change expert meeting on communication. In: Lynn J, Araya M, Christophersen Ø, El Gizouli I, Hassol SJ, Konstantinidis EM, Mach KJ, Meyer LA, Tanabe K, Tignor M, Tshikalanke R, van Ypersele J-P (eds) World Meteorological Organization, Geneva, p 229

Lambi CM (2001) The impact of human activity on land degradation in some highland regions of cameroon: implications for development. Environmental issues: problems and prospects. Unique Printers, Bamenda, p 53

Molua EL, Lambi CM (2007) The economic impact of climate change on agriculture in Cameroon. Policy research working paper 4364, World Bank, Washington, DC, p 33

Moser SC, Dilling, L (2011) Communicating climate change: closing the science-action gap. In: Dryzek JS, Norggard RB, Schlosberg D (eds) The Oxford book of climate and society. Oxford University Press, Oxford, pp 161–174

Myhre G, Shindell D, Bréon F-M, Collins W, Fuglestvedt J, Huang J, Koch D, Lamarque J-F, Lee D, Mendoza B, Nakajima T, Robock A, Stephens G, Takemura T, Zhang H (2013) Anthropogenic and natural radiative forcing. Climate change 2013: the physical science basis. Contribution of working group I to the Fifth Assessment Report of the intergovernmental panel on climate change. In: Stocker TF, Qin D, Plattner G-K, Tignor M, Allen SK, Boschung J, Nauels A, Xia Y, Bex V, Midgley PM (eds) Cambridge University Press, Cambridge, United Kingdom and New York, NY, USA, pp 675, 686–687

Ngonga LN, Tume SJP (2015) Indicators of spontaneous settlements in Bamenda, Northwest Region of Cameroon. Afr J Soc Sci 6(4):97 Unique Printers, Bamenda

Northwest Region (Cameroon) (2016) https://en.wikipedia.org/wiki/Northwest_Region_(Cameroon). Accessed 25 Jun 2016

United Nations Development Program (UNDP) (2009) Supporting integrated and comprehensive approaches to climate change adaptation in Africa-Cameroon. Ministry of the Environment, Protection of Nature and Sustainable Development, Yaounde, p 101

Author Biographies

Suiven John Paul Tume has a first degree in Geography (2004), a postgraduate diploma in Education (2006) and master's degree in Geography (2008) all from the University of Buea. He is currently a Ph.D. research fellow working on indigenous adaptations to climate change in the agriculture and water sectors. He is a part-time instructor at the department of Geography and Environmental Studies of the Catholic University of Cameroon (CATUC), Bamenda. He has six publications in diverse subjects on climate change and the environment. He volunteers at Green Care Association, Shisong–Cameroon as a researcher on indigenous climate change adaptation.

Mbilam Samson Jumbam is a holder of a bachelor's degree in Philosophy from Saint Thomas Aquinas Major Seminary (STAMS), Bambui–Cameroon (Affiliate of Pontifical Urban University in Rome) in 2002. He also obtained Master of Philosophy in Education from the University of Oslo–Norway and a Master of Science in Diakonia and Christian Social Teaching from VID University College Oslo–Norway in 2016. His current research interest on climate change from the perspective of the social teachings of the Church in line with Pope Francis' *Laudato Si*'.

Ndze Albert Nsoseka has a bachelor's degree in Geography (2006) at the University of Buea and a double master's degree in Urban and Rural Geographic Space in 2010 and 2011 respectively. In 2010, he was a consultant with Geo-Spatial Technology group on forest resources management and inventory. Presently, he is the CEO of the Kailan Foundation Cameroon to promote local talents and development.

Ngoran Divine Nyarka has a bachelor's degree in Geography at the University of Buea in 2012 and a Diploma in Teaching Geography from the Higher Teachers' Training Centre of the University of Bamenda in 2015. He is presently studying at the Faculty of Health Sciences at Century College, White Bear Lake, Minnesota.

Lawong Judith Yenla has a first degree in Urban and Regional Planning (2000) at Ahmadou Bello University, Zaria–Nigeria and a master's degree in Geography (2009). At the University of Buea. She is a trainer at the Local Government Training Centre Buea, Cameroon and a part-time lecturer in the National Advanced School of Public Works, Annex-Buea. Her research is in the areas of land development control, land use planning, principles and techniques of town planning, strategic planning, management of council assets, public utility planning, town planning practice and management of road networks and infrastructures.

Njodzeka Gilbert Njodzeka has a Diploma in Tree Nursery and Soil Conservation in 1997 at Rural Training Centre Mfonta (RTC). He is the Coordinating Manager and Head of Project Development at Green Care Association, Shisong–Cameroon. He is a crusader in combating environmental degradation through tree planting, apiculture, water catchment protection, developing renewable energy and animal husbandry to non-conventional livestock. He has won several international awards such as Bui Family Union, New Jersey Chapter–Appreciation of Service, 2010; United Kingdom-Commonwealth Mid-Career Fellowship, 2010 and United Kingdom-World Environment Radio-First Prize, Best Feedback, 2008.

Rural Indonesian Insight on Mass Media Role in Reducing Climate Change Risk

Syarifah Aini Dalimunthe

1 Introduction

Climate change is anthropogenic—the product of a billions act of daily consumption. However, not everyone has heard of climate change, but changes in climate impact everyone. This research asked questions about people's perception of changes in temperature, rainfall, and extreme weather events over a 10-year period. Bostrom et al. (1994) report that many of their subjects had difficulty distinguished between weather and climate. In fact, media and communication can be used to help people respond to change across Indonesia. This empirical research has revealed numerous opportunities to help people respond to changes in climate using mass media and face-to-face communication.

In Indonesia, current communication about climate change is having an effect. However, awareness and understanding of climate change are higher in the major urban areas; that have received the most communication. Many people are not yet being reached with the information they understand and can use. These people, more often in rural areas, have lower access to information and are less likely to feel informed about how to respond to changes in climate.

This research had used a mixed method approach, including qualitative and quantitative methods, to understand people's perceptions of changes in climate and the environment as well as the impacts of these changes in their lives. The qualitative research included in-depth interviews with experts and opinion formers, audience focus groups, and community assessments in Blitar and Pacitan (East Java), Kapuas Hulu (West Kalimantan) and Pelalawan (Riau). The in-depth interviews were conducted with the principal experts and opinion-formers from the national and local government, the media, the private sector, civil society, science,

S. A. Dalimunthe (✉)
Research Center for Population, Indonesian Institute of Sciences (LIPI),
Gd. Widya Graha Lt. 7, Jakarta Selatan 12710, Indonesia
e-mail: syar008@lipi.go.id

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_5

and academia. Focus group participants were members of the public. At each location, focus group participants were selected according to age, gender, occupation, and social class to capture a diversity of views within the population. Initial insights from some of this research and the communication development process, which included workshops and an evaluation of existing initiatives, shaped the approach to quantitative studies.

This paper used 2832 respondents that were observed as representative of rural community across Indonesia. This sample out of 4985 Indonesia general respondents, which were surveyed by Climate Asia. People followed a stratified random sampling approach. First, the country's population was separated by province. In each province, regencies were randomly chosen. Within each regency, some sub-districts were selected from urban and rural areas following the probability proportionate to size (PPS) method. Within each location, households were randomly selected following the right-hand rule of field movement and five households were skipped after every successful interview.

2 Rural Indonesia and Changing Climate

This section does not include any comparison with existing meteorological or developmental records. The information on changing in weather and frequency of extreme weather event was based on people's observation benchmarking 10–15 years back from the time of interview. As a tropical maritime archipelago, Indonesia experiences high humidity and annual wet and dry seasons. Indonesia is also subject to bouts of extreme weather as a result of the effects of El Niño (associated with drought) and La Niña (associated with heavy rainfall and flooding), which occur periodically. The Intergovernmental Panel on Climate Change suggests that the region has experienced an increase of 0.1–0.3 °C per decade between 1951 and 2000 and has projected a temperature rise of 2.5 °C by 2100 for South East Asia (World Bank 2013). A recent report by the World Bank noted that Indonesia is expected to see an increase in temperature extremes and that Jakarta is projected to become 5–15% drier by 2080 between June and August (IPCC 2007). Precipitation patterns have been observed to change over Indonesia—broadly speaking there has been a decline in annual rainfall in the south and an increase in the north, although there have been local variations within this trend.

Across the country, people perceived changes in climate over the last ten years. Perceptions of change varied by region across this large and geographically diverse country. However, broad trends do emerge: just over half the population felt that temperatures have increased this. Precipitation patterns have been observed to change over Indonesia broadly speaking there has been a decline in annual rainfall in the south and an increase in the north, although there have been local variations within this trend.

To people living in Rural, the emerging broad trends were increasing temperature (88%), declining annual rainfall (69%), unpredictable season for the last ten years (54%), increasing extreme weather events (52%). The lack of predictability is affected preparedness among people in Kalimantan. Deforestation, development, and general human activity were seen as the reasons for the changes in temperature, rainfall, and extreme weather that people had noticed. They were also identified as causes of climate change. In-depth interview and community assessment found out how in the past four decades tropical forest have experienced major land-use changes. The forest area declined significantly, while the area used for agricultural production increased. In Kalimantan in particular, the land under oil palm was expanded considerably. Nowadays, Indonesia is the largest palm oil producer worldwide; the oil palm area increased from 0.7 million ha in 1990 to 6.5 million ha in 2012 (Copsey et al. 2013; Gatto et al. 2014). With a high number of a campaign to support the pledge in reducing climate change risk in Indonesia, 97% of the respondent reported they have heard about the term climate change. The frequent forest fire and flash flood coming regularly greatly intensified public fears about changing the climate.

3 Response Strategies

Human can respond to changing in climate trough one or a combination of the strategies adaptation. In response to closed question “what is the impact of changing the climate to your current life? What do you think the most effective action to response to it?” Response were classified into 10 categories. The respondent (64%) recall how changing in climate impact their ability to earn money. It means they must find an alternative to it.

From an FGD in Kenasau, a village within Danau Sentarum National Park (DNSP)—West Kalimantan, life has been getting hard. DNSP is an extensive area (132,000 ha) of freshwater lakes and low land swamp forest in West Kalimantan, Borneo, some 700 km up the Kapuas River from Pontianak. During the wet season, this lake stores a significant amount of water, and it can be up to 6–8 m deep but at the peak of the dry season, the lake is almost dry. Forest people unexceptionally hit hardest by changing climate. Their livelihood threatened.

People living in a rural area vulnerable as their livelihoods (farming and fishing) are dependent on the land. They will shift their livelihood off land or find the alternative (Fig. 1). Most of rural Indonesia make a living by growing rain feed paddy for their food security. At the same the people also catch fish form the river in the traditional way. Head of the household often leaves their family for a period. Become a temporary migrant to neighboring countries such as Malaysia and Brunei Darussalam. They employed in plantation and construction sites. The women with the handicraft-making skills trained by NGO, they expected to have extra cash while the man temporary leaving the country away.

The biggest concern after losing or alter livelihood was health. Of the people interviewed for this study, 77% felt that changes in climate were having an impact on their health. In focus groups, people linked respiratory problems to prolonged

No	Impact	Response	How response helps	Negative impacts of response
1	Longer rain season causes floods and inundated settlement for months	Handicraft production is potential	Alternative livelihood with the help of NGO brings in alternative income to the household.	-
		Villagers go fishing during high tide and farming during low tide	Provide uncertain instant cash	• Farmer ended up selling their crop and fish to middlemen. The middlemen offer lower prices than the market. • Uncertain income brings into the household has limited the chance to have access to credit/loan.
2	Unusual and longer dry season as a force to the abnormal cropping schedule.	Using fast-growing paddy variety to cope with the situation.	The mechanism provides cash for a short time.	Variety of crops is vulnerable to pest attack
		Rubber tapping and honey gathering	Obtaining cash more than farming activity.	The activity is highly weather dependent
		Temporary migration to Malaysia	Provide money to buy boat engine, to fish further away	• Illegal migration • The loss of young workforce • Forcing a woman to have work extra hour, doing a domestic activity, making handicraft and work at the paddy field. • Self-adaptation sometimes failed as job diversification not the kind of self-employed system in agriculture and fisheries.

Fig. 1 Impact and response in rural Indonesia. *Source* Primary data

dry seasons, and poor nutrition to failing crops. An increase in pests was also noted by 46% of people in the region, affecting not only crops but also disease.

4 New Messages to Lessen the Information Gap

Even the study show a high number of people heard the term climate change and aware of the current campaign, likely people having less ability to act if they are not aware of solutions to their problems. The national government is still struggling to come up with adequate responses to the impacts of climate change, making it all the most important that the little knowledge that is available be widely shared. Rural people felt the already media covers related issues—water, food, energy, extreme weather—well (78%) and tend to get information from television (92%) over other

	All	Male	Female	Larger cities	Smaller cities	Rural	Poor	Very poor
Base	4985	2469	2516	281	1872	2832	1518	1062
%	%	%	%	%	%	%	%	%
Television	93%	93%	93%	97%	97%	90%	93%	87%
Mobile	54%	56%	53%	77%	61%	47%	49%	35%
Newspaper	7%	8%	5%	15%	10%	4%	3%	2%
Radio	13%	13%	12%	13%	13%	12%	11%	11%
Internet	5%	6%	4%	14%	7%	2%	2%	1%

Fig. 2 Media use (yesterday or today). *Source* Primary data

media (Fig. 2). Television was both the most trusted media and the preferred way to receive information on climate and resource changes, followed by respected community members, local government and family and friends. This preference, however, varied by location type with larger cities more likely to prefer television and rural preferring respected community members. Surprisingly, despite a high level of social media use in Indonesia, less than 2% of people would like to have information delivered to them via the internet.

Some farmers asked for more reliable climate information and help in finding crops suitable for changing weather patterns. Many also expressed a desire for information that would assist them to maintain their livelihood or lifestyle as changes occurred.

There was a strong emphasis on the need for any communication to be engaging and entertaining. A television or radio talk show was suggested by some as the best format as it allowed experts to impart information and for the audience to participate.

> I have many questions if there is a phone number provided we can ask questions instead of the presenter asking them for us. You know … like when we request songs to the radio station (Man, 16–24, Pacitan).

People also suggested using a reality television show format to convey climate information. In Jakarta, a group of men explained that they thought reality television would be a good idea as it demonstrated to others the problems they were experiencing:

> A reporter would invite the viewers to explore the community. Viewers could see firsthand what sort of challenges and issues we face every day (Man, 35–44, Blitar).

Along with television formats, there was a strong desire for face to face communication. In some cases, this was because it allowed people to receive locally specific information, and in others, it was because it meant people could be assured the information was correct as it came from a professional or expert. Respondents also suggested providing training videos, featuring experts that provided step-by-step guidance on how to use new farming techniques.

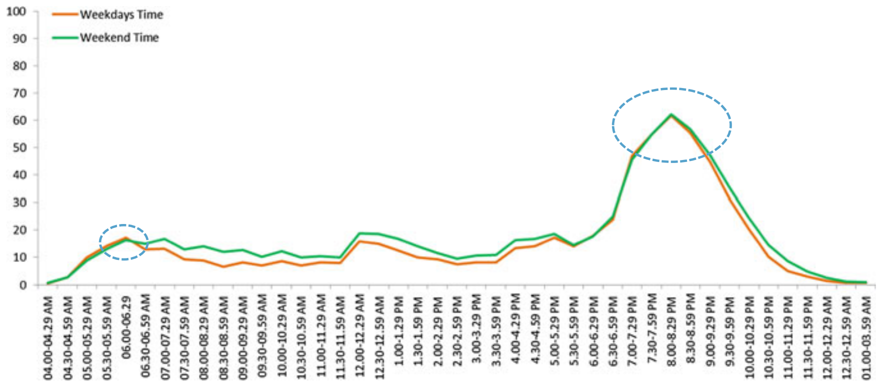


Fig. 3 Preferred television watching times. *Source* Primary data

> Since we do not have any idea of how to start [growing new crops], reading a book probably wouldn't do us much help. It would give us more assurance if we were able to talk with a real professional (Woman, 25–34, Langgam).

Television was the most popular type of media with over 9 in 10 Indonesians having watched it in the last day. Those who watched it mainly did so in their home (97%). Four national television stations, all Jakarta-based, shared audiences above 50 per cent including RCTI (watched by 77% of those who watched television), SCTV (68%), Trans7 (65%), Trans TV (60%) and Indosiar (54%) (Fig. 3). Satellite dishes were used mostly in rural areas, and outside of Java, where the signal for Jakarta-based channels would be difficult to receive otherwise. The news was popular viewing, with 87% of people who watched television saying they watched it, rising to 93% of people in larger cities. Meanwhile, drama and soap operas were particularly popular in rural areas (56% watched them compared with the national figure of 35%). Reality television shows were also popular (36%) as they showed people in different areas, with different lives, working together to solve problems. Within older groups, an emphasis on tradition emerged, and they wanted programming that reflected the traditions, culture and ethnic identities of Indonesia.

> Most of the village prefer to watch TV instead of listening to the radio, because we can see the picture, live. Moreover, TV is up to date for its news (Female, Blitar, 35–44).

5 Conclusion

Across the country, there is a pressing and immediate need to improve preparedness for extreme weather events. This presents an opportunity to communicate with people particularly rural community; to show them the importance of preparing and to equip them with new skills. Rural Indonesian are willing to make changes to their work and lifestyles to respond to climate change and feel a responsibility to do so. However, the decisions people need to make are complex, and it is important that they have enough information to make decisions for themselves and their communities.

Acknowledgements This article used data and framework of the Climate Asia report written by Tan Copsey, Syarifah Dalimunthe, Leonie Hoijtink, and Naomi Stoll. Indonesian Institute of Sciences provides funding to author attendance at the 16th conference of the Science Council Asia in Colombo, Sri Lanka.

References

Bostrom A, Morgan MG, Fischhoff B (1994) What do people know about climate change: model mental studies of lay opinion leaders. Risk Anal 30–35

Copsey T, Dalimunthe S, Hoijtink L, Stoll N (2013) Indonesia: how the people of Indonesia live with climate change and what communication can do. A country report by BBC Media Action’s Climate Asia project, London

Gatto M, Wolni M, Qaim M (2014) Oil palm boom and land-use dynamics in Indonesia: the role of policies and socioeconomic factors. Discussion paper series, Georg-August-Universität Göttingen, Gottingen

Intergovernmental Panel on Climate Change (2007) Summary for policymakers. In: Solomon S, Qin D, Manning M, Chen Z, Marquis M, Averyt KB, Tignor M, Miller HL (eds) Climate change 2007: the physical science basis. Contribution of working group I to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge and New York

Liverani, A (2009) Climate change and individual behaviour. Policy research working paper, The World Bank, New York

World Bank (2013) Turn down the heat: climate extremes, regional impacts, and the case for resilience: a report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics. World Bank, Washington, pp 66–72

Mapping Issues, Stakeholders and Actions on Youth Climate Change Communication in Indonesia for the Period 2008–2015

Emilia Bassar, Impron and Paramitha Yanindraputri

1 Introduction

Climate change can influence human and natural ecosystem, and may cause impacts —positive or negative—on nearly all development sectors. The level of impact severity varies between countries, depending on the condition of sociocultural, economic and biophysical environment. Therefore, the management of climate change must synergize the mitigation efforts to control the cause and adaptation efforts to manage risks and impact benefits.

The young generation is expected to be the leaders of tomorrow, especially in this time of climate urgency. The youth has a great potential as change agent in climate change management and preventive actions. Further benefits would arise by engaging the youth in the climate change policy- and decision-making processes, and in the high-impact climate actions.

As education, training and public awareness on climate change became the focus of Article 6 of the United Nations Framework Convention on Climate Change (UNFCCC 2012), it underlies the importance of young people to participate in tackling the climate change issues. The climate change communication, as an entry point of climate change awareness raising for the young generation, need to be delivered in ways easily understood by them. Climate communication for the youth

E. Bassar (✉)
Center for Public Relations Outreach and Communication (CPROCOM), Bogor, Indonesia
e-mail: emiliabassar@gmail.com

Impron
Department of Geophysics and Meteorology, Bogor Agricultural University (IPB), Bogor, Indonesia
e-mail: impron@gmail.com

P. Yanindraputri
Indonesian Association of Urban and Regional Planners, Jakarta, Indonesia
e-mail: yanindraputri@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_6

will effectively deploy if the communication agents are the young generation themselves. There are several climate communication actions that can be done by the youth, such as climate change campaign through social media. However, the youth movement on climate change issue is still limited, particularly in Indonesia.

Indonesia has potential to mobilize the youth in climate change management activities. According to law in Indonesia, youth is defined as the citizen between 16 and 30 years old (GOI 2009). The potential of the youth is enormous, considering Indonesia has experienced demographic bonus since 2012, with the youth at age between 16 and 30 years old estimated to reach 25% of the total population in 2015 (BPS 2013). In term of commitment under Article 6 of the UNFCCC and Article 2 of Paris Agreement, Indonesia has implemented various activities through education, training, public access to information, public awareness, public participation, and international cooperation (Bassar and Impron 2014).

The aims of this paper is to synthesize the lessons learned from several climate change communication activities for youth and by youth-focused organizations in Indonesia for the period 2008–2015. In this paper, the term of climate change communication is expanded to also cover activities that facilitate transfer and dialog on knowledge, understanding, and actions on climate change. The paper also map the issues, target audiences, using of medias, and type of climate change communication activities in two broad categories of capacity building and public awareness. The findings are expected to provide baseline to develop future strategies on climate change communication for youth in Indonesia.

2 Capacity Building and Awareness of Youth on Climate Change

Capacity building of youth on climate change could be enhanced through education and training. The main objective of climate change education is to generate a long term change of behavior (Supangat 2015), by applying various methods that promote a comprehensive learning process on climate change; and to encourage individuals to develop skills and expertise for the solution of climate change at local, national and global levels. In Indonesia, education is implemented through formal, non-formal or informal channels (GOI 2003). Climate change education will result in the change of people behavior to conduct mitigation and adaption actions. The process of climate change education and learning not only focuses on the increase of understanding in the climate system, climatology, climate change impacts, mitigation and/or adaptation of climate change, but also how it relates with, among others, social science, behavior, economy, and environment (Bassar and Impron 2014). Meanwhile, the purpose of climate change training is to instill specific and applicable knowledge and skills by applying methods that provide adequate knowledge and technical skills to deal with climate change (UNFCCC 2012).

It is important to integrated capacity building and public awareness activities to increase knowledge, skills and youth participation (real action) on climate change. Public awareness for youth and by youth-organization is categorized in three types: public awareness with various activities and media, public access to information, and public participation (UNFCCC 2012). The main purpose of public awareness is to reach and encourage immediate actions of individuals or collective; and also to ensure and motivate public action and contribution in handling climate change. Cooperation between stakeholders is also required to bring up the issue of climate change into public attention and to enhance public capacity in tackling climate change.

Public action is conducted by motivating contributions and actions in coping with climate change; supporting climate-friendly policy; providing opportunities for the public to influence their decisions in a democratic process; and encouraging change of behaviour, including through a variety of media. The government and relevant stakeholders must facilitate the public involvement in the process of decision-making and activities of climate change management through various ways, such as coordination meetings, public consultations, focus group discussion (FGD), and public debates (Bassar and Impron 2014).

3 Methodology

The research method used in this study consisted of a qualitative analysis with a review of secondary data and information collected from various sources.

The synthesis are mainly based on secondary data and information during 2008–2015 compiled from: (i) results of two surveys and ten interactive dialogs between 2011 and 2013 conducted by Indonesia National Council on Climate Change (DNPI), (ii) Indonesia National Strategy on Article 6 of the UNFCCC (Bassar and Impron 2014), and (iii) online media and media monitoring.

All data and information were qualitatively analyzed to map the issues, target audiences, using of medias, and type of climate change communication activities in two broad categories of capacity building and public awareness campaign.

4 Results and Analysis

4.1 Capacity Building on Climate Change for and by Youth

The data from Indonesia National Strategy on Article 6 of the UNFCCC (Bassar and Impron 2014) showed that in the formal curriculum at primary and secondary levels, education on climate change has been conducted through three main activities, namely:

1. Integrating climate change issue into a formal curriculum at Elementary Schools (*SD*), Junior High School (*SMP*), and Senior High School (*SMA*). As an example, in the Curriculum 2006 (known as competence-based curriculum/*KTSP*) and in Curriculum 2013 (replacing the *KTSP*), Ministry of Education and Culture of Indonesia (*Kemendikbud*) has included teaching on climate change in every primary and secondary education levels. In *KTSP*—under Joint Agreement between the Minister of Environment and Minister of Education and Culture[1]—climate change became a part of subjects on Environmental Education (*Pendidikan Lingkungan Hidup/PLH*). Whereas in Curriculum 2013, teaching on the climate change are integrated in various relevant subjects (Research and Development Agency Ministry of Education and Culture 2014). Cooperation between universities and NGOs, namely, University of Lampung (Unila) and Mercy Corps Indonesia, in integrating climate change material at schools through the textbook[2] on climate change curriculum material (University of Lampung 2014) for students and teachers of SD, SMP, and SMA in Bandar Lampung City. Seven thousand and five hundred textbooks were distributed freely to approximately 38 teachers and 1853 students. The printing of climate change textbooks was allocated in the Bandar Lampung City Government Budget (APBD) in year 2014 amounted to IDR 400 million.
2. Developing modules on climate change education for teachers and students. As an example, the Ministry of Education and Culture of Indonesia in collaboration with Indonesian Agency for Meteorology, Climatology and Geophysics (*Badan Meteorologi, Klimatologi dan Geofisika/BMKG*) since 2011 has prepared Module of Climate Change Curriculum for SD, SMP, and SMA[3] (BMKG

[1]Joint Agreement between the State Minister for Environment and Minister of National Education No. 03/MENLH/02/2010 and No. 01/II/KB/2010 concerning Environmental Education, Article 2 on the scope, stated that "development of the implementation of Education for Sustainable Development (ESD) including education on environment implemented on every channels, ranks and types of education as the vessel or facility in creating change of mindset, attitude and behavior of environmentally cultured human resources." Based on the agreement, Ministry of Environment formulated a design on curriculum of Environmental Education covering various issues, among others, global warming and climate change.

[2]Textbook on climate change is not a specific book, but materials containing several subjects for *SD* or *SMP* students. In those books some materials on climate change were inserted, adjusted with the core competence (*kompetensi inti/KI*) and basic competence (*kompetensi dasar/KD*) of the respective subject (http://www.unila.ac.id/buku-materi-iklim-dianggarkan-apbd-2014/).

[3]Preparation of teaching modules, teachers' guidelines, and training guidelines to integrate climate change education into Education Unit Level Curriculum (*KTSP*). The overall modules consist of 10 teaching models, (i.e.: *1*. Teaching Module of Integration of Climate Change Education for Elementary School (*SD*) at lower level (Grade 1–3), *2–4*. Teaching Module of Integration of Climate Change Education for Grade 4, Grade 5, and Grade 6 of SD, *5–7*. Teaching Module of Integration of Climate Change Education for Junior High School (*SMP*) Grade 7, Grade 8, and Grade 9, *8–10*. Teaching Module of Integration of Climate Change Education for Senior High School (*SMA*) Grade 10, Grade 11, Grade 12); 3 Teachers' Guidelines, (i.e.: *1–3*. Teacher Guidelines: Learning of Climate Change Education for *SD, SMP, SMA*); and 3 training guidelines

2013). Development of the modules was funded by Indonesia Climate Change Trust Fund (ICCTF).

3) Developing tools, materials and technology of climate change education, including through online-based system. As an example, British Council supported *Kemendikbud* in the application of educational integration on climate change in the curriculum for primary and secondary schools, through Climate4Classrooms[4] program (British Council and Royal Geographical Society 2014). The teaching materials consists of 12 modules for teachers and students that could be accessed freely in the website.

In some universities like Bogor Agricultural University (IPB) and Bandung Institute of Technology (ITB), it has undergraduate and postgraduate study programs focusing on climate science and applied science. In that particular programs, climate change issues are integrated into the subjects, for instance Climatology, Oceanography, Hydrology, Agronomy, Geography, Disaster Management, etc. (see Table 1). Through such integration, the understanding on responses to climate change of each sciences and development sector in regards to adaptation and mitigation has also been developed.

Centers of climate change study are already existed[5] in several universities, and in governmental and non-governmental institutions. The focus of study centers is

---

for trainers (i.e.: *1–3*. Training Guidelines for Trainers on Learning of Climate Change Education in *SD*, *SMP*, *SMA*).

(Source: Foreword of the Division Head of Research and Development of the Ministry of Education and Culture in Module of Climate Change for Junior High School (*SMP*), BMKG 2013).

[4]Climate4Classrooms are program of provision of knowledge and understanding on climate change, as part of the program on instilling values of Education for Sustainable Development. The teaching materials on environment and climate change were prepared by team of experts from the Royal Meterological Society and Royal Geographical Society, England. Integration of those materials into teaching subjects was conducted by the team from British Council in cooperation with *Widya Iswara* of *Kemdiknas* and consultants from Environmental Education Network. The targets of this program implementation are teachers of all teaching subjects from the level of kinderganten (*TK*) to *SMA*, students from the level of *TK* to *SMA*, related school principals, environmental education organizations. The number of schools already received training: 90 schools and 1312 teachers, and 45,360 students.

(Source: Listiawati 2013).

[5]Bogor Agricultural University (IPB): Centre for Climate Risk and Opportunity Management in Southeast Asia and Pacific (CCROM SEAP)—http://ccromseap.ipb.ac.id/; Bandung Institute of Technology (ITB): Center of Climate Change; University of Indonesia (UI): Research Center for Climate Change/RCCC UI—http://rccc.ui.ac.id/; Sepuluh Nopember Institute of Technology (ITS): Center of Earth, Disaster, and Climate Change Study; University of Mulawarman: Center of Climate Change Study; University of Mercu Buana (UMB): Center of Climate Change Study; Islamic University of Indonesia (UII): Center of Climate Change and Disaster Study—http://puspik.uii.ac.id/; University of Gunadarma: Center of Climate Change Adaptation and Disaster Mitigation Study; Ministry of Forestry: Research and Development Center for Climate Change and Policy—http://www.puspijak.org/; The Indonesia Climate Change Center (ICCC)—http://www.iccc-network.net/.

Table 1 Example of lessons learned of capacity building on climate change for youth in Indonesia

No.	Lessons learned of capacity building
A.	**Organized by Government Institutions**
1.	Ministry of Agriculture (*Kementerian Pertanian/Kementan*) a. Research Center for Agro-climate and Hydrology (*Balai Penelitian Agroklimat dan Hidrologi/Balitklimat*) of *Kementan* in cooperation with Indonesian Agency for Meteorology, Climatology and Geophysics (BMKG) held training on Climate Field School (*Sekolah Lapang Iklim/SLI*) in 25 provinces (150 regencies/cities) to enhance understanding on climate information and its utilization for farmers and young people in the villages (2008–2014)
2.	Ministry of Maritime and Fisheries Affairs (*Kementerian Kelautan dan Perikanan/KemenKP*) a. *KemenKP* in cooperation with UNESCO, *BMKG* and The National Council on Climate Change (*DNPI*) held Indonesia Coastal School (*Sekolah Pantai Indonesia/SPI*) for the students and public awareness of coastal management and development, as well as a briefing on the impact of climate change on coastal ecosystems (2013–2014)
3.	Ministry of Environment (*Kementerian Lingkungan Hidup/KemenLH*) a. Ministry of Environment in cooperation with The National Rover Scout Council (*Kwartir Nasional Gerakan Pramuka*), Provincial Environment Agency (*Badan Lingkungan Hidup/BLH*), non-government institutions, and private sector organized Kalpataru Scout Unit (*Pramuka Saka Kalpataru*) aiming to provide facilitation in education and training for *Pramuka Penegak* (16–20 Year Old Scout) and *Pramuka Pendega* (21–25 Year Old Scout) to channel interest and develop talent, ability and experience in knowledge and technology as well as skills, especially in which related to the substance of Environmental Protection and Management (PPLH). These knowledge and skills will be their livelihood asset to serve the community, state and nation. The Kalpataru Scout Unit in the early stage includes three sub-unit (*Krida*), namely: (1) 3Rs *Krida* (Reduce, Reuse, Recycle), (2) Climate Change *Krida*, and (3) Biodiversity Conservation *Krida* (2014)
4.	Indonesian Agency for Meteorology, Climatology and Geophysics (*Badan Meteorologi, Klimatologi dan Geofisika/BMKG*) a. Global Atmosphere Monitoring Stations (GAW) Bukit Kototabang *BMKG* of West Sumatra cooperated with University of Andalas and University of Padang for the use of Air Quality and Greenhouse Gas (GHG) laboratory GAW station for research, thesis and undergraduate and postgraduate student internships (2007–2014) b. School's field trip to Water Quality laboratory of *BMKG* to understand the effects and causes of climate change and global warming (2008–2014) c. *BMKG* published "Curriculum Modules on Climate Change" for Elementary School (*SD*), Junior High School (*SMP*), Senior High School (*SMA*) and marine vocational school (2011)
5.	The National Council on Climate Change (*Dewan Nasional Perubahan Iklim/DNPI*) a. *DNPI* in cooperation with other government institutions, regularly conducted various training with diverse topics, for instance, training on Calculation of Land-based Greenhouse Gas Emission and its Reporting Based on the Method of IPCC Guideline 2006; and Training on Climate Change and Tourism/Hospitality Sector for public and youth people (2008–2014) b. *DNPI* conducted *workshop* "The Use of Audio Visual Media *Bumiku (My Earth)* as Instructional Media for Dissemination of Climate Change" for students (2011)

(continued)

Table 1 (continued)

No.	Lessons learned of capacity building
B.	**Organized by NGO**
1.	Mercy Corps Indonesia a. Mercy Corps Indonesia conducted a training “Strengthening and Empowering Teachers and Student Capacities in Urban Climate Change Resilience (UCCR) in Bandar Lampung (Under Asian Cities Climate Change Resilience Network (ACCCRN) Program)” for teachers and students empowerment in increasing resilience to climate change in Bandar Lampung (2012–2014) b. Mercy Corps Indonesia held training on climate change adaptation (*adaptasi perubahan iklim/API*) for the students of Islamic boarding school (*pondok pesantren*) in West Sumatra Province (2012) c. Mercy Corps Indonesia in cooperation with University of Lampung (Unila) held training on preparation of the implementation on city resilience curriculum to climate change intended to improve the understanding of teachers and students to the impact of climate change and adaptive capacity of the understanding reflected by the attitude and behavior of students. As many as 40 Teachers of *SD* and *SMP* in Bandar Lampung attended training on the preparation of curriculum implementation on city resilience to climate change, initiated by Unila and ACCCRN Mercy Corps Indonesia (2011–2014) (University of Lampung 2012)
2.	Institution of Prof. Dr. Soepomo (*Lembaga Prof. Dr. Soepomo/LPDS*) a. *LPDS* in cooperation with The Norwegian Embassy organized the “Climate Change Writing Clinic” for students and academics communities (2011)
3.	Hijauku.com a. The first green portal in Indonesia established in 2011, hijauku.com, organized Climate Change Class (*Kelas Perubahan Iklim/KPI*) and Climate Change Training (*Pelatihan Perubahan Iklim/PPI*). These training combined climate change campaigns in social media by utilizing social media network of Hijauku.com which currently reached 77,000 persons and direct training action with target community users of social media, students, college students and public. During the period of 2011–2014, Climate Change Class has succeeded to provide training on climate change to more than 600 participants in *Jabodetabek* area (Jakarta, Bogor, Depok, Tangerang, and Bekasi) areas with the majority of participants were students and college students in accordance with the target of communication media used (2011–2015)
C.	**Organized by Education Institutions**
1.	Bogor Agricultural University (*Institut Pertanian Bogor/IPB*) a. In *IPB*, there are Study Program on Applied Meteorology (for Bachelor Degree/*S1*) and Study Program on Applied Climatology (for Master Degree/*S2* and Doctoral Degree/*S3*) that offer compulsory and elective subjects related to climate change. For examples, the Applied Meteorology offers Subjects of Climatology, Meteorology, Climate Change Science, and Climate and Environment; while the Applied Climatology offers Subjects of Analysis of Global Climate Change, Climate Change Impacts, Vulnerability and Adaptation, and Climate Modeling. Starting in Academic Year 2014/2015, Applied Climatology Study Program offers three specialization (minor), namely; (1) Agroclimatology (2) Climatological Modeling, and (3) Climate and Development; where compulsory and elective subjects are closely related to climate change science, adaptation and mitigation as well as climate change management b. Centre for Climate Risk and Opportunity Management in Southeast Asia and Pacific (CCROM-SEAP in Bogor Agricultural University) has focus research area on the development impact of climate variability and climate change. CCROM-SEAP has done

(continued)

Table 1 (continued)

No.	Lessons learned of capacity building
	various joint-research, one of them targeted youth and held through international cooperation "Columbia University and IPB Partnership to Build Capacity for Adaptation Climate Risk in Indonesia" (2012–2015)
2.	Bandung Institute of Technology (*Institut Teknologi Bandung/ITB*) a. In *ITB*, there are Study Program of Meteorology (for Bachelor Degree/*S1*), and Earth Sciences with Special Field of Atmospheric Science (for Master Degree/*S2* and Doctoral Degree/*S3*). The Study Program of Meteorology offers compulsory subject: Capita Selecta of Meteorology, and elective subjects: Climate Change and Climate Policy. The Atmospheric Science offers subject of Climate Modeling, Policy and Climate Change, and Atmospheric Modeling (Faculty of Earth Sciences and Technology Bandung Institute of Technology 2013a, b, c)
3.	British Council a. British Council and Ministry of National Education (*Kementerian Pendidikan Nasional/-Kemendiknas*) held a Climate4Classrooms (C4C) with the emphasis on climate change awareness for students starting from Elementary School (*SD*) to Senior High School (*SMA*). There are two C4C teaching materials for Indonesia. First, the online material compiled by the British Council, Royal Geographical Society (RGS), and the Royal Meteorological Society (RMeS) England. The second material, compiled by the British Council together with Ministry of National Education *(Kemendiknas*) that involved the teachers from kindergarten level to high school level (2010–2014)
4.	University of Lampung (Unila) a. *Unila* has successfully supported SMP Negeri 7 Bandar Lampung and SD Negeri 1 Langkapura to integrate the materials on climate change adaptation into the learning materials and student activities. The two schools were awarded by Adiwiyata Award of year 2013. SMPN 7 Bandar Lampung and SD Negeri 1 Langkapura were two of the four fostered schools of Unila that have implemented educational curriculum on climate change which was a cooperation between Government of Bandar Lampung City and Unila (2013) (University of Lampung 2013)
D.	**Organized by Private Sectors**
1.	PT Pertamina (Persero) a. PT Pertamina (Persero) in partnership with Task Force of Reducing Emission from Deforestation and Forest Degradation Plus (*Satuan Tugas/Satgas* REDD+) has founded *Sekolah Sobat Bumi* (Friend of Earth School) in 2011 intended to build characters of school community to care about the environment through four programs, i.e. (1) small scale practices on the utilization of renewable energy; (2) efficiency on the utilization of fossil energy; (3) management of waste from school, canteen and school environmental, trees planting; and (4) efforts to optimize the use of environmentally friendly transportation (2011–2015)

Source Bassar and Impron (2014). And other resources

mostly on cooperation of research, survey and training activities. Many academic staffs are involved in the study centers, so that the activity results can be utilized for the development of climate change education in Indonesia, especially which are related to local issues. Besides, the study centers help educational activities through research, training and internship.

Since year 2008–2015, various institutions—government institutions, NGOs, educations institutions, and private sectors—have conducted capacity building on climate change with the themes/topics of: (1) climate system; (2) climatology; (3) climate change impacts; (4) mitigation and adaptation of climate change; (5) calculation of land-based greenhouse gas emission; (6) climate change on coastal management and development; (7) climate change impact on coastal ecosystems; (8) urban climate change resilience; (9) climate change and tourism/hospitality sector; (10) biodiversity conservation; (11) trees planting; (12) waste management; (13) renewable energy; (14) efficiency on the utilization of fossil energy; and (15) the use of environmentally friendly transportation. While, the method and media of capacity building for and/by youth in general are: (1) training; (2) workshop; (3) teaching clinic; (4) field trip; (5) module; (6) film, (7) farmer school; and (8) coastal/fishermen school.

4.2 Public Awareness of Youth on Climate Change

Contributions and actions of youth in coping with climate change can be realized, among others, by way of supporting the climate friendly policy and by encouraging a change of behavior, through various media (see Table 2). In general, public awareness of youth on climate change covers the following issues: (1) global warming; (2) climate change impacts; (3) climate change solutions—mitigation and adaptation; (4) greenhouse gas emissions reduction; (5) environmental management, such as tree planting, mangrove planting, waste management; (6) ecosystem management; and (7) biodiversity conservation.

Specifically, various activities of public awareness intended for children, students or youth, come in various forms, among others are: (1) climate change socialization, i.e.: interactive dialog, youth forum on climate change, seminars, workshops, international conferences; (2) field trip; (3) youth camps; (4) competition on climate change, i.e.: debate competitions, writing contests, poster competitions; (5) short film screenings; (6) exhibition or expo; and (7) survey or polling public campaigns.

Based on available information and data, it is known that public can access various scientific data/information/publication concerning climate change, both popular and technical, through print media (such as books, journals, newspapers), proceedings, electronic media (such as radio, television), internet, social media, and film production. There were some public awareness activities using face-to-face communication aimed to inform, educate and encourage young people to perform real action on climate change.

One of the methods for public awareness raising is by facilitating community involvement in the process of decision making and in the activities of climate

Table 2 Example of lessons learned of public awareness on climate change for youth in Indonesia

No.	Lessons Learned of Public Awareness
A.	**Organized by Government Institutions**
1.	Ministry of Environment (*Kementerian Lingkungan Hidup/KemenLH*) a. *KemenLH* held "National Environmental Debate (NED) (Anak UI 2008) on Climate Change". This debate competition at national level with orientation on environmental issues was expected to increase concern in preserving the environment through critical thinking of the young generation of Indonesia (2008) b. *KemenLH* in cooperation with government institutions held "Indonesia Climate Change Education Forum and Expo (ICCEFE)" in Jakarta with various activities, such as: exhibition, school's field trip, interactive dialog, youth forum on climate change, creativity competition on climate change solutions, and film parade on climate change (2012–2015)
2.	Ministry of Youth and Sports Affairs (*Kementerian Pemuda dan Olahraga/Kemenpora*) a. *Kemenpora* arranged International Youth Conference (IYC) in Yogyakarta in which youth-participants discuss the issues of climate change and global warming in order to contribute to tackling climate change (2011) (Grehenson 2011)
3.	Indonesian Agency for Meteorology, Climatology and Geophysics (*Badan Meteorologi, Klimatologi dan Geofisika/BMKG*) a. *BMKG* in cooperation with Indonesia Climate Change Trust Fund (ICCTF) produced a pocket book "Adaptation and Mitigation on Climate Change in Indonesia" for students, fisheries and farmer (2011) b. *BMKG* held Sports and Arts Week in commemoration of World Meteorological Day with the theme of "Weather and Climate: Engaging Youth" to encourage young people to care about the environment. These activities are participated by students, which also includes the journalism and scientific short story competition in weather and climate theme (2014) (Tety 2014)
4.	The National Council on Climate Change (*Dewan Nasional Perubahan Iklim/DNPI*) a. *DNPI* disseminated information of climate change through website, blog, Facebook, twitter, Flickr, LinkedIn, and YouTube for general public and young people (2008–2014) b. *DNPI* produced short films or documentary films with duration of 24–40 min every year (since 2009) to socialize and provide education on climate change. The documentary film "*Lakukan Sekarang Juga*" or "Do It Now" (2009) provides information on the evidences that climate change has happened in Indonesia; impacts of climate change; and also adaptation and mitigation efforts that can be conducted by society and individuals. Documentary film "*Perubahan Iklim di Halaman Kita*" or "Climate Change in Our Yard" (2010) illustrates the efforts of public in Jakarta, Papua and Sulawesi in adapting to climate change. Children movie "*Bumiku*" or "My Earth" (2011) and teenage movie "*Senandung Bumi*" or "Earth Hum" (2012) provides understanding on climate change; adaptation and mitigations measures that can be conducted in everyday life; and concerns toward environment (2009–2014) c. *DNPI* held Youth for Climate Camp for high school and college students with variety of themes and locations which includes "One Land One Homeland, Indonesia" in Sawangan, West Java (2011), "Inherit the spirit of Heroism in Climate Change Era" in Sawangan, West Java (2012), "Establish Togetherness in the Middle of Climate Change" in Cibubur, Jakarta (2013), "Youth Harmonization in the response to Climate Change" in Bogor, West Java (2014), "Agriculture and Climate Change" in Prigen

(continued)

Table 2 (continued)

No.	Lessons Learned of Public Awareness
	(2015), "Local Food and Climate Change" in Bali (2015), "Maritime and Climate Change" in Makassar, South Sulawesi (2015) (YFCC 2016) d. *DNPI* held national survey in year 2011 and 2013 theme "Climate Change Awareness" in 27 Provinces in Indonesia for public and youth which indicated that people understood the process and impact of climate change; they supported and were committed to deal with/control climate change in Indonesia; and it required socialization activities which is continuous, sustainable, and consistent to enhance public awareness and knowledge, as well as actions conducted by society and individuals (2011 and 2013)
B.	**Organized by NGO**
1.	World Wide Fund for Nature (WWF) a. Since 2009, WWF has been campaigning "Earth Hour" to urge people to have a living style which is energy saving and low emission. "Earth Hour" is a global climate change campaign of WWF done by turning off the lights for an hour as a statement of supporting the efforts to cope with climate change. In 2014, community support for "Earth Hour" program increased to 37 cities in Indonesia–making Indonesia as the biggest community-based "Earth Hour" movement in the world (2009–2015)
2.	Tunas Hijau a. Tunas Hijau attended "International Children and Youth Conference Brazil 2010" organized by the Ministry of Education of Brazil. The goal of this event is for all children and youth in the world has a real commitment to participate in saving the environment (2010) (Tunas Hijau 2010)
3.	Plan International Indonesia a. Since the year 2011, Plan International Indonesia has conducted implementation of climate change adaptation project focusing on children referred to as Child Centered Climate Change Adaptation (4CA). This project intended to create a safe and strong community where children and young people contribute to manage and mitigate risks related to climate change and disasters. Through 4CA project, Plan International Indonesia in year 2013 conducted National Poster Competition on "Children and Climate Change" for children aged 10–18 years (2011–2014)
4.	World Assembly of Youth (WAY) and Indonesian Youth National Committee (*Komite Nasional Pemuda Indonesia/KNPI*) a. WAY in cooperation with *KNPI* conducted "International Youth Forum on Climate Change 2011" event which comprised of (1) International Conferences that consisted of seminar and focus group discussion (FGD); (2) International Youth Forum on Climate Change 2011 namely Field Research in Tanjung Putting—Central Kalimantan, Takabonerate—South Sulawesi and Komodo Island—Nusa Tenggara Timur; and (3) International Youth Movement on Climate Change Declaration. This event was bundled with Youth Greenstration Lab Exhibition (2011) (Pangerang 2011)
C.	**Organized by Education Institutions**
1.	British Council a. British Council organized School Climate Challenge Competition "Developing Climate Solutions within School Communities" in the form of competition which aimed to promote high school teachers and students in Indonesia to initiate project which are innovative, creative, sustainable, and particularly contribute to climate change solution and have economic benefits for the schools and community. This school based initiative, was expected to encourage greater climate change action in the community (2009)

(continued)

Table 2 (continued)

No.	Lessons Learned of Public Awareness
2.	Bandung Institute of Technology (*Institut Teknologi Bandung/ITB*) Students a. *ITB* Students held Indonesia Youth for Climate Change (IYCC) in year 2010
3.	Bogor Agricultural Institute (*Institut Pertanian Bogor/IPB*) a. *IPB* organized IAAS National Seminar "Youth in Green Attitude on Climate Change" for the youth. This event aimed to motivate environmental-wise habitual changes of the young generation (2011)
4.	Research Center for Climate Change of University of Indonesia (RCCC UI) a. RCCC UI conducted program development "Petualang Alam" or "Nature Adventure"to engage children to be closer with nature and introduce them to climate change issue (2014)
5.	Student Executive Agency of Sepuluh Nopember Institute of Technology (Badan Eksekutif *Institut Teknologi Sepuluh November/BEM ITS*) a. *BEM ITS* conducted Youth Environmental Leader Summit which includes forum, workshop, mangrove planting action, beach cleaning to create youth cadres who have concern in environment issues (2013)
6.	Environment Health Student Association, Faculty of Public Health, University of Indonesia (*Asosiasi Mahasiswa Kesehatan Lingkungan UI*) a. *Asosiasi Mahasiswa Kesehatan Lingkungan UI* arranged "Ever Green Festival" in the form of plastic bag used by students and UI community exchange with reusable bag, 3Rs products exhibition, tree planting action, and national environment health seminar with the theme "Climate Change Mitigation and Adaptation Effort in Health Impact" (2014)
7.	Climate Change Championship Club London School of Public Relations (LSPR) a. Climate Change Championship Club LSPR conducted Heart Ocean "Sea Coral Planting and Clean Up The Beach in the form of coral planting action and beach cleaning (2014)

Source Bassar and Impron (2014). And other resources

change actions. To some extend, the government could mobilize the community, ensuring that they are actively involved in the actions and decision-making on climate change.

4.3 Strategic Design on Capacity Building and Public Awareness

We have shown that the number of capacity building and public awareness activities have been implemented in Indonesia for the period 2008–2015. By elaborating these previous activities, the following strategic on capacity building and public awareness for and by youth people in Indonesia (see Table 3) is considered as suitable for future direction in Indonesia.

Table 3 Element of strategic design on capacity building and public awareness considered suitable for youth in Indonesia

Objective	Current condition	Strategic plan	Method/media
Capacity building			
To integrate climate change into the curriculum of primary and secondary education level	• Under current formal national curriculum, there is no dedicated teaching subject on climate change • Integration of climate change into the curriculum is through lessons/teaching subjects, but the integration is still limited	• Integrating climate change issues into formal curriculum at primary and secondary education levels • Strengthening of climate change learning system at primary and secondary education level, formal, non formal or informal	• Develop educational modules of climate change for trainers, teachers and students • Develop tools, materials, and technology of climate change education, including the website based
To develop Study Program (*PS*) on climate change at university level	• In several universities, climate change has already been taught as a subject or integrated as a part of a subject • At undergraduate level (*S1*) and postgraduate level (S2/S3) climate change subject as a part of the curriculum structure of the already existing *PS*; e.g. Applied Meteorology (S1) and Applied Climatology (S2/S3) Study Programs at Bogor Agricultural University (IPB); and Meteorology (S1) and Earth Sciences Study Program for S2/S3 with minor Atmospheric Sciences at Bandung Institute of Technology (ITB)	• Development of multilevel curriculum on Climate Change Study Program (especially at S2, S3 level)	• Develop curriculum, tools, materials, and technology of climate change, including the website based
To develop quality teaching and learning materials made and available for teachers/lecturers and students in sufficient number to support the	• Climate change teaching and learning materials available, among others in the form of modules with diverse quality and contents	• Development of teaching and learning materials on quality climate change in accordance with the level and channel of education	• Information access of teaching and learning materials through various media

(continued)

Table 3 (continued)

Objective	Current condition	Strategic plan	Method/media
process of teaching and learning according to the education level	• Limited availability and ease of access to teaching and learning material	• Increase of availability and access to quality teaching and learning materials of climate change	
To ensure availability and easy access to quality training materials according to the target groups in various priority sectors	• Various trainings have been implemented, but not fully based on identification of training type needs in various target groups and priority sectors • Various training materials already available, but availability and ease of access to the training materials still limited	• Development of training modules with specific topic to various target groups in priority sectors	• Information access of training materials through various media • Training or workshop • Field school
Public awareness			
To raise and foster-grow public awareness of youth on climate change	• Empirical observation showed that there were not many youth aware of climate change problems	• Development of programs/activities of climate change public awareness integrated with follow-up of real actions	• Socialization or public campaign • Seminars, conferences, talk show, interactive dialog, or Focus Group Discussions (FGDs) • Debate competition or writing competition • Film screening • Radio/television shows • Exhibition • Music concerts • Youth camp • Survey or polling
To enhance active participation of youth in various forms of actions for climate change management	• Lack of youth people attendance or representation in the activities within the scope of public awareness element • Youth already participated in various activities, such as planting/maintaining	• Attendance or representation of youth people in public awareness activities still need to be improved • Strengthening of the roles of youth leaders in various activities of climate change management	• Develop a forum for formal and non-formal youth leaders in the management of climate change • Coordinate meeting, FGDs, or public debate

(continued)

Table 3 (continued)

Objective	Current condition	Strategic plan	Method/media
	mangroves, trees, coral reefs; waste management; and campaigning the energy-savings and low-emission life style • Youth leaders and/or local champion already strengthened their spirit to conduct real actions in tackling climate change		• Sending youth delegates to COP UNFCCC • Planting/maintaining trees, mangrove or coral reefs
Utilize diverse media in public awareness activities to reach different target groups of youth	• Diverse communication media that existed have not been utilized optimally to reach different target groups of youth	• Enhancement of the utilization of diverse media, including social media, alternative media and traditional media to reach different target groups	• Provision of data/-information/popular and technical scientific publication through mass media and internet • E-book and e-journal on climate change • Film production
To enhance availability and ease of access to information on climate change and its management in priority sectors	• Official data and information from the government were placed at the highest position of importance as they were used as the base for decision making associated with the lives of many people; however, the availability and access to information on climate change were still limited	• Increase availability and access of various information products, print or digital, to reach out various youth groups	• Provision of data/-information/popular and technical scientific publication through mass media and internet • E-book and e-journal on climate change • Film production

Source Bassar and Impron (2014). And writers' analysis

5 Conclusion

During the period of 2008–2015, many institutions—e.g. government offices, NGOs, universities, research centers, private companies—have implemented some activities in climate change communications that serve as means for increasing capacity building and public awareness in climate change for and by youth in Indonesia. Youth has also already participated in the actions of climate change management, for example, by getting involved in the activities of planting/

maintaining mangroves, trees and coral reefs; waste management; and in campaigning energy-savings and low-emission life style.

Much progress has been achieved in climate change education in Indonesia at every level of formal education, namely in the forms of: (1) development of curriculum; (2) development of teaching and learning materials; (3) capacity building of the educators; and (4) capacity building of higher education and research center institutions. Non-formal education has also organized various capacity building activities to enhance the knowledge as well as specific and applicative skills by applying method that provides technical skills and sufficient knowledge to deal with climate change.

Climate change training is important to build capacity of human resources and to transfer technology and knowledge. Training activities in various forms such as workshop, training, counseling, and field school have been implemented through local, regional, bilateral and multilateral cooperation, or through partnership between government and private sectors involving donors and NGOs. Training materials of climate change were diverse, consisted among others: actions of climate change mitigation and adaptation, carbon emission reduction, coastal areas governance, transfer of technology, social and economic impacts from climate change, and development of curriculum and modules of climate change.

Climate change capacity building and public awareness for and by youth people in Indonesia are still need to be enhanced. Enhancement of capacity building on climate change could include the following strategies: integrating climate change into formal education curricula, developing teaching and learning materials, increasing availability and access to quality teaching and learning materials of climate change, and developing training modules with specific topic to various target groups in priority sectors. While public awareness on climate change could be enhanced by the following strategies: developing programs/activities of climate change public awareness integrated with follow-up of real actions, increasing the representation of youth in public awareness activities, strengthening of the roles of youth leaders in various activities of climate change management, enhancing utilization of diverse media to reach different target groups, and increasing availability and access of various information products to reach out various youth groups.

References

Anak UI (2008) EDS UI: Juara Nasional dalam National Environmental English Debating (NED) Competition 2008. www.anakui.com. Available at: http://www.anakui.com/2008/12/31/eds-ui-juara-nasional-dalam-national-environmental-english-debating-ned-competition-2008/#.V-i9T_B97IU [Last accessed 26 July 2016]

Badan Pusat Statistik Indonesia (2013) Proyeksi Penduduk Indonesia/Indonesia Population Projection 2010–2035, Jakarta

Bassar E, Impron (2014) National strategy on article 6 of the UNFCCC. Dewan Nasional Perubahan Iklim (DNPI) and Japan International Cooperation Agency (JICA), Jakarta, p 91

BMKG (2013) Modul Perubahan Iklim untuk Sekolah Menengah Pertama (SMP). BMKG, Jakarta

British Council and Royal Geographical Society (2014) Climate4Classroom. British council. Available at: http://id.climate4classrooms.org/ [Last accessed 12 April 2014]
Earth Science and Technology Faculty Bandung Institute of Technology (2013a) Kurikulum ITB 2013–2018 Program Doktor Program Studi Sains Kebumian Fakultas Ilmu dan Teknologi Kebumian. Bandung Institute of Technology, pp 1–27
Earth Science and Technology Faculty Bandung Institute of Technology (2013b) Kurikulum ITB 2013–2018 Program Magister Program Studi Sains Kebumian Fakultas Ilmu dan Teknologi Kebumian, pp 1–58
Earth Science and Technology Faculty Bandung Institute of Technology (2013c) Kurikulum ITB 2013–2018 Program Sarjana Program Studi Meteorologi Fakultas Ilmu dan Teknologi Kebumian, pp 1–63
Government of Indonesia (2003) Undang-Undang Republik Indonesia Nomor 20 Tahun 2003 Tentang Sistem Pendidikan Nasional, Indonesia
Government of Indonesia (2009) Undang-Undang Republik Indonesia Nomor 40 Tahun 2009 Tentang Kepemudaan, Indonesia
Grehenson G (2011) Universitas Gadjah Mada: International Youth Conference Siap Hasilkan Resolusi Pemuda untuk Perubahan Iklim. Available at: http://ugm.ac.id/id/berita/3061-international.youth.conference.siap.hasilkan.resolusi.pemuda.untuk.perubahan.iklim. [Last accessed 26 July 2016]
Listiawati N (2013) Pelaksanaan Pendidikan untuk Pembangunan Berkelanjutan oleh Beberapa Lembaga (Implementation of Education for Sustainable Development by Several Institutions). J Educ Culture 19(3)
Pangerang P (2011) Sambutan Ketua Panitia Penyelenggara Pada Acara Pembukaan International Youth Forum on Climate Change 2011. www.pahlevipangerang.com. Available at: http://www.pahlevipangerang.com/tulisan/12/sambutan-ketua-panitia-penyelenggara-pada-acara-pembukaan–international-youth-forum-on-climate-change-2011 [Last accessed 26 July 2016]
Research and Development Agency Ministry of Education and Culture (2014) Kurikulum 2013 Ajarkan Perubahan Iklim. litbang.kemdikbud.go.id. Available at: http://litbang.kemdikbud.go.id/index.php/index-berita-kurikulum/645-kurikulum-2013-ajarkan-perubahan-iklim [Last accessed 1 April 2014]
Supangat A (2015) Pendidikan dan Perubahan Iklim. dnpi.go.id. Available at: http://dnpi.go.id/portal/id/component/content/article/179-bahasa/lumbung-pengetahuan/publikasi/paper/240-pendidikan-dan-perubahan-iklim [Last accessed 12 April 2015]
Tety (2014) BMKG Ajak Generasi Muda Peduli Pada Perubahan Iklim. possore.com. Available at: http://possore.com/2014/03/15/bmkg-ajak-generasi-muda-peduli-pada-perubahan-iklim/ [Last accessed 26 July 2016]
Tunas Hijau (2010) International Children & Youth Conference Brazil 2010, Tunas Hijau Ikutsertakan 1 Youth Fasilitator, 1 Pendamping dan 1 Peserta. Available at: http://tunashijau.org/2010/05/27/international-children-youth-conference-brazil-2010-tunas-hijau-ikutsertakan-1-youth-fasilitator-1-pendamping-dan-1-peserta/ [Last accessed 26 July 2016]
UNFCCC (2012) Article 6 of the Convention. FCCC/SBI/2012/L.47
University of Lampung (2012) Universitas Lampung (Unila) mendukung Pemerintah Kota Bandar Lampung dalam program Asian Cities Climate Change Resilience Network (ACCCRN) sebagai tridarma perguruan tinggi. www.unila.ac.id. Available at: http://www.unila.ac.id/en/component/content/article/74-berit-depan/2683-unila-dukung-acccrn-sebagai-tridarma-perguruan-tinggi [Last accessed 1 April 2014]
University of Lampung (2013) Sekolah Binaan Unila Raih Adiwiyata. www.unila.ac.id. Available at: http://www.unila.ac.id/sekolah-binaan-unila-raih-adiwiyata/ [Last accessed 31 July 2016]
University of Lampung (2014) Buku Materi Iklim Dianggarkan APBD 2014. www.unila.ac.id. Available at: http://www.unila.ac.id/buku-materi-iklim-dianggarkan-apbd-2014/ [Last accessed 31 January 2014]
YFCC (2016) Kegiatan Youth for Climate Camp dan Alumni YFCC Periode 2011–2015

The *Klimablog* www.cambioclimatico-bolivia.org: Personal Reflections After 5 Years of Blogging on Climate Change from, for and About Bolivia

Dirk Hoffmann

1 Introduction

For the past five years, I have been blogging about climate change as the editor of the *Klimablog* (www.cambioclimatico-bolivia.org), a source of information and communication for Spanish-speakers. The blog mostly focuses on climate issues in Bolivia, but the weekly blog posts cover a broad range of topics related the to the science, politics, and communication of climate change.

In this paper the author gives a personal account of the motivation for creating the *Klimablog*, at a time when Spanish-language information on Bolivia was hard to come by. The paper describes the blog's basic characteristics, leads through its development and highlights its main achievements over the past years, reflecting on some of the challenges ahead.

The present paper is neither a contribution to theoretical discussions on the role of blogging on climate change, nor is it an overview of internet-based climate change communication in Bolivia. The intention is to give testimony of one of the longest and most permanent climate bloggers from Bolivia, which might be a first step in opening this new field to scientific research.

According to its web presentation, the *Klimablog* "Cambio Climático Bolivia" (Climate Change Bolivia) is "a space in the internet dedicated to all things climate change in Bolivia. The blog facilitates access to reliable and up-to-date scientific

Full article prepared for the Handbook of Climate Change Communication

D. Hoffmann (✉)
Bolivian Mountain Institute—BMI, Casilla 3-12417, La Paz, Bolivia
e-mail: dirk.hoffmann@bolivian-mountains.org

D. Hoffmann
Klimablog, Möllentordamm 10, 13597 Berlin, Germany

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_7

information and also to information and commentary about climate change policy at international and national levels".

While the blog is meant for anyone interested in the topic, the main objective—at least at its inception—is to be a useful source for decision makers, social movement leaders, public employees, NGO personnel, the scientific community (abroad and local), journalists, and economic actors. The aim is to give the reader an overall understanding of each topic as well as my own commentary, with the aim of continuing to deepen knowledge by listing links to primary and related resources.

The *Klimablog* over the years has grown from a few thousand to presently 90,000 visits per month (BBClone), and it is now a major reference on climate change related issues in Bolivia.

2 How It All Started

The impacts of climate change in Bolivia are ever more strongly felt by its population (Hoffmann and Requena 2012). Glaciers are melting, extreme events, like the "historic" floods in the lowlands in early 2014, are increasing, and the once predictable onset of the rainy season is becoming erratic (*Klimablog*, April 28, 2014). In 2010, and again during the last months of 2015 and into 2016, El Niño has had an additional impact on drought conditions in many parts of the country (*Klimablog*, January 18, 2016).

Due to a combination of factors ranging from water mismanagement and the effects of the aforementioned strong El Niño, Bolivia's second largest lake, Lago Poopó, dried out completely by the end of December 2015 with little hope for complete recovery (*Klimablog*, March 7, 2016).

A few years ago, Bolivia's most iconic glacier, *Chacaltaya*, succumbed to the onslaught of global warming. The *Chacaltaya* glacier, once advertised as "the world's highest ski slope with a lift", disappeared forever in 2010, leaving a cabin overlooking a barren and rocky slope (Hoffmann 2010). The harrowing site is now a destination for tourists seeking to understand the impacts of climate change.

As coordinator, and for some time executive director of the Bolivian Mountain Institute (BMI), many of our work areas were close to the glaciers in the High Andes. These glaciers, mistakenly still called "eternal ice", are often located at the source of many crucial watersheds, which are being impacted by the loss of glacial regularity. Their rapid melting was the first and most visible sign of climate change, which we started to document and monitor starting in the mid-2000s.

In short, living and working on Sustainable Mountain Development meant that climate change was a daily presence. Our first approach was to look at the socio-economic consequences of glacial recession (Hoffmann 2006, 2008), but soon the scope widened to looking at climate change impacts in a more systematic way across Bolivia.

Despite the dire climatic realities facing the country, climate change studies about Bolivia were scarce at that time. Even direr, information on climate change in

Spanish was almost non-existent. This situation motivated me to start reading scientific papers published in international journals, and begin disseminating the contents to a Spanish-speaking audience of fellow scientists, decision makers and a generally interested public.

Amidst a growing number of natural scientists engaging with wider society about the implications of their research findings and the impacts of climate change, I was especially intrigued by James Hansen, the "grandfather of climate change", who was at the time still head of NASA's Goddard Institute for Space Studies (*Klimablog*, November 25, 2013). It was Hansen, who alerted the public about the imminent threat of global warming in the summer of 1988 during a congressional hearing. His work was crucial in shaping my understanding of the climate change science and for comprehending the severity of its potential impacts for humanity.

Joe Romm, an expert communicator and the world's foremost blogger on climate policy, serves as another inspiration for my work. His ClimateProgress blog, (www.climateprogress.org), has been equally fundamental in my understanding of climate science and climate communication, and in his book "Language Intelligence" (Romm 2012) he outlines the essentials of a successful climate change communication via blog posts.

In 2009, Romm had been named by *Time* magazine as one of its "Heroes of the Environment", calling him "The Web's most influential climate change blogger" (Walsh 2009). ClimateProgress is now part of AmercianProgress, and Joe Romm is part of a team of regular climate bloggers.

Blogging seemed like a powerful new way of communicating climate change to a large, potentially global, audience. Communicating climate change has often been seen as a difficult endeavor, due to a number of reasons, as has been well explained by Moser (2010), and others (e.g. Nerlich et al. 2010). In the first place, the two main greenhouse gases, carbon dioxide (CO_2) and methane (CH_4), are invisible to the human eye, nor do they have a smell, which means they can only be detected indirectly, via sophisticated instruments. Secondly, there is a temporal and geographic lag between cause and effect, which again makes it challenging for humans to grasp the magnitude of the consequences of the massive burning of coal, oil and gas over the past two centuries, and especially since the end of WW II.

With this in mind, I began to think about my own efforts to create awareness and help distribute scientific information on climate change, given that my research at the time focused on climate impacts and adaptation efforts in the Bolivian Andes. Thus, I had the idea to set up a website for regular blog posts, focusing on all things climate change from a Bolivian perspective. This meant on the one hand, giving Bolivians access to information on climate change in Spanish language, which would otherwise go mainly unnoticed. On the other hand, the blog also provides information on climate change impacts and policy in Bolivia to a wider audience, putting the country on the 'map' for other climate researchers.

After many months of planning and preparation, the *Klimablog* went online on December 11th, 2011(*Klimablog*, December 19, 2011). The date was specifically chosen because of its symbolism. Since being declared as such by the United Nations in 2002, December 11th is celebrated as International Mountain day.

The idea was to launch the new blog on this day to catch the attention of the international mountain research community.

The *Klimablog* carries a dedication to James Hansen and Joe Romm as a sign of gratitude and appreciation for their pioneering work in communicating with the public and framing climate change as a political and social issue rather than just an environmental problem (*Klimablog*, December 11, 2011).

3 What Has Been Achieved Over the Past 5 Years

Since launching in 2011, the *Klimablog* has maintained a regular routine, posting a new article every Monday. These blog posts follow a standardized format of two to three pages in length, two or three illustrations (photos or graphics), with a two-paragraph introduction and numerous links to other websites, documents or original sources of information. The idea is to be transparent and encourage further pursuit of any given topic. The intention is to avoid creating another internet black box with ill-defined content and doubtful sources. The ultimate hope is to have a source of up-to-date, reliable information.

I choose to use a uniform format. After the title, there is a short two-paragraph introduction accompanied by a graphic element, usually a photograph. This graphic is also visible when people log onto the *Klimablog*. The introductions give a clear outline of the blog post. The article is between two and three pages long and contains another one or two graphic elements. This format allows the reader to grasp each topic in between 5 and 10 min. The short length is meant to give a broad impression of the topic, and then, if the reader is interested, to encourage him or her to follow the links to original sources of information for a more in-depth understanding. In doing so, the *Klimablog's* editorial style aims for functionality and transparency.

Another key function of the website is its comment section. The idea is to use the *Klimablog* as a platform not only for two-way communication, but also for wider discussions within Bolivian society. There has been, however, limited feedback and commentary via the comments section, which leads me to think that we have been unable to generate as active of a forum for discussion of climate change as we would have hoped. Perhaps one of the reasons for this lack of online discussion may be that people in South America generally favor oral conversation over written discussions. Another issue may be that readers must register to comment, which is a more obvious barrier. This process, however, seemed necessary in light of Bolivia's recent changes in press regulations, which mandate that anyone providing a platform for racist comments be liable for those comments.

On the more technical side, the *Klimablog* is hosted by a small company with great customer service and trouble-shooting. In terms of content, the blog has maintained a mix of national and international topics, taking up scientific as well as political perspectives on climate change. However, it has continued to focus on Bolivia as well. Below are some recent blog post titles:

- "El Bala, desarrollo y cambio climático" (El Bala, Development and Climate Change), August 15, 2016
- "Informe sobre Financiamiento Climático en Bolivia" (Report on Climate Financing in Bolivia), June 6, 2016
- "Lecciones sobre las inundaciones del 2014 en la Amazonía boliviana" (Lessons from the 2014 Floods in the Bolivian Amazon), May 21, 2016
- "Atlas Socioambiental de Tierras Bajas y Yungas de Bolivia" (Socio-environmental Atlas of Tierras Bajas and Yungas in Bolivia), April 18, 2016
- "Adaptación al cambio climático en el turismo al Chacaltaya" (Adaptation to Climate Change in Chacaltaya Tourism), March 14, 2016
- "¿Se podrá recuperar el Lago Poopó?" (Will it be possible for Lake Poopó to recover?, March 7, 2016

As far as international content, the *Klimablog* has followed the UN climate change negotiations with direct coverage from Durban, Doha, Warsaw, Lima, and Paris. Because of financial constraints, however, we were only able to provide daily coverage of COP20 in Lima. From COP20, we covered before, during and after the conference, reporting on side events, civil society mobilizations, scientific presentations, round tables, new reports as they were being released, as well as high-level and associated events organized in and around Lima (*Klimablog*, November 28, 2014).

Outside of our internet presence, two books were published, bringing together the most relevant blog entries of the previous two years. Initially, we were hesitant to turn our open access web content into traditional book formatting, but we were assured by direct reader feedback. Especially readers above a certain age were appreciative of being able to read the articles in book format, even though this meant having to go without the numerous hyperlinks provided in the online versions. The first publication, produced with financial assistance from the German Embassy in La Paz, Bolivia, was published in 2013, (Hoffmann and Torres-Heuchel 2013). Then, a second volume of selected articles from the blog posts of 2013 through 2015 was published as a paperback in November 2015, just before the Paris climate conference COP21 (Hoffmann and Torres-Heuchel 2015).

4 Sustainability of the *Klimablog*

Over the past five years, the *Klimablog* has grown from a few thousand visits per month to presently 90,000 (BBClone), and it is now a major reference on climate change related issues in Bolivia. Reconstructing statistical information of hits on the website, as registered by BBClone, we find the following numbers, indicating the growing relevance of the *Klimablog* (Tables 1 and 2).

As seen from these numbers, growth was not linear but sustained on a month-by-month basis. After a strong upward trend in 2015, figures for this year

Table 1 Numbers of selected monthly hits

Month and year	Number of hits
February 2012	3700
August 2012	8700
December 2012	13,000
May 2013	19,000
September 2013	27,000
December 2013	19,000
March 2014	30,000
July 2014	34,000
November 2014	42,000
April 2015	39,000
October 2015	78,000
January 2016	94,000
August 2016	86,000

Source BBClone

Table 2 Annual averages of monthly hits to the *Klimablog* website

2011	2012	2013	2014	2015	2016
Blog started on December 11th	8000	20,000	33,000	90,000	90,000*

Source BBClone
*Preliminary figure as of September 17th

tend to be more constant. We are unable to clearly identify reasons behind different trends in growth rates the *Klimablog* has experienced over time. However, we imagine that the heightened media attention on climate change in the months leading up to the Paris Climate Summit in December 2015 may have increased interest in climate change information and could explain some of the website growth in that period. It should be noted that while the number of hits on the website certainly indicates views, this information does not allow us to see whether any articles were read, downloaded, or reposted. To access this information, we would need a more detailed program for data analysis.

Because of its presence on the internet, the *Klimablog* offers subscriptions free of cost. The most recent blog post is automatically sent to the e-mail addresses of the subscribers every Monday. The number of subscriptions has increased, and we currently have over 500 subscribers. Though started in conjunction with the Bolivian Mountain Institute, the *Klimablog* now functions independently and is considered a climate change communication on its own.

The blog's financial sustainability, however, has always been, and remains, to be a critical issue. The first two years of its operation had base funding from Germany's "Climate Fund", operated via the country's embassy in La Paz. Since then, the blog has depended heavily on voluntary contributions by the editor and other contributing authors with the exception of 2013 and 2014, during which some funds were granted once again from the "Climate Fund" to cover COP19 in Warsaw and COP20 in Lima.

With financial sustainability in mind, a donation button was added to the website in 2015, followed by a call for donations. The response, however, has been admittedly lackluster. Despite these obstacles, the number of subscribers to the *Klimablog* website, as well as comments received from colleagues and professionals, indicate a growing appreciation of the blog's work.

5 Conclusions and Outlook

Since 2011, the *Klimablog* posts a new article every Monday, and by now has established itself firmly as a major reference for climate change in Bolivia as well for the wider Spanish-speaking South American region. At present, it registers around 3000 hits a day and has over 500 regular subscribers.

We have described the motivation and continued efforts for the *Klimablog* "Cambio Climático Bolivia" (Climate Change Bolivia), a blog dedicated to all aspects related to climate change in Bolivia. Here, we have also presented the blog's achievements and reflected on its sustainability.

The main lessons that can be drawn from the blogging experience with the *Klimablog* in Bolivia can be resumed as follows:

There is a sustained interest within Bolivian society on climate change information, as is well illustrated by the reception of the two book publications containing a selection of blog posts published over a two year period.

A second aspect concerns blogging as a tool for climate change communication. The growing numbers of subscribers and visitors to the blog indicate a continued (and growing) relevance of this kind of internet-based communication on topics related to climate change.

Thirdly, it was evidenced that expanding the number of readers is not a guarantee for the sustainability of the *Klimablog*. Without financial assistance, this blog would not have come to life, and only sustained personal dedication has allowed it to continue to exist as one of the main sources of climate change information in Bolivia.

Thus, despite our achievements, challenges still lie ahead. The most pressing challenge is to maintain our weekly rhythm of blog posts, guaranteeing a quality mix of informative topics from Bolivia, as well as the international sphere. While the *Klimablog* is uniquely Bolivian, we strive to continuously expand our audience beyond Bolivia, as the Spanish language provides a much greater potential readership.

Another challenge is to engage more directly with social media in order to not only spread our information further but to catch the attention of new readers. This would include a Facebook presence as well as regularly posting on Twitter for starters.

While these are formidable challenges, there are also opportunities on the horizon. The impacts of climate change are becoming ever more visible, yet there are still few journalists trained and equipped to grasp the scope of this global problem and meaningfully link it to local topics of societal interest. To bridge this gap, there is a need for competent journalists that are capable of communicating climate change stories to a mainstream audience. With this in mind, the *Klimablog* presents itself as a valuable instrument for journalistic training. All articles remain online and maybe accessed via a search function, thus building up an archive on climate change information.

In terms of topics, the upcoming COP22 will provide a great opportunity to report on global climate policy, the entering into force and subsequent implementation of the Paris Agreement, as well as the Nationally Determined Contributions (NDCs).

We conclude this outlook with a quote from the introduction to the *Klimablog*'s latest book publication of a selection of its most relevant articles from the years 2013–2015:

> We are convinced that without an active and well-informed society it will be impossible to stand up to big economic and political interests that still follow the fossil pathway of burning coal, oil and gas: a path towards disaster. In that sense, we see the *Klimablog* as part of a global movement towards the goal of zero carbon emissions until 2050.
>
> Hoffmann and Torres-Heuchel (2015: 11).

Acknowledgements The author would like to express his gratitude for the continuous support from "behind the curtains" to Yorck Reymann, for providing the *Klimablog*'s technical basis and troubleshooting whenever necessary, and to Javier Fernando Corro Ayala for language editing and putting the weekly blog posts online.

References

BBClone. http://cambioclimatico-bolivia.org/bbclone/

ClimateProgress. www.climateprogress.org

Hoffmann D (2006) Socio-economic impacts of glacier retreat in the Bolivian Andes. In: Price MF (ed) Global change in mountain regions. Sapiens Publishing, Duncow, pp 80–81

Hoffmann D (2008) Consecuencias del retroceso glaciar en la Cordillera boliviana. Pirineos 163:77–84

Hoffmann D (2010) Andean glaciers vanish, add socio-economic strains. Focal Point. Can Spotlight Am 9(1):13–15

Hoffmann D, Requena C (2012) Bolivia en un mundo 4 grados más caliente. Escenarios sociopolíticos ante el cambio climático para los años 2030 y 2060 en el altiplano norte. Fundación PIEB and Bolivian Mountain Institute, La Paz, p 168

Hoffmann D, Torres-Heuchel T (eds) (2013) Cambio climático en Bolivia. Lo mejor del Klimablog 2011–2013. PIEB e Instituto Boliviano de la Montaña, La Paz, p 130

Hoffmann D, Torres-Heuchel T (eds) (2015) Cambio climático en Bolivia. Lo mejor del Klimablog 2013–2015. Instituto Boliviano de la Montaña, La Paz, p 128

Klimablog. www.cambioclimatico-bolivia.org

Moser SC (2010) Communicating climate change: history, challenges, process and future directions. WIREs Clim Change 1:31–53

Nerlich B, Koteyko N, Brown B (2010) Theory and language of climate change communication. WIREs Clim Change 1(1):97–110

Romm JJ (2012) Language intelligence: lessons on persuasion from Jesus, Shakespeare, Lincoln, and Lady Gaga. CreateSpace, North Charleston

Walsh B (2009) Heroes of the environment 2009—activists: Joe Romm. Time magazine, September 2009

Klimablog blog posts

(all links accessed for the last time on September 23, 2016)

"El Bala, desarrollo y cambio climático", 15 Aug 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=390#390

"Informe sobre Financiamiento Climático en Bolivia", 6 June 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=380#380

"Lecciones sobre las inundaciones del 2014 en la Amazonía boliviana", 21 May 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=378#378

"Atlas Socioambiental de Tierras Bajas y Yungas de Bolivia", 18 April 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=373#373

"Adaptación al cambio climático en el turismo al Chacaltaya", 14 Mar 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=367#367

"¿Se podrá recuperar el Lago Poopó?", 7 Mar 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=366#366

"El "Súper-El Niño" en Bolivia", 18 Jan 2016: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=359#359

"Aviso especial: Reportes diarios desde la COP 20 en Lima en el *Klimablog*", 28 Nov 2014: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=278#278

"Conversatorio FES: 'Inundaciones en el Beni - ¿Desastre natural o efecto del cambio climático?'", 28 Apr 2014: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=242#242

"James Hansen: Sin mitigación fuerte e inmediata, el planeta se volverá inhabitable", 25 Nov 2013: http://cambioclimatico-bolivia.org/index-cc.php?&cod_aporte=212#212

"11 de Diciembre – Día Internacional de las Montañas", 19 Dec 2011: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=22#22

"Bienvenidos al Klimablog 'Cambio Climático Bolivia'", 11 Dec 2011: http://cambioclimatico-bolivia.org/index-cc.php?cod_aporte=18#18

"Acerca de este Blog": http://cambioclimatico-bolivia.org/about.php

Climate Change Impacts and Adaptation in the Agriculture Sector of Sri Lanka: What We Learnt and Way Forward

Rasu Eeswaran

1 Introduction: Agriculture in Sri Lanka

Sri Lanka is a South Asian island, located in between 5° 55′–9° 5′ North latitudes and 79° 42′–81° 53′ East longitudes. Agriculture is one of the key sectors of the Sri Lankan economy and livelihood of its people. It consists of crop production, farm animal production, forestry and fisheries. In 2015, the contribution of agriculture sector to the national gross domestic product was about 8% and showed 5.5% growth rate relative to 2014. The contributions of crop production, farm animal production, forestry and fisheries were 5.4, 0.6, 0.6 and 1.4% respectively (CBSL 2015). It clearly shows the dominance of crop production (68%) in the country's agriculture sector. Moreover, the sector provided direct employment to about 30% of the total labour force in 2013 (DOA 2014). Further, 72% of the population indirectly involved in agriculture related activities for their livelihood (Gunasena 2008).

Sri Lanka enjoys a tropical monsoonal climate with three major climatic zones namely dry zone, intermediate zone and wet zone. This classification is based on annual rainfall, effectiveness of southwest monsoon rains, soil types, land use and vegetation characteristics. The wet zone receives a relatively high mean annual rainfall over 2500 mm. The dry zone receives a mean annual rainfall of less than 1750 mm and the intermediate zone falls in between (Marambe et al. 2015). Geography and landscape of Sri Lanka decide the local temperature variations across the country especially with changes in altitude/elevation. Thus, it has been further categorized into 46 agro-ecological regions to account the greater diversity of agro-ecology (Punyawardena et al. 2003). These diverse regions support wide range of domesticated crops, animals and forest species that are used to produce food, fodder, fiber, fuel etc. Sri Lanka being an island nation in the Indian ocean,

R. Eeswaran (✉)
Postgraduate Institute of Agriculture, University of Peradeniya, Peradeniya 20400, Sri Lanka
e-mail: eeswaranr@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_8

has greater potential for both coastal and deep sea fisheries. Furthermore, inland water bodies also provide the substantial ground for freshwater fisheries.

The agricultural systems are increasingly threatened by the negative impacts of climate change. Moreover, it has been predicted that the food production will be vulnerable in the future climate of Sri Lanka. Thus, this chapter synthesizes the available information on climate change impacts and adaptation in Sri Lankan perspectives with the aim of facilitating comprehensive knowledge transfer to various stakeholders.

2 Evidences of Climate Change in Sri Lanka

Sri Lanka is now confident of significant changes on its climate, associated to global climate change. Findings of Punyawardena and Premalal (2013), Wickramasinghe (2013), Nissanka et al. (2011), De Silva (2009), Panabokke and Punyawardena (2009), Premalal (2009), De Costa (2008), Malmgren et al. (2003) and Chandrapala (1996) elucidated the significant increase of ambient temperature and recent increase of variability in rainfall. The temperature increase was very clear in which the rates of warming at many locations during the past century have exceeded the global average of the same period (De Costa 2008). Furthermore, Marambe et al. (2012) highlighted that, the increase of nighttime minimum temperature is much pronounced than the increase of daytime maximum temperature.

The variability of both summer (south west) and winter (north east) monsoon rains and rains of convectional origin has increased significantly during recent decades which leads to the extreme weather events i.e. droughts and floods that damage crops frequently (Marambe et al. 2015). Furthermore, irrigation water demand will increase in future as increasing temperature causes higher crop evapotranspiration (Wickramasinghe 2013). Temperature projections in Sri Lanka using climate downscaling of ECHAM4 general circulation model revealed that the average annual temperature of Sri Lanka could increase anywhere in between 2.5–4.5 °C by the year 2080 while rainfall projections indicated that, dry zone will become drier and wet and intermediate zones may become wetter than at present (Marambe et al. 2015; Punyawardena et al. 2013a). According to De Silva (2009), the north east monsoon rains are expected to decrease, together with increasing annual average temperatures it will increase the potential water shortages in the northern dry zone of Sri Lanka. Punyawardena et al. (2013b) and Seo et al. (2005) demonstrated that climate change impacts and vulnerabilities vary by regions as the country is very diverse in its agro-ecology. Seo et al. (2005) further alarmed that, already dry regions such as Northern and Eastern Provinces are expected to lose large portions of their agriculture with predicted future warming trends.

3 Impacts of Climate Change on Agriculture in Sri Lanka: Lessons Learnt

3.1 Crop Production

Rice is the staple food crop, mainly cultivated in all three climatic zones of the low and mid elevations in Sri Lanka. Hence, the impacts of climate change was intensively investigated in rice than the other crops, especially in terms of physiology of growth and yield formation. Rice being a C_3 plant, always shows a positive response to increasing atmospheric CO_2 concentrations (Tanaka 1976). This CO_2 enrichment associated enhancement of net photosynthetic rate, crop growth rate and yield was elucidated by several scientists through growth chamber studies (Baker et al. 1992) open top chamber studies (De Costa et al. 2003), free air CO_2 enrichment research (Hasegawa et al. 2013) and few crop modeling approaches (Delpitiya et al. 2014; Dharmarathna et al. 2012; De Costa 2000).

The problem arises with the increasing ambient temperatures. The suitable temperature range for the vegetative growth of rice is from 12 to 35 °C with an optimum around 25 to 30 °C (Yoshida 1978). The most dangerous effect of increasing temperature is on rice grain sterility. A very short episode (1–2 h) of high temperature events at anthesis (flowering) can make a large number of pollen grains sterile. Rice grain sterility increasing when the spikelet temperature increased over 30 °C and become completely sterile at 36 °C especially under high relative humidity according to Weerakoon et al. (2008) and Abeysiriwardena et al. (2002). Thus, even though increasing atmospheric CO_2 concentration has a positive impact on yield, the combined effects at the real field situation showed a decrease in rice yields or the positive effects of CO_2 almost totally negated by elevated temperature (Delpitiya et al. 2014; De Costa 2000). Delpitiya et al. (2014) quantified that yield reduction as 12% for the increase in temperature (both maximum and minimum temperature) by 2 °C. Moreover, a study conducted on the impacts of global warming on productivity of rice varieties available in one of the major rice growing districts of Sri Lanka (Kurunegala) suggested that more than 20% grain yield reduction as predicted using GCM's RCP 8.5 scenario (the worst case) by the mid century (Weerakoon 2013).

Rice, being a crop grown on standing water for most of its life cycle, usually requires 1500–2000 mm of water per season for establishment, growth and weed control (Bouman 2001). Variability in precipitation amounts, distribution and variability in the onset of rainy season limit the yield of rainfed rice and leads to variation in farming operations. Irrigated rice systems also may get affected if rainfall is poor or delayed in the catchments of respective reservoirs. As noted by Nguyen (2002), flood is the most important constraint to rice production in low-lying areas like Eastern and Western Provinces of Sri Lanka. In recent years, increasing weather extremes such as floods and droughts caused severe damage to rice production (Marambe et al. 2015). Rice grown near coastal regions will be increasingly affected by increasing salinity in paddies due to saline water intrusion associated to sea level rise (De Costa 2010).

In addition to rice, most of other crops such as coarse grains, legumes, fruits, vegetables and tuber crops also seem to adversely affected by the impacts of climate change (Titumil and Basak 2010). Yield reductions were evident for maize (Malaviarachchi et al. 2014) and Mung bean (Malaviarachchi et al. 2015, 2016) with increasing growing season temperatures. Droughts and floods significantly affect fruit and vegetable production mainly in the dry zone. Increasing temperature regimes will increase the evapotranspiration losses, lead to increasing soil moisture deficits and temporal evolution of soil salinity in upland cropping systems. Moreover, increasing ambient temperatures could increase the field heat and respiration rates of perishable horticultural produces, thereby increasing post-harvest losses and storage costs.

Increasing trends of nighttime minimum temperatures in many locations as observed in the recent decades, resulting in diurnal temperature ranges to become increasingly narrower (Marambe et al. 2015). It negatively affects the yield of tuber crops, for an example potato, as the temperature window of opportunity for assimilation and tuber bulking get narrowed. Meanwhile, increasing temperatures, especially nighttime minimum temperatures could decrease the edible quality of fruits, fodder and other harvestable organs by reducing the sugar contents and increasing the fiber contents (Marambe et al. 2015).

Increasing temperature and variability in rainfall have negative impacts on tea production which is a major export commodity of the country (Wijeratne 2011; De Costa 2010; Wijeratne et al. 2007). The negative impacts are much significant in low elevations where tea is grown. Karunaratne et al. (2015) argued that the vulnerability of tea to climate change is increasing even in the central hills of Sri Lanka. Extended dry spells reduce the coconut production (Fernando et al. 2007) and increasing pest disease problems (Peiris et al. 2004). Wijesuriya and Samarappuli (2009) demonstrated the vulnerability of rubber plantations to climate change.

In contrast, recent evaluation on vulnerability of homegarden systems to climate change in Sri Lanka (Weerahewa et al. 2012) showed that homegardens are much resilient to climate change impacts due to greater diversity of crop species and farmers continuously adopt appropriate technologies in their small land holdings to face the challenges of climate change. In addition, homegardens deliver mitigation benefits through carbon sequestration according to Mattsson et al. (2013).

At present there is a lack of studies in the country on how climate change will modify agricultural environments in terms of biotic and abiotic factors. Nevertheless, there is an increasing perception that pest damages, weed infestations and all kind of pathogens could be altered in future warmed humid climate (Marambe et al. 2015). It is widely accepted that, climate change modifies the changes in pest and pathogen dynamics, populations and their interactions with crops (Gregory et al. 2009). The consequences on diversity and abundance of insect-pests and associated crop losses are expected to increase in the future warmer climates. These biotic constraints may become severe to rice crop as it is grown in humid environments. There is an increasing tendency for virus diseases to become severe in the warmer and humid climate as the vector populations get increased (Fand et al. 2012). De Costa (2010) noted the population shifts of different nematode species affecting tea crops in Sri Lanka in response to increasing soil temperature. Further, variability in rainfall regime could induce shifts in important fungal diseases such as *Oidium* leaf fall in rubber, caused by *Oidium hevea*. Increasing temperatures have shown to induce blister blight (*Exobasidium vexans*) in tea, especially when warm periods coincide with high humidity (De Costa 2010).

Increasing rainfall variability and increasing heavy intense rains (>25 mm h^{-1}) will wash away the fertile top soils in the arable lands (Marambe et al. 2015). Meanwhile, increasing temperatures could deplete soil organic matter, thus lead to soil fertility degradation and loss of production potential of soils especially in the dry zone of Sri Lanka. Tropical smallholdings are already suffered by low soil fertility, top-soil erosion, sub-optimal crop management and subsistence farming conditions (De Costa and Sangakkara 2006) where farmers indiscriminately use synthetic agro-chemicals as a strategy to maintain productivity. This predicted increase in pest and disease pressures and decline of soil fertility may motivate farmers to invest more on synthetic agro-chemicals in future that can further increase serious public and environmental health hazards. Invasive alien flora could be a potential threat to agro-biodiversity and agricultural ecosystems that may accelerate with climate change (Iqbal et al. 2014). Furthermore, Berry et al. (2011) argued that the vulnerability of farmers to mental health problems (stress, trauma and solastalgia) is greatly increased as climate change associated drought and other weather-related disasters frequently erode their social and economic bases on which farming communities depend.

3.2 *Farm Animal Production*

Farm animal production can be affected by climate change through direct impact on growth and reproductive physiology and indirectly due to the impacts on feed availability. Wickramasinghe (2013) argued that extensively managed livestock systems are more vulnerable to climate change compared to intensively managed livestock systems in Sri Lanka as they completely depend on the rain-fed pasture systems, natural water bodies and crop based by-products especially in dry regions.

Increasing temperatures associated heat stress could decrease the growth, fertility and production performances of almost all kind of livestock and poultry species (Wijayagunawardane 2009). These negative effects are more pronounced in high-yielding temperate breeds and in the animals in extreme dry parts of the country. As recorded by Marambe et al. (2015), droughts and floods also significantly devastated poultry and cattle production systems in the dry zone of Sri Lanka. However, present level of understandings on the interactions of climate change and farm animal production is not adequate enough to face the future challenges of the sector (Silva 2009).

3.3 Fisheries and Forestry

There is a dearth of findings on how forest and forest plantations could respond to future climate in Sri Lanka. In fact, any negative impacts could cause serious consequences to country's economy and environment as forests are both source and sink of carbon. Moreover, non-timber forest products are the main source of economy for the rural communities dwell in the vicinity of forest areas (Senaratne et al. 2003). Somaratne and Dhanapala (1996) found the declining trend of tropical wet forest due to climate change in Sri Lanka. Further, newly emerging pests and pathogens in response to climate change could affect several forest tree species.

Athulathmudali et al. (2011) showed that the fisheries sector in Sri Lanka is also vulnerable to climate change. Sea level rise and ocean acidification could cause loss and changes of coastal habitats, breeding grounds and species distribution. Floods and prolonged droughts will devastate fresh water inland fisheries, especially in seasonal tanks. Senaratne et al. (2009) pointed out that, increase in oceanic temperature, changes in rainfall regimes, sea level rise and extreme weather events such as storm surges would lead to changes in distribution, growth and reproduction of fish stock, alteration of species composition, damages to fishing infrastructure and disturbance to fishing activities. These would all have serious implications to socio economic conditions, nutritional health and livelihood for dependent communities.

Recent report of Ahmed and Suphachalasai (2014) showed that the economic cost of climate change in South Asia will increase over time. According to their projections, Sri Lanka will face 1.2% loss of annual gross domestic product by 2050 and roughly 2.5% by 2100. All these studied impacts emphasized the importance of advancing climate change adaptation in agriculture sector and integrating climate change response policies within the overall national development strategy.

4 Adaptation of Agriculture to Climate Change in Sri Lanka

In Sri Lanka, the agricultural systems have evolved over hundreds of years in close harmony with local environmental conditions with farmers managing the system in wide range of agro-ecological regions. This wide range of agro-ecological setup have given rise to greater agro-biodiversity. Farmers have been using the genetic diversity intelligently over centuries to select varieties and species adapted to various environmental stress conditions (Marambe et al. 2015). Thus, the immense agro-biodiversity itself delivers opportunities for climate change adaptation. Further, farmers have a long tradition of management practices that reflects a greater cultural diversity in agricultural systems which can provide adaptations on crop establishment, irrigation, crop protection, soil fertility management, management of animal husbandries and predictions of local weather.

Chandrasiri (2013) demonstrated that awareness on climate change impacts is increasing among the farming communities in the country, however the implementation of field level adaptations are far below the rate of increasing trends of climate change. Weerahewa et al. (2012) found changing of planting dates, agronomic practices, soil and water conservation measures and technologies such as new varieties and irrigation equipment are some of the adaptation strategies used by local farmers and the decisions towards adaptation is significantly influenced by perception towards climate change, employment, diversity of farm, age, gender, education level of the household head and size of the farmland.

The National Climate Change Adaptation Strategy for Sri Lanka 2011–2016 is the current policy document for national priority-setting in the face of ambiguous climate projections (MOE 2010). Vulnerability index mapping of Eriyagama et al. (2010) used to develop the five year adaptation strategy accompanied with multiple-benefit adaptation interventions that simultaneously deliver climate resilience and address current development needs. The best example of such an intervention in Sri Lanka is the restoration of the ancient tanks, to provide resilience against climate variability in the vulnerable districts. Other non-target interventions for water and agriculture, currently practiced at a low level, but warranting wider adoption, are rainwater harvesting, development of sustainable groundwater, adoption of micro irrigation technologies, and wastewater reuse.

Moreover, Punyawardena et al. (2013b) recently developed the climate change vulnerability map of Sri Lanka which clearly shows that vulnerability varies with regional characters, for an example already dry regions (Kilinochchi, Mullaitivu, Mannar, Vavuniya and Puttalam) are categorized as "very high" to climate change vulnerability. Although, the Jaffna district is located in the extreme dry zone, it is "low" vulnerable as it has improved economy, infrastructure, education and health. In fact, Ratnapura district falls under "very high" category due to frequent floods and landslides. This highlights the fact that, both long term and near term, regional-specific adaptation planning urgently required with accounting climate change impacts and vulnerability projections available for Sri Lanka. There are immense of adaptation options available from international literature that can be applicable to Sri Lankan context.

Harvey et al. (2013) argued that, many tropical agricultural systems similar to Sri Lanka, can provide both adaptation and mitigation benefits if they are designed and managed appropriately at a large landscape context. Cooper et al. (2009) demonstrated that, adoption of improved crop, soil and water management practices will result in higher yields even under climate change. The development and adoption of temperature adapted varieties, together with improved management practices, could result in almost complete mitigation of the negative impacts of temperature rise.

According to Howden et al. (2007), altering inputs such as varieties and species those with more appropriate thermal time (phenological matching), increased resistance to abiotic stresses (heat shock, drought, flood and salinity), altering fertilizer rates to maintain grain and fruit quality consistent with the prevailing climate, altering amounts and timing of irrigation, drainage and other water management practices, alteration of time or location of cropping activities, diversifying farming activities and income generation, improving the effectiveness of pest, disease and weed management practices through wider use of integrated pest management, development and use of varieties and species resistant to pest and diseases and using climate forecasting to reduce production risk, all will be the potential adaptation strategies.

The adaptation strategies to climate change have been categorized by Smit and Skinner (2002) into four groups namely, technological developments (crop development, weather and climate information systems, resource management innovations, farming practices etc.), government programs and insurance (agricultural subsidy and support programs, private insurance, resource management programs etc.), farm practices (farm production, land use, land topography, irrigation, timing of operation etc.) and farm financial management (crop insurance, crop shares, income stabilization, household income etc.).

Seasonal climate predictions and forecasting of weather information will offer the potentials to anticipate variations in crops and livestock management early enough to adjust critical decisions thus, guiding farmers to adaptation. It can also be used in coordinating input and credit provision, food crisis management trade and innovative index-based insurances as a decision support system in climate risk management (Hansen et al. 2011). Management decisions of farmers on changing of crop and varietal selection, planting dates, inputs, land use, and adjusting marketing practices could potentially be influenced by seasonal climate forecasts. However, this facility is not well developed in Sri Lanka.

Van Noordwijk et al. (2014) highlighted the potentials of agroforestry and benefits of incorporating perennial trees into agricultural systems, in buffering climate variability, favouring the outcomes of the abiotic and biotic factors. Thus, appropriate use of trees especially in annual agricultural landscapes can be a relevant part of climate change adaptation. Agroforestry and homegardens are often integral parts and in practice for long time in Sri Lanka. Adjusting feeding, watering and housing requirements with stress tolerant breeds are essential to adapt farm animal production to climate change. All these adaptation options need to be integrated at different levels and scales into the agricultural development agenda and policy framework in order to achieve sustainable development in the agriculture sector of Sri Lanka.

5 Communicating Climate Change and Adaptation Information to Farmers and Other Stakeholders

The available information on local impacts of climate change and potential adaptation options should be effectively communicated to farmers and other stakeholders in order to implement new adaptation measures and to strengthen the existing adaptation measures thereby to achieve the expected adaptation targets. The ability of farmers to adapt to climate change is determined by the availability of technology, capacity for learning and by the ethics of the treatment of vulnerable people and regions within societal decision-making structures.

There are many barriers to climate change adaptation operating at different levels. These are the obstacles that hinder planning and implementation of climate change adaptation. Usually farming households constrained by financial barriers, socio-cultural barriers, institutional barriers, technological barriers and a lack of information on climate change characteristics (Antwi-Agyei et al. 2014). Households need to be supported through the provision of micro-credit schemes, community empowerment and extension initiatives aimed at enhancing social networks within farming communities in order to overcome the barriers. Howden et al. (2007) stated that, overcoming these barriers will require a comprehensive and dynamic policy approach covering all range of scales and issues from individual farmer awareness to the establishment of more efficient markets.

Workshops, seminars, field tours, extension services and other training programs could create platforms for climate change communication among farmers, stakeholders and policy makers. In addition to that, adaptive research programs in the context of adaptation science, can create opportunities to farmers to implement and evaluate the strengths and weaknesses of adaptation measures and researchers to learn opportunities and constraints of adoption in real field situations. Adaptive research is the systematic and methodological research done at farmer fields by farmers, guided by a scientific group to evaluate the promising adaptation measures to critical farm level problems (De Costa 2010; Meinke et al. 2009). It can create an opportunity for mutual learning thus, strengthen climate change communication.

Adaptive research can focus on evaluating stress tolerant crop genotypes and/or on evaluating promising crop management practices that can mitigate yield losses under climate change. Currently, this type of farmer participatory research activities are lacking in the context of climate change research in Sri Lanka. Majority of the studies were carried out at research fields and through modelling approaches. Although these studies delivered a wealth of knowledge for climate change communication, the findings must be effectively and comprehensively communicated especially to farmers to ensure adaptations are implemented on the ground.

In 2013, Eeswaran et al. (2014) from a project of the University of Peradeniya, emphasized the needs of adaptive research especially in vulnerable regions of Sri Lanka and initiated the adaptive research on upland annual cropping systems in the Northern Province of Sri Lanka with a group of farmers in three locations. The findings clearly showed the benefits of adaptive research to promote climate change adaptation at farmer level (Eeswaran et al. 2015). We also conducted a series of training workshops to farmers and field level extension officers on climate change adaptation for upland cropping systems at different agro-ecological regions.

6 Conclusions and Way Forward

Sri Lankan agriculture and food systems are increasingly threatened by the negative impacts of climate change which is in line with the challenges faced by global food systems. Climate change has continued to affect agricultural productivity (crops, farm animals, forestry and fisheries) through increasing temperatures, increasing rainfall variability and increasing extreme weather events, while agricultural productivity has to be increased to cater ever increasing demands and living standards of people. Farmers have perceived these changes and adopting certain technologies to mitigate the negative impacts that reduce their productivity. However, the implementation of field level adaptations are far below the rate of increasing trends of climate change aspects.

Hence, relevant national policy frameworks need to be strengthened in a way that can promote farm level adaptations which can empower the coping capacity of farmers to the negative impacts of climate change. Climate change adaptation agenda could be included to public-private partnerships and corporate social responsibility (CSR) of the private companies involved in food sector. Collaborative and participatory research programs need to be promoted for the generation and dissemination of new findings. These findings will be important to develop and strengthen both long term and short term regional-specific, multiple adaptation planning to sustain the food security and economic growth of Sri Lanka under the anticipated challenges of climate change.

In this regard, climate change communication will support appropriate decision making, planning and implementation of adaptation practices. Moreover, experiences from the climate-smart agriculture (CSA) and conservation agriculture (CA) programs especially from Africa, Latin America and other Asian countries (Delgado et al. 2013; FAO 2013) can be taken into consideration when prepare for local knowledge dissemination activities and certain policy decisions. This can help to cross-disciplinary discussions among scientists and to develop human resources in the field of climate adaptation in agriculture.

Acknowledgements The author wishes to thank the team members of the HETC/QIG/W3/PGIA project for their motivation to write this book chapter.

References

Abeysiriwardena DSDZ, Ohba K, Maruyama A (2002) Influence of temperature and relative humidity on grain sterility in rice. J Nat Sci Found Sri Lanka 30(1&2):33–41

Ahmed M, Suphachalasai S (2014) Assessing the costs of climate change and adaptation in South Asia. Asian Development Bank, Mandaluyong City

Antwi-Agyei P, Dougill AJ, Stringer LC (2014) Barriers to climate change adaptation: evidence from northeast Ghana in the context of a systematic literature review. Clim Dev 7(4):297–309

Athulathmudali S, Balasuriya A, Fernando K (2011) An exploratory study on adapting to climate change in coastal areas of Sri Lanka. Working Paper Series No. 18, Centre for Poverty Analysis, Colombo

Baker JT, Allen LH, Boote KJ (1992) Temperature effects on rice at elevated CO_2 concentration. J Exp Bot 43:959–964

Berry HL, Hogan A, Owen J, Rickwood D, Fragar L (2011) Climate change and farmers' mental health: Risks and responses. Asia-Pac J Public Health 23(2):119S–132S

Bouman BAM (2001) Water-efficient management strategies in rice production. Int Rice Res Newsl 26(2):17–22

CBSL (2015) Annual Report 2015, Central Bank of Sri Lanka, Colombo, Sri Lanka

Chandrapala L (1996) Long term trends of rainfall and temperature in Sri Lanka. In: Abrol YP, Gadgil S, Pant GB (eds) Climate variability and agriculture. Narosa Publishing House, New Delhi, pp 153–162

Chandrasiri WACK (2013) Farmers' perception and adaptation to climate change: a case study in vulnerable areas of Kurunegala district. Ann Sri Lanka Dept Agric 15:13–23

Cooper P, Rao KPC, Singh P, Dimes J, Traore PS, Rao K, Dixit P, Twomlow SJ (2009) Farming with current and future climate risk: advancing a 'Hypothesis of Hope' for rainfed agriculture in the semi arid tropics. J SAT Agric Res 7:1–19

De Costa WAJM (2000) Prediction of the effect of elevated CO_2 and temperature on irrigated rice yields in the low-country dry zone of Sri Lanka using a process based simulation model. J Nat Sci Found Sri Lanka 28(3):165–184

De Costa WAJM (2008) Climate change in Sri Lanka: myth or reality? evidence from long-term meteorological data. J Nat Sci Found Sri Lanka 36 (Special Issue): 63–88

De Costa WAJM (2010) Adaptation of agricultural crop production to climate change: A policy framework for Sri Lanka. J Nat Sci Found Sri Lanka 38(2):79–89

De Costa WAJM, Sangakkara UR (2006) Agronomic regeneration of soil fertility in tropical Asian smallholder uplands for sustainable food production. J Agric Sci 144:111–133

De Costa WAJM, Weerakoon WMW, Herath HMLK, Abeywardena RMI (2003) Response of growth and yield of rice (*Oryza sativa*) to elevated atmospheric carbon dioxide in the subhumid zone of Sri Lanka. J Agron Crop Sci 189:83–95

De Silva CS (2009) Climate change effects on the North–East monsoon and dry zone agriculture in Sri Lanka. In: De Costa WAJM, Nissanka SP, Mohotti AJ, Weerakoon WMW (eds) Proceedings of the First National Conference on Climate Change & Its Impacts on Agriculture, Forestry and Water, Faculty of Agriculture, University of Peradeniya, Peradeniya, p 4

Delgado JA, Nearing MA, Rice CW (2013) Conservation practices for climate change adaptation. Adv Agron 121:47–115

Delpitiya DGPS, Weerakoon WMW, Nissanka SP, Punyawardena BVR, Karunarathne MA, Hearth RM (2014) Impact of climate change on rice yields in Sri Lanka: a crop modeling approach using decision support system for agro technology transfer (DSSAT4.5). Ann Sri Lankan Dept Agric16:71–81

Dharmarathna WRSS, Weerakoon SB, Rathnayake UR, Hearth S (2012) Variation of irrigated rice yield under the climate change scenarios. In: Proceedings of the SAITM Research Symposium on Engineering Advancements Malabe, Sri Lanka, pp 31–34

DOA (2014) AgStat: pocket book of agricultural statistics, vol 6. Department of Agriculture, Peradeniya

Eeswaran R, De Costa WAJM, De Costa DM, Dandeniya WS (2014) Adaptive research to test climate change-resilient agronomic practices for the upland cropping systems in the Northern Province of Sri Lanka. In: Proceedings of the HETC Symposium 2014 Organized by Higher Education for the Twenty First Century (HETC) Project, Ministry of Higher Education, Sri Lanka, p 92

Eeswaran R, De Costa WAJM, De Costa DM, Dandeniya WS, Sivakumar S, Suriyagoda LDB (2015) Evaluation of a climate change-adaptive, eco-friendly agronomic package for potato

(*Solanum tuberosum* L.) cultivation in the farmer fields of the Jaffna District of Sri Lanka. Trop Agric Res 27(2):190–202

Eriyagama N, Smakhtin V, Chandrapala L, Fernando K (2010) Impacts of climate change on water resources and agriculture in Sri Lanka: a review and preliminary vulnerability mapping. IWMI Research Report 135, International Water Management Institute, Colombo. doi:10.5337/2010.211

Fand BB, Kamble AL, Kumar M (2012) Will climate change pose serious threat to crop pest management: a critical review? Int J Sci Res Pub(IJSRP) 2(11):1–14

FAO (2013) Climate Smart Agriculture Sourcebook. Food and Agriculture Organization, Rome

Fernando MTN, Zubair L, Peiris TSG, Ranasinghe CS, Ratnasiri J (2007) Economic value of climate variability impacts on coconut production in Sri Lanka. AIACC Working Paper No. 45 The AIACC Project Office, International START Secretariat, 2000, Florida Avenue, NW Washington, DC 20009 USA, pp 1–7

Gregory PJ, Johnson SN, Newton AC, Ingram JSI (2009) Integrating pests and pathogens into the climate change/food security debate. J Exp Bot 60(10):2827–2838

Gunasena HPM (2008) Strategies for increasing food production in Sri Lanka: some suggestions for government's food production drive. Econ Rev (Sri Lanka) 34(7&8):28–31

Hansen JW, Mason SJ, Sun L, Tall A (2011) Review of seasonal climate forecasting for agriculture in Sub-Saharan Africa. Exp Agric 47(2):205–240

Harvey CA, Chacon M, Donatti CI, Garen E, Hannah L, Andrade A, Bede L, Brown D, Calle A, Chara J, Clement C, Gray E, Hoang MH, Minang P, Rodriguez AM, Elverfeldt CS, Samroc B, Shames S, Smukler S, Somarriba E, Torquebiau E, Etten J, Wollenberg E (2013) Climate smart landscapes: opportunities and challenges for integrating adaptation and mitigation in tropical agriculture. Conserv Lett 00:1–14

Hasegawa T, Sakai H, Tokida T, Nakamura H, Zhu C, Usui Y, Yoshimoto M, Fukuoka M, Wakatsuki H, Katayanagi N, Matsunami T, Kaneta Y, Sato T, Takakai F, Sameshima R, Okada M, Mae T, Makino A (2013) Rice cultivar responses to elevated CO_2 at two free-air CO_2 enrichment (FACE) sites in Japan. Funct Plant Biol 40(2):148–159

Howden SM, Soussana JF, Tubiello FN, Chhetri N, Dunlop M, Meinke H (2007) Adapting agriculture to climate change. Proc Natl Acad Sci U S A 104:19691–19696

Iqbal MCM, Wijesundera DCA, Ranwala SMW (2014) Climate change, invasive alien flora and concerns for their management in Sri Lanka. Ceylon J Sci (Bio. Sci.) 43(2):1–15

Karunaratne GMMRB, Nissanka SP, Punyawardena BVR, Gunawardena AR (2015) Vulnerability of tea sector for climate change in the major tea growing regions in central hills of Sri Lanka. J Environ Professionals Sri Lanka 4(1):29–48

Malaviarachchi MAPWK, De Costa WAJM, Fonseka RM, Kumara JBDAP, Suriyagoda LDB (2015) Can seasonal temperature extremes alter the growth and yield of mung bean (*Vigna radiata* (L.) Wilczek)?. An investigation with different agronomic management packages conducive for climate adaptation. Ann Sri Lanka Dept Agric 17:92–96

Malaviarachchi MAPWK, De Costa WAJM, Kumara JBDAP, Suriyagoda LDB, Fonseka RM (2016) Response of mung Bean (*Vigna radiata* (L.) R. Wilczek) to an increasing natural temperature gradient under different crop management systems. J Agron Crop Sci 202(1):51–68

Malaviarachchi MAPWK, De Costa WAJM, Fonseka RM, Kumara JBDAP, Abhayapala KMRD, Suriyagoda LDB (2014) Response of maize to a temperature gradient representing long-term climate change under different soil management systems. Trop Agric Res 25(3):327–344

Malmgren BA, Hulugalla R, Hayashi Y, Mikami T (2003) Precipitation trends in Sri Lanka since the 1870s and relationships to El Niño—Southern Oscillation. Int J Climatol 23:1235–1252

Marambe B, Weerahewa J, Pushpakumara G, Silva P, Punyawardena R, Premalal S, Miah G, Roy J, Jana S (2012) Adaptation to climate change in agro-ecosystems: a case study from homegardens in South Asia. In: Proceedings of the MARCO symposium 2012—strengthening collaboration to meet agro-environmental challenges in Monsoon Asia, National Institute for Agro-Environmental Science, Tsukuba, pp 81–87

Marambe B, Punyawardena R, Silva P, Premalal S, Rathnabharathie V, Kekulandala B, Nidumolu U, Howden M (2015) Climate, climate risk, and food security in Sri Lanka: the need for strengthening adaptation strategies. In: Filho WL (ed) Handbook of climate change adaptation. Springer-Verlag Berlin, Heidelberg, pp 1759–1789

Mattsson E, Ostwald M, Nissanka SP, Marambe B (2013) Homegardens as a multi-functional land-use strategy in Sri Lanka with focus on carbon sequestration. Ambio 42:892–902

Meinke H, Howden SM, Struik PC, Nelson R, Rodriguez D, Chapman SC (2009) Adaptation science for agriculture and natural resource management-urgency and theoretical basis. Curr Opin Environ Sustain 1:69–76

MOE (2010) National climate change adaptation strategy for Sri Lanka 2011–2016. Ministry of Environment, Sri Lanka

Nguyen NV (2002) Global climate changes and rice food security. Food and Agriculture Organization Publication, Rome

Nissanka SP, Punyawardena BVR, Premalal KHMS, Thattil RO (2011) Recent trends in annual and growing seasons' rainfall of Sri Lanka. In: Proceedings of the International Conference on the Impact of Climate change in Agriculture, Faculty of Agriculture, University of Ruhuna, Sri Lanka, pp 249–263

Panabokke CR, Punyawardena BVR (2009) Climate change and rain-fed agriculture in the dry zone of Sri Lanka. In: Evans A, Jinapala K (eds) Proceedings of the National Conference on Water, Food Security and Climate change in Sri Lanka, Volume 02: Water Quality, Environment and Climate change. International Water Management Institute, Colombo, pp 141–146

Peiris TSG, Wijeratne M, Ranasinghe CS, Anandacumaraswamy A, Fernando MTN, Jayakody A, Ratnasiri J (2004) Paper presented at 2nd AIACC Regional Workshop for Asia and the Pacific, Manila

Premalal KHMS (2009) Climate change in Sri Lanka. In: De Costa WAJM, Nissanka SP, Mohotti AJ, Weerakoon WMW (eds) Proceedings of the First National Conference on Climate Change & Its Impacts on Agriculture, Forestry and Water, Faculty of Agriculture, University of Peradeniya, Peradeniya, p 3

Punyawardena BVR, Premalal KHMS (2013) Do trends in extreme positive rainfall anomalies in the central highlands of Sri Lanka exist? Ann Sri Lanka Dept Agric 15:1–12

Punyawardena BVR, Bandara TMJ, Munasinghe MAK, Jeyaratne Banda M, Pushpakumara SMV (2003) Agro-ecological regions of Sri Lanka (Map). Natural Resources Management Centre, Department of Agriculture, Peradeniya, Sri Lanka

Punyawardena BVR, Mehmood S, Hettiarachchi AK, Iqbal M, Silva SHSA, Goheer A (2013a) Future-climate of Sri Lanka: an approach through dynamic downscaling of ECHAM4 General Circulation Model (GCM). Trop Agric 161:35–50

Punyawardena BVR, Dissanayaka T, Mallawatantri A (2013b) Vulnerability of Sri Lanka to climate change—monograph. Department of Agriculture, Peradeniya

Senaratne A, Abeygunawardena P, Jayatilake W (2003) Changing role of non-timber forest products (NTFP) in rural household economy: the case of Sinharaja World Heritage site in Sri Lanka. Environ Manage 32(5):559–571

Senaratne A, Perera N, Wickramasinghe K (2009) Mainstreaming climate change for sustainable development in Sri Lanka: Towards a national agenda for action. Working Paper Series No. 14, Institute of Policy Studies, Colombo, Sri Lanka

Seo SN, Mendelsohn R, Minasinghe M (2005) Climate change and agriculture in Sri Lanka. a Ricardian Valuation. Environ Dev Econ 10:581–596 Cambridge University Press UK

Silva P (2009) Climate Change and Livestock. In: De Costa WAJM, Nissanka SP, Mohotti AJ, Weerakoon WMW (eds) Proceedings of the First National Conference on Climate Change & Its Impacts on Agriculture, Forestry and Water, Faculty of Agriculture, University of Peradeniya, Peradeniya, Sri Lanka, p 34

Smit B, Skinner MW (2002) Adaptation options in agriculture to climate change: a typology. Mitig Adapt Strat Glob 7:85–114

Somaratne S, Dhanapala AH (1996) Potential impact of global climate change on forest distribution of Sri Lanka. Water Air Soil Poll 92(1):129–135

Tanaka I (1976) Climatic influence on photosynthesis and respiration of rice. In: Proceedings of the symposium on climate and rice, International Rice Research Institute, Philippines

Titumil RAM, Basak JK (2010) Agriculture and food security in South Asia. A historical analysis and a long run perspective. The Innovators, Dhaka

Van Noordwijk M, Bayala J, Hairiah K, Lusiana B, Muthuri C, Khasanah N, Mulia R (2014) Agroforestry solutions for buffering climate variability and adapting to change. In: Fuhrer J, Gregory PJ (eds) Climate change impact and adaptation in agricultural systems, CAB International, pp 216–232

Weerahewa J, Pushpakumara G, Silva P, Daulagala C, Punyawardena R, Premalal S, Miah G, Roy J, Jana S, Marambe B (2012) Are home garden ecosystems resilient to climatic change? An analysis of adaptation strategies of home gardens in Sri Lanka. APN Sci Bull 2:22–27

Weerakoon WMW (2013) Impacts of climate change on food security in Sri Lanka. In: Proceedings of the international conference on climate change impacts and adaptation, Coconut Research Institute of Sri Lanka, Lunuwila, Sri Lanka

Weerakoon WMW, Maruyama A, Ohba K (2008) Impact of humidity on temperature-induced grain sterility in rice (*Oryza sativa* L.). J Agron Crop Sci 194:135–140

Wickramasinghe WMADB (2013) Present status of climate change, its impact on Sri Lankan agriculture and the way forward. In: International Symposium on Agriculture and Environment, University of Ruhuna, Sri Lanka, pp 73–78

Wijayagunawardane MPB (2009) Impacts of global warming on livestock reproduction. In: De Costa WAJM, Nissanka SP, Mohotti AJ, Weerakoon WMW (eds) Proceedings of the First National Conference on Climate Change & Its Impacts on Agriculture, Forestry and Water, Faculty of Agriculture, University of Peradeniya, Peradeniya, pp 36–37

Wijeratne MA (2011) Adaptations to the threats of climate change: Strategies for plantation crops with special reference to tea. J Natl Inst Plantation Manage 25(1):23–31

Wijeratne MA, Anandacoomaraswamy A, Amaratunge M KSLD, Ratnasiri J, Basnayake BRSB, Kalra N (2007) Assessment of impact of climate change on productivity of tea (*Camellia sinensis* L.) plantations in Sri Lanka. J Natl Sci Found Sri Lanka 35(2):119–126

Wijesuriya W, Samarappuli L (2009) Impact of climate change on rubber plantations. J Natl Inst Plantation Manage 23(2):1–17

Yoshida S (1978) Tropical climate and its influence on rice. IRRI Research Paper Series 20, International Rice Research Institute, Los Baños, Philippines

What's the Worst Thing that Can Happen?—A Simple Exercise to Communicating and Reasoning About Climate Change

Markus Will and Joost Platje

1 Climate Communication and the Knowledge-Behavior Gap

Scientists and other actors have been engaged in communicating their results to the public since years.[1] Climate communication, as a special form of environmental and risk communication, is challenging not only due to characteristics of climate change itself,[2] the psychological mechanisms[3] and cognitive restrictions,[4] but also due to conflicting world views and the (lack of) institutionalization and politicization of the topic.[5] Past efforts to foster behavioral changes with the help of (climate) communication have not been very successful.[6] Generally speaking, incentives for

[1]Moser (2010).
[2]E.g., complex physics, lack of immediacy and visibility of impacts, time-lag and geographical distance between cause and effects, etc.
[3]Defense mechanisms such as denial, rational distancing, apathy and delegation as well as confirmation bias and polarization.
[4]Cognitive limitations refer to the non-immediacy and non-tangibility of environmental problems, that are often not directly noticed due to slow and gradual rates of occurrence and time lags or simply due to the inability to detect. Humans are also often not able to grasp dynamic and complex systems and then to linear thinking and simplification (Kollmuss and Agyeman 2002 Ref. to Preuss 1991; Fliegenschnee and Schelakovsky 1998).
[5]Stehr (2015a, b), Giddens (2009), Prins et al. (2010).
[6]Gifford et al. (2011), Corner et al. (2011) cited in Hagen et al. (2015).

M. Will (✉)
University of Applied Sciences Zittau/Görlitz, Theodor-Körner Allee 16, 02763 Zittau, Germany
e-mail: m.will@hszg.de

J. Platje
WSB University in Wrocław, Ul. Fabryczna 29/31, 53-609 Wroclaw, Poland
e-mail: johannes.platje@wsb.wroclaw.pl

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_9

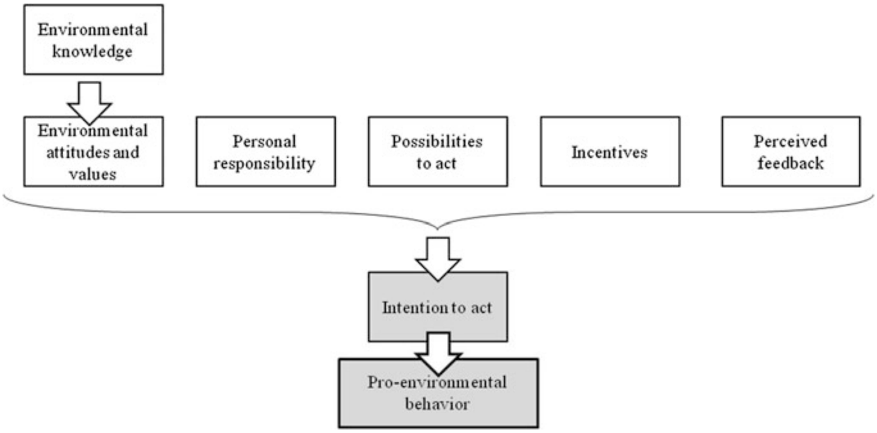


Fig. 1 Triggers of environmental behavior (based on Hines et al. 1986; Fietkau and Kessel 1981)

individual actions and political interventions are weak, because costs for climate mitigation are visible in the short term, while benefits are unsure and may become only visible in the long run. Also, climate communication is often based on the *information deficit model*,[7] but apparently science and knowledge alone will not bring people to change their behavior.[8] Information about climate change are, due to the complexity of climate sciences, often mediated and therefore people tend to rely on secondary information, which often leads to emotional detachment and non-involvement.[9] And even when people are informed about climate change and consider it as a serious problem, this is often not reflected in corresponding life style changes ("*knowledge-behavior gap*"). There must be other triggers for pro-environmental and climate friendly behaviors, such as incentives and possibilities to act pro-environmentally as well as a perceived positive feedback reinforcing (see Fig. 1).

In order for the outreach from the scientific community to the public in the form of climate communication to be useful to close the *knowledge-behavior gap,*[10] the psychological mechanisms regarding risk perception as well as the values and mind sets of different public groups should to be addressed.[11] Essentially, a change of mental models is needed for a profound transformation, which is typically also most difficult[12] as it involves reflective thinking.

[7]Nerlich et al. (2010), cited in Hagen et al. (2015).

[8]Moser and Dilling (2010).

[9]Kollmuss and Agyeman (2002) Ref. to Preuss (1991) and Fliegenschnee and Schelakovsky (1998).

[10]Moser and Dilling (2007), Shome and Marx (2009).

[11]Kahan et al. (2011), Moser (2010, 2016), Weber and Stern (2011).

[12]Meadows (1999).

The aim of this chapter is to provide and critically assess a structured exercise and a facilitation guideline as a tool for lecturers, teachers, consultants and other practitioners, who need to communicate about climate change to a wider (non-academic) public audience. The purpose of the paper is to help facilitating of general discussions about climate change within a rational framework. Making use of the Craven's grid, its limits are assessed and opportunities for further development are derived. The grid can be developed into an instrument that may prepare participants for understanding small probability, high impact events. As such, the exercise can be very useful for discussing climate change issues, but also other events which are grounded in the increasing complexity of systems.

The work presented here is based on a comprehensive and systematic literature review and, even more important, includes knowledge from several years of experiences reaching from lectures at many universities as well as consulting projects in the field of municipal climate change management with citizen participation.

2 A Step-by-Step Guide to the Exercise "What's the Worst Thing that Can Happen"

In this section an exercise is suggested to be applied in seminars and discussions. It consists of four steps and it will take about 2.5 h to be conducted with a group of 10–25 people. The exercise is based on a decision grid, which was developed by Gregory Craven (therefore "Cravens grid"). It is actually an adoption of an argument in apologetic philosophy that was derived by the French philosopher, mathematician and physicist Blaise Pascal (1623–1662). Pascal's Wager (Pensées III, § 233) deals with the question whether good exists and how a rational person should believe and live. A rational person, according to Pascal, should seek to believe in God, because if God actually does not exist, such a person will have only a finite loss, for example abstinence from some pleasure, luxury, etc.). If God exists, infinite gain (eternity in heaven) can be gained and infinite losses (eternity in hell) can be avoided.[13] To put it very simple, a rational person should believe in God because it is simply the best bet.[14] Pascal's Wager is one of the first theoretical contributions to decision making under uncertainty and pragmatism. Pragmatic arguments are designed in a way to motivate belief even in the absence of strong (scientific) evidence. Prudential reasoning is employed on behalf of the conclusions,[15] i.e. the proposition that some behavior would be beneficial, instead of relying to scientific or ontological proof or cosmological arguments. When it comes to climate change there is also no 100% evidence that global warming is related to

[13]Hacking (1972), Jordan (2006).

[14]Hájek (2012).

[15]Jordan (2006).

human activities, though the IPCC latest reports considers is as extremely likely that anthropogenic activities are the dominant cause of the observed warming since mid 20th century.[16] The question in discussions with skeptics and deniers is: when faced with uncertainty, contradictory expert judgments and in absence of a "silver-bullet-argument", what is a lay person supposed to do to avoid risk or harm?[17] This line of the argument is related to the precautionary principle. Another line of Craven's argument is what would a skeptic have to see for changing her opinion? We suggest dealing with those questions in the following steps.

Step 1: Setting the Stage (15 min.)

Before starting the exercise with a group of about 10–25 people it is important to set the stage (e.g., a flip chart in the center of the room, participants should sit in a circle) and to create a productive working atmosphere. The participants should get a short description of what they are about to experience in the session. The learning objective is to understand the role of science when faced with uncertainty and highly disruptive, low probability events and to interpret the precautionary principle. The exercise does not focus on the question on what to think about climate change but on how to think and how to take decisions. Participants can come up with a conclusion on their own. It might be useful to ask the group to agree with to some basic requirements, i.e.

- Openness towards the exercise as such and openness to considering new ideas or arguments.
- Participation, as everybody will have to participate in the exercise as it is not a lecture but a discussion.
- Respectful dialogue is a central requirement, it includes the willingness and explore alternative perspectives but also to deal with each other in a friendly way. This does however not mean that everyone is expected to agree or to hold the same values.

> ***Facilitation Note***: *Make a proper room arrangement and set the tone—Explain the learning objective(s) of the session.*

Step 2: Conditions for Changing your Mind (10 to 15 min.)

When dealing with conflicting opinions and evaluations in a discussion, it is a precondition that everybody is at least willing to listen to the others argument and, principally, willing and able to change the own point-of view. If people are not able or willing to change their opinion, the whole discussion is tainted with dogmatism.

---

[16]IPCC (2014).

[17]Craven (2010), Blumen (2010).

Table 1 Perspectives on global warming

Perspective	Conditions to change your mind
(X) You are inclined to think that global warming is overblown…	What would you have to see for you to become convinced that serious and massive action should be taken right now to combat global warming?
(Y) You are inclined to be concerned about global warming and you think we should do something about it	What would you have to see for you to become convinced that we should NOT do anything right now to mitigate or adopt to climate change?

Craven (2010)

As nobody is perfect, there is of course the possibility to act on a wrong understanding. A discussion therefore should be directed to uncover errors and invalid arguments. If people are not willing to change their opinion and stick to their perceptions instead, a discussion is actually a waste of time and would probably ending up in shouting against each other without any fruitful results.

Facilitation Note: *Ask the participants of the discussion or seminar to choose one of the perceptions given in Table 1 and to come up with a description of the conditions for changing their opinions. In the case the majority of participants shares perspective Y, work with this result and explain that finding arguments "contra action" is still a worthy exercise for preparing a campaign* etc. *The important issue still is to find out, what people need to change their mind.*

Step 3: Craven's Grid—What's the Worst That Could Happen? (25 min.)

Craven combines the perspective on global warming (true | not true) and the necessity for taking action in order to reduce GHG emissions (do something | do nothing) into a very simple decision grid with four-fields. The premise is that the problem of dealing with climate change can be reduced to choosing one of four possible outcomes (A, B, C, and D) (Table 2).

Facilitation Note: *Ask the participants to brainstorm conceivable outcomes from a worst-case perspective. The participants should answer the question 'What is the worst that could happen?' in each field of the grid (A, B, C and D).*

With the help of the grid, four different scenarios and possible outcomes can be developed by the participants. Taking actions may require the sacrifice of a significant amount of resources, which cannot be used for other purposes. There also

Table 2 Craven's decision grid with examples

	Actions	
Global warming	Do something	Do nothing
False	(A) Wasted resources, global economic depression	(B) Avoid of wasting financial resources
True	(C) Prevent total disaster	(D) Total disaster (ecological systems, impacts on economic, social and political systems, public health etc.)

Craven (2010), Blumen (2010)

may be some sort of social cost related to a restriction of liberties and democratic participation.[18] However, the cost of action may be irrelevant compared to the cost of inaction,[19] as a global catastrophe would destroy life as we know it.[20] The grid allows for discussing possible consequences of the choices to be made and to compare the outcomes, for example[21]:

- *Field A*: If action is taken, but global warming turns out to be not real, the possible consequences are runaway government spending and increased cost and waste of money for industry and consumers, leading to job losses as well as translocation of industry to countries with less restrictive regulation ("carbon leakage"). Positive environmental and health effects, for example to reduced emissions from coal power plants, are excluded.
- *Field B*: It turns out that a business as usual scenario, with no or low ambitious actions to mitigate climate change, was the right decision because dramatic global warming does not occur. Everybody is happy; the skeptics because they were right and the activists because this was not the end of the world after all.
- *Field C*: The lower left box shows the future where action was taken. This was a good thing, because the doomsayers were right. The increased cost and more regulation were worth it, as dramatic global warming impacts could be avoided.
- *Field D*: This is the second mistake one can make with even more tremendous consequences compared to (A). The doomsayers predictions of dramatic impacts of global warming (such as sea level rise, climate refugees, infectious diseases, extreme weather events) are true, but serious actions have not been taken in time to mitigate and avoid severe impacts.

[18]Stehr (2015a).

[19]Harris et al. (2015), Stern (2007), Nordhaus (2008).

[20]Schellnhuber (2010), Ehrlich and Ehrlich (2013), Mann (2009).

[21]Based on Craven (2010).

Step 4: Column Thinking Versus Row Thinking—What's the Most Acceptable Risk? (25 min.)

> ***Facilitation Note***: *Let the participants discuss which scenario (A, B, C or D) is the most acceptable, i.e. the one related to the least risk. What arguments do the participants bring up for making a choice between* do something | do nothing*? What are the criteria of acceptability?*

Although the grid is an over-simplification, it might be useful to analyze decision making with regard to the precautionary principle. Craven distinguishes row thinking and column thinking. *Row thinking* means that with regard to global warming to answer the question whether the predictions about global warming are true or not. However, climate models are uncertain and one cannot know which row is true beforehand. Row thinking leads to getting stuck with guessing about the future and the accuracy of modeling. In *column thinking*, a choice has to be made about things that can be controlled, i.e. taking action or wait-and-see. Making choices about uncertain future outcomes is something that everybody does every day, whether unconsciously or with help of sophisticated decision-systems. Framed like this, Craven's reasoning becomes clear. The only rational choice which minimizes risk is taking action in order to avoid scenario (D), and therefore employ the precautionary principle.

Step 5: Debriefing (40 min.)

Debriefing is the most essential part of the exercise. Debriefing is more than a reflection as it also involves some teaching and should led to effective learning. Debriefing aims at sharing observations and giving clarification. In this exercise, debriefing concerns in particular the conditions and the legitimation of arguments and of the precautionary principle. During debriefing, reflective thinking about the usefulness and the limitations of Craven's grid should be encouraged. Debriefing provides a structure for reflection and review of an exercise in an emotional, cognitive and practical way.[22] Typically, debriefing is a series of questions asked to the participants in order to recall the exercise and to evaluate the participant's role in it. Obviously further and deeper examination of the topic should be triggered. The following questions are suggested.

(1) What happened during the exercise?
(2) What are the main features of Craven's grid?
(3) Do you find any characteristics of Craven's grid in real life situations?
(4) After this experience, how could you better manage discussions about complex issues?

---

[22] Allan (2011).

Some of them will be discussed in the next sub-chapter:

(5) What are the limitations of Craven's grid?
(6) What is the role of science in decision making under uncertainty (related to climate change impacts and the solutions for mitigation and adaptation)?
(7) What can be learned for the application of the precautionary principle?

Facilitation Note: *Debriefing should take place after a short coffee break. Document discussion points at a flip chart. Some aspects that may come up will be discussed in the next section.*

3 Food for Thought—Limitations of Craven's Grid

First of all, Gregory Craven's grid is a simplification. It aims at breaking "analysis paralysis" caused by waiting for 100% scientific proof. Instead, the question is (re-) framed to what seems to be the best bet?. It is about whether the participants would like to play a kind of Russian Roulette, while accepting low probability of high impact and "no impact" outcomes at the same time.[23] However, with regard to the uncertainty involved, is should be clear that uncertainty in this case means a higher probability of seriously adverse outcomes rather than a chance that climate change will not occur or that the impacts are minor.

Obviously there are some limitations with regard to the logic and completeness of the argumentation, while specific issues of so-called statistical "fat tails" involved in low probability and high impact events are not dealt with.[24] The grid is, however, an appropriate tool as it can guide a decision. It gives a relatively clear answer which option is preferable. The answer is actually determined by two factors: the likelihood (probability) of the rows and the magnitude of the consequences. This is a simple risk management approach (Risk = P $\times$ C). However, trying to reliably determine the factors again needs extensive scientific investigations, which actually should be avoided. There is also the general problem, that, as Kahneman (2011) shows, there is a tragedy for policy makers because they never can prove that a disaster was prevented. People preventing a disaster may be persecuted, even feel themselves losers, as even they themselves may not know they prevented the disaster.

The exercise can, however, induce fruitful discussions with participants about various issues how to deal with uncertainty and small probability, high impact

[23]See Taleb (2007).

[24]http://scienceblogs.com/stoat/2015/01/03/greg-cravens-viral-climate-decision-grid-video/ (2016-04-08).

scenarios. In this section the following selected questions will be addressed. Be prepared that other limitations of the approach might come up during discussions:

1. The role of science and uncertainty about climate change impacts
2. Uncertainty related to climate change impacts
3. The role of science in assessing the effectiveness of mitigative actions
4. The precautionary principle and climate change.

Ad (1) The Role of Science and Uncertainty About Climate Change Impacts

The core of the argument that is used relates to Pascal's Wager. It is some sort of cost-benefit analysis (though without any quantified data). Craven argues that a decision between taking serious action and doing nothing (column thinking) is more appropriate in the face of uncertainty than waiting for ultimate scientific evidence regarding the occurrence of climate change, the anthropogenic causes and future impacts. The grid therefore is composed of rows, e.g. is global warming true and damages should be expected and columns, e.g. representing hypothetical (potential) cost of action and inaction. The argumentation of Craven's grid relies basically on the premise that something really bad, e.g. catastrophic climate change might happen.

The point is that if the damages are exaggerated, the same sort of argument can be used to guard against any potential danger, no matter how ridiculous it is. The list of hypothesis about what *might happen* is unlimited as long less evidence is required for any particular event. If the level of paranoia and the stakes are high enough it also does not matter how expensive or risky the mitigative counter action could be. For the sake of the greater good action should be nevertheless taken. This sort of argument has been used several times, from the allies invasion on WW II to the invasion in Iraq because the danger of weapons of mass destruction. The conclusion of column thinking is inescapable to all rational people—action must be taken.[25] Craven is aware of this limitation and tries to deal with it by using another widely speculative and dangerous threat (giant mutant space hamsters),[26] which apparently makes the grid pointless.[27]

The key here lies in the likelihood of certain global warming impacts and their magnitude, which are both assumed to be high with 'some' evidence is available.[28] Uncertainty is of course a fundamental issue here, also with respect how the information will be received by the public.[29] The IPPC is very aware of this fact,[30] and is also criticized for way it deals with uncertainty.[31] In the IPPC guidelines, the

[25]Blumen (2010).

[26]Another examples of this argument was used by Richard Lilton in this comment: http://www.blackswanreport.com/blog/2015/05/our-statement-on-climate-models/ (2015-08-16).

[27]Craven (2010: 30).

[28]IPCC (2014).

[29]Curry (2011), Cooke (2015), Platje and Kampen (2016), Oppenheimer (2005).

[30]Mastrandrea et al. (2010), Moss and Schneider (2000), cited in EEA (2013).

[31]van der Sluijs et al. (2010a, b) in Curry (2011), Curry and Webster (2011).

statistical uncertainty is distinguished from the systemic or structural uncertainty, such as ignorance and unquantifiable uncertainty. The uncertainty of results for different GHG future emission scenarios is described with the likelihood for statistical uncertainty[32] and with a depiction of evidence and agreement as a synthesis of the IPCC author team's judgments. The IPCC author's team validates findings regarding the type, amount, quality and consistency of the evidence[33] and the degree of agreement.[34]

However a logical fallacy (circular logic, *circulus in probando*) occurs when trying to establish valid and reliable information about probabilities. Craven, on the one hand, argues for a making choice in the face of uncertainty instead of waiting for complete scientific evidence. On the other hand, the grid relies on the assumption that there is some likelihood for occurrence of negative impacts, which in itself requires scientific evidence. Although the climate scientist's community has developed ways to deal with and communicate uncertainty, this is very different to the way policymakers and laymen frame uncertainty.[35] Despite a broad consensus about climate change, there is a cacophony of opinions expressed by different actors including voices of doubt, skepticism and denial. Especially when a skeptical or contrarian discourse gets much public attention and media coverage (e.g. the TV documentation The Great Global Warming Swindle from 2007), or in combination with other events ("climate gate") which are claimed as evidence of scientific dishonesty, there is a rise in climate change denial and postponement of action. In the end, uncertainty cannot be avoided. The grid exercise suggests to base decisions on the assumption that it is more important to be safe than to be right, or, to be better safe than sorry, which is an attitude of risk aversion.

Ad (2) The Role of Science in Assessing the Effectiveness of Mitigative Actions

The same logical limitation occurs with regard specific actions to be taken. Craven separates the decision between *"do something"* and *"do nothing"* from the question what exactly should be done. "Do something" refers to significant and effective measures that might reduce the emission of greenhouse gases. "Do nothing" means little of no action. However, it is quite not sure that the desired results will be achieved and therefore effective. Instead, unintended and unexpected side-effects may occur. Therefore, all the measures to be taken to combat climate change should be evaluated regarding their direct and indirect effects. These side-effects can be positive or negative (see Table 3).

[32]Likelihood scale according to Mastrandrea et al. (2010): virtually certain (99–100% probability), very likely (90–100% probability), likely (66–100% probability), about as likely as not (33–66% probability), unlikely (0–33% probability), very unlikely (0–10% probability), exceptionally unlikely (0–1% probability).

[33]Evidence scale according to Mastrandrea et al. (2010): limited, medium, robust.

[34]Agreement scale according to Mastrandrea et al. (2010): low, medium, high.

[35]Pidgeon and Fischoff (2011).

Table 3 Side-effects and their evaluation (Gloede 2007, translated)

Assessment	Intended	unintended/unexpected
Positive	Aspired "Synergies"	Pleasant Surprises
Neutral	Negligible, Minor by-products	
Negative	Accepted collateral damage	Awkward surprises Problems to be eliminated

Technological interventions, such as the increased uses of renewable energies or climate engineering may have positive side-effects in addition to their primary effects such as low-carbon energy generation or albedo enhancements through aerosol injection into the atmosphere.[36] However, technological interventions have their own risks[37] and are potentially creating new problems. Nuclear power is considered as low-carbon technology, but there is a potential risk of nuclear reactor meltdowns and the release of radioactive material. The increased use of biofuels have had some impacts on the environment (land use, biodiversity) as well as on agricultural markets and food security.[38] Climate engineering in particular involves large-scale interventions in complex Earths systems. The effectiveness and potential side-effects to environmental, social, political and economic risks are not adequately understood.[39] As the technological fixes will probably not be sufficient to cope with the problem, major political interventions might be necessary in order to change public and individual behavior. In times of a perceived exceptional circumstances, weakening of democratic institutions and the suspension of freedom is suspected.[40]

Some sort of scientific analysis is needed to establish a cause-effect chain between a set of concrete actions and the desired result. There will be no one single answer, no simple silver bullet, instead a mixture of different approaches and measures on multiple governance levels is needed.[41] Again, scientific advice, for instance in the form of *prospective technology assessment*, is needed for rational decision making. All decisions to be taken for combating climate change have to accept limited budgets. It seems rational to only spend money for measures that are effective. If a vast amount of money is used to prevent or mitigate only one risk, then the ability to deal with other sustainability problems is limited. Therefore, the grid needs more columns perhaps an unlimited number of columns representing a wider range of choices to provide sufficient guidance on a more detailed level.

[36]Crutzen (2006), Heckendorn et al. (2009).

[37]Hegerl and Solomon (2009), Leisner and Müller-Klieser (2007).

[38]FAO (2008).

[39]NAS (2015).

[40]Stehr (2015a, b).

[41]Prins and Rayner (2007).

Ad (3) The Precautionary Principle and Climate Change

The premise that actions should be induced rather than waiting for near-to certain scientific evidence is known as the precautionary principle. It relates to the questions addressed here in different ways, e.g. regarding (a) the need for action in the face of anticipated damage, (b) the proof of effectiveness of certain actions and finally (c) the risk of side effects of some far-reaching technologies such as climate engineering. According to the Rio Declaration on Environment and Development[42] the precautionary principle states:

> Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

The precautionary principle is meant to deal with decisions in the absence of evidence or the incompleteness of scientific knowledge. Throughout application of the precautionary principle decision makers should be prevented from putting society and future generations at risk from postponing necessary action or from unexpected side effects. The precautionary principle is often criticized as unreasonable and paranoid.[43] However, there are few cases where applying the precautionary principle was unnecessary ("false positives" in field A of Table 2), as the risks turned out not to be as serious as initially feared:

- Swine flu mass immunization of the entire American population in the US in 1976,
- Reluctance of the US Food and Drug Administration to allow food irradiation due to expected consumer health impacts,
- Labeling of saccharin as potential human carcinogen.

The costs of the false positives are mainly economic, for instance because some technologies became restricted and money spent diverted resources from other potentially serious risks. in some cases innovation was driven due to stringent regulations such as in the case of saccharin. However, there are far more examples of cases were the precautionary principle was appropriate (e.g. smoking cigarettes) and also some case of false negatives, where early warnings exist but no or late action was taken (asbestos, halocarbons, TBT, hormones as growth promoters, mad cow disease).[44]

It remains an open question when the precautionary principle should be applied in order to prevent naive justification of any act of caution and regulatory abuse. It seems to be common sense, that it should only be applied to serious risks, where

---

[42]http://www.unep.org/documents.multilingual/default.asp?documentid=78&articleid=1163 (2016-08-15).

[43]Sandin (2004), Sandin et al. (2011) is aims to defend the PP but illustrates some arguments against it.

[44]EEA (2001).

statistical evidence is limited or absent.[45] Serious risks are extreme situations and high impact events which can lead to irreversible ruin of mankind and/or ecosystems. A ruin problem or X-event, in the language of insurance, is an event that causes unrecoverable systemic (rather than local) losses with a non-zero but poorly known probability such as the extinction of species or a planet wide irreversible termination of life.[46] The other question is, whether disruptive climate change should be considered a ruin event that eventually leads to collapse.[47] A number of possible impacts that are large-scale, non-linear and irreversible in a reasonable time-scale have been identified.[48] Of course, these impacts may occur in combination with other connected sustainability challenges trends such as overconsumption, soil degradation etc. There are also opinions that do not see anthropogenic climate change as ruin and catastrophe.[49] In order to answer the question if climate change is to be considered a ruin event, further scientific analysis is needed. However, further investigation may leads to infinite regress: the truth of the proposition "Climate change is likely to be a ruin event" (P1) requires the truth of another proposition P2 ("Vulnerabilities of ecosystems can be quantified"), which requires P3 to be true (e.g. "Resilience of ecological systems will be overstrained"), which requires the truth of another proposition P4 (e.g. "Climate change will trigger tipping points in ecosystems"), and so on and so forth. Waiting for more scientific evidence can mean to get stuck in "analysis-paralysis" and postponing decisions.

The standard evidence based approach common to scientific methods cannot work. The idea of the precautionary principle is categorically different from the approach of evidence-based decision making. Evidence-based approaches, e.g. statistical-evidentiary approaches to risk management count the frequency of past events and generate probabilities of future events. The evidence therefore occurs when an impact can be experienced, which, in the case of disruptive climate change is then too late to avoid it.[50]

Stepping aside from skepticism about the correctness of climate models, an important implication of the arguments presented in this paper is that we face the risk of disruptive climate change. As it concerns the whole Earth, no experiments, no trial-and-error can take place. While this legitimates applying the precautionary principle, the exercise with Craven's Grid should make the participants aware that when not doing anything, we are playing a kind of Russian Roulette.

---

[45]Whether there are no data available, because there are no models and measurements or "because it [the event] has not had time to show up" (Taleb et al. 2014).

[46]Taleb (2014), Casti (2013).

[47]Ehrlich and Ehrlich (2013), World Bank (2012).

[48]Examples of climate change impacts taken from van der Sluijs and Turkenburg (2006): such as a regime shift in the thermohaline ocean circulation, sea level rise of several meters, loss of unique ecosystems, extinction of species, migration of environmental refugees, more frequent and intense extreme weather events, reduction of food security and changes in the distribution of diseases.

[49]https://judithcurry.com/2015/03/30/is-climate-change-a-ruin-problem/ (2015-08-08).

[50]Taleb et al. (2014).

4 Limitations of the Exercise

The exercise as such is, of course, a simplification of a complex issue. A central requirement for an effective experience is an respectful dialogue and openness. It might be useful that the facilitator ask the group to agree on the principles of openness, participation and respectful dialog.

5 Concluding Remarks

In this paper a simple exercise to climate communication and decision making under uncertainty was presented. This exercise is important in the context of the high level of public indecisiveness regarding climate change.[51] This is because (a) people often have difficulties with understanding the statistical nature of climate change,[52] (b) people have difficulties with understanding complex systems[53] and think rather in simple cause-consequence relations[54] and because of a lack of (c) systematic politics and governance mechanisms.[55]

Under the claim "*What's the worst thing that can happen?*", participant should experience a situation where they can derive an own opinion. Most likely the decision will be in favor for the precautionary principle. The simplicity of the exercise is both a benefit and a drawback.

It should be kept in mind that Craven's target audience are high school students. However, discussion about these limitations may also support an effective communication about climate change or other issues regarding complexity and uncertainty in decision making. There are other, let's say more scientific studies, that support Cravens claim against the wait-and-see approach.[56]

But still, the Craven's grid is a simple exercise which can be extended in various ways to overcome its limitations. Doing so would allow discussing a number of issues more deeply. A simple extension would be to use numbers instead of symbolic representations ("smiley's") in order to describe the cost of action and inaction. For instance, one can represent the cost of action with 20 and the cost of inaction, the impact of catastrophic global warming with 400, which is the upper-limit of cost-benefit estimations in the Stern report. The grid can also be extended by including more increments for the climate change impacts, for example from "true vs. false" to a scale from "none", "low", "high" or "extreme". Also an extra option of "adapt" can be added to the make the range of actions in

[51]Leiserowitz et al. (2016).

[52]Kahneman (2011), Platje and Kampen (2016).

[53]Sterman (2000), Casti (2013).

[54]Kahneman (2011).

[55]Giddens (2009).

[56]Newell and Smithson (2014), Lewandowsky et al. (2014).

"do something" more precise. While Craven's grid and its precursor Pascal's Wager are straightforward decision making tools, every extension would need more information and analysis. A direction of development of the exercise for academic purposes is to make a link to system theory.[57] In system theory, developing a system diagram is a basis for identifying mental models and understanding complex systems and non-linearities. This creates a more advanced basis for decision-making under uncertainty. This exercise can in fact be a nice preparation for a system approach. While such system exercises are very time consuming, they may be a good follow up of this simple exercise.

References

Allan H (2011) Debrief: a reflective tool for workplace based learning. https://www.kcl.ac.uk/lsm/research/divisions/meded/teachers/resources/debrief.pdf. Accessed 8 Apr 2016

Blumen R (2010) Must we do something, anything, about global warming? Published on Mises Institute. https://mises.org/print/8326. Accessed 5 Aug 2016

Casti JL (2013) X-Events—complexity overload and the collapse of everything. HaperCollins Publishers, New York

Cooke RM (2015) Messaging uncertainty in climate change. Nat Clim Change 5(8–10) doi:10.1038/nclimate2466

Corner A, Venables D, Spence A, Poortinga W, Demski C, Pidgeon N (2011) Nuclear power, climate change and energy security: exploring British public attitudes. Energ Policy 39 (9):4823–4833. doi:10.1016/j.enpol.2011.06.037

Craven G (2010) What's the worst that could happen? A rational response to the climate change debate. Perigee Book by Penguin Group, New York, USA

Crutzen PJ (2006) Albedo enhancements by stratospheric sulfur injections: a contribution to resolve a policy dilemma? Clim Change 77(2006):211–219

Curry J (2011) Reasoning about climate uncertainty. Clim Change 108:723–732

Curry JA, Webster PJ (2011) Climate science and the uncertainty monster. Bull Am Meteorol Soc 2011:1677–1682. doi:10.1175/2011BAMS3139.1

EEA (2001) Late lessons from early warnings: the precautionary principle 1896–2000. European Environment Agency, Luxembourg

EEA (2013) Late lessons from early warnings II: science, precaution, innovation. European Environment Agency, Luxembourg

Ehrlich PR, Ehrlich AH (2013) Can a collapse of global civilization be avoided? Proc R Soc B 280:20122845. doi:10.1098/rspb.2012.2845

FAO Food and Agriculture Organization of the UN (2008) Biofuels—prospects risks and opportunities. Rome

Fitkau HJ, Kessel H (1981) Umweltlernen: Veränderungsmoeglichkeiten des Umweltbewusstseins. Modelle-Erfahrungen. Schriften des Wissenschaftszentrums Berlin. Vol 18, 1st ed. Königstein/Ts.: Hain

Fliegenschnee M, Schelakovsky M (1998) Umweltpsychologie und Umweltbildung: eine Einführung aus humanökologischer Sicht. Facultas Universitäts Verlag, Wien

Gifford R, Kormos C, McIntyre A (2011) Behavioral dimensions of climate change: drivers, responses, barriers, and interventions. WIREs Clim Change 2(6):801–827. doi:10.1002/wcc.143

[57] Sterman (2000).

Giddens A (2009) The politics of climate change. Polity Press, Cambridge, UK
Gloede F (2007) Unfolgsame Folgen—Begründungen und Implikationen der Fokussierung auf Nebenfolgen bei TA, *Technikfolgenabschätzung—Theorie und Praxis* Nr. 1, 16. Jg., März 2007
Hacking I (1972) The logic of Pascal's Wager. Am Philos Q 9(2):186–192. http://www.jstor.org/stable/20009437
Hagen B, Middel A, Pijawka D (2015) European climate change perceptions: public support for mitigation and adaptation policies. Environ Pol Gov. doi:10.1002/eet.1701
Hájek A (2012) Pascal's Wager. In: Edward N. Zalta (ed) The Stanford Encyclopedia of Philosophy (Winter 2012 Edition). http://plato.stanford.edu/archives/win2012/entries/pascal-wager/, http://plato.stanford.edu/entries/pascal-wager/. Accessed 5 Aug 2016
Harris JM, Roach B, Codur AM (2015) The economics of global climate change. Global Development and Environment Institute, Tufts University, Medford
Heckendorn P, Weisenstein D, Fueglistaler S, Luo BP, Rozanov E, Schraner M, Thomason LW, Peter T (2009) The impact of geoengineering aerosols on stratospheric temperature and ozone. Environ Res Lett 4(4):045108, 1–12. doi:10.1088/1748-9326/4/4/045108
Hegerl GC, Solomon S (2009) Risks of climate engineering. Science 325:S 955–956
Hines JM, Hungerdford HR, Tomera AN (1986) Analysis and synthesis of research on responsible pro-environmental behavior: a meta-analysis. J Environ Educ 18(2):1–8
IPCC 2014 Climate change 2014: Synthesis Report. [Core Writing Team, Pachauri RK, Meyer LA (eds) Contribution of Working Groups I, II and III to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change. Geneva, Switzerland, pp 151
Jordan J (2006) Pascal's Wager: pragmatic arguments and belief in god. Clarendon Press, Oxford
Kahan DM (2014) Making climate-science communication evidence-based—all the way down. http://papers.ssrn.com/sol3/papers.cfm?abstract_id=2216469
Kahnemann D (2011) Thinking, Fast and Slow. Farrar, Straus and Giroux, New York USA
Kollmuss A, Agyman J (2002) Mind the gap—why do people act environmentally and what are the barriers to pro-environmental behavior. Environ Educ Res 8(3):2002
Leiserowitz A, Maibach E, Roser-Renouf C, Feinberg G, Rosenthal S (2016) Climate change in the American mind: March, 2016. Yale Program on Climate Change Communication, Yale University and George Mason University, New Haven, CT
Leisner T, Müller-Klieser (2007) Aerosolbasierte Methoden des Climate Engineering—Eine Bewertung. Technikfolgenabschätzung – Theorie und Praxis 19. Jg., Heft 2, Juli 2010
Lewandosky S, Rishbey J, Smithson M, Newell BR, Hunter J (2014) Scientific uncertainty and climate change: part I uncertainty and unabated emissions. Clim Change 124:21–37. doi:10.1007/s10584-014-1082-7
Mann ME (2009) Defining dangerous anthropogenic interference. PNAS Proc Natl Acad Sci, USA, p 106
Mastrandrea MD, Field CB, Stocker TF, Edenhofer O, Ebi KL, Frame DJ, Held H, Kriegler E, Mach KJ, Matschoss PR, Plattner GK, Yohe GW, Zwiers F (2010) Guidance Note for Lead Authors of the IPCC Fifth Assessment Report on Consistent Treatment of Uncertainties. Intergovernmental Panel on Climate Change (IPCC). Available at http://www.ipcc.ch
Meadows D (1999) Leverage points—places to intervene in a system. The Sustainability Institute, Hartland VT, USA
Moser S (2010) Communicating climate change: history, challenges, process and future directions. WIREs Clim Change 1:31–53 (John Wiley & Sons, Ltd)
Moser S (2016) Climate change communication. The International Encyclopedia of Geography: People, the Earth, Environment, and Technology. Wiley
Moser S, Dilling L (eds) (2007) Creating a climate for change: communicating climate change and facilitating social change. Cambridge University Press, Cambridge

Moser SC, Dilling L (2010) Communicating climate change: closing the science-action gap. In: Norgaard Richard, Schlosberg David, Dryzek John (eds) The oxford handbook of climate change and society. Oxford University Press Inc., New York

Moss R, Schneider S (2000) Uncertainties. In: Pachauri R, Taniguchi T, Tanaka K (eds) Guidance Papers on the Cross Cutting Issues of the Third Assessment Report of Intergovernmental Panel on Climate Change (IPCC). Switzerland, Geneva

NAS National Academy of Sciences, U.S. (2015) Climate intervention—reflecting sunlight to cool earth

Nerlich B, Koteyko N, Brown B (2010) Theory and language of climate change communication. Wiley Interdisc Rev Clim Change 1(1):97–110. doi:10.1002/wcc.2

Newell B, Smithson M (2014) Uncertainty isn't cause for climate complacency—quite the opposite. The Conversation. https://theconversation.com/uncertaintyisntcauseforclimatecomplacencyquitetheopposite25481

Nordhaus WD (2008) A question of balance—weighing the options on global warming policies. Yale University Press

Oppenheimer M (2005) Defining dangerous anthropogenic interference: the role of science, the limits of science. Risk Anal 25(6):1399–1407. doi:10.1111/j.1539-6924.2005.00687.x

Pidgeon N, Fischoff B (2011) The role of social and decision sciences in communicating uncertain climate risks. Nat Clim Change 1

Platje J, Kampen R (2016) Climate justice from a club good perspective. Int J Clim Change Strat Manage 8(4):520–538

Preuss S (1991) Umweltkatastrophe Mensch. Ueber unsere Grenzen und Moeglichkeiten, oekologisch bewusst zu handeln. Roland Asanger Verlag, Heidelberg

Prins G, Rayner S (2007) The wrong trousers: radically rethinking climate policy. James Martin Institute for Science and Civilization, University of Oxford and the MacKinder Centre for the Study of Long-Wave Events, London School of Economics

Prins G, Galiana I, Green C, Grundmann R, Korhola A, Laird F, Nordhaus T, Pielke Jnr R, Rayner S, Sarewitz D, Shellenberger M, Stehr N, Tezuko H (2010) The hartwell paper: a new direction for climate policy after the crash of 2009. Institute for Science, Innovation & Society, University of Oxford; LSE Mackinder Programme, London School of Economics and Political Science, London, UK

Sandin P (2004) The precautionary principle and the concept of precaution. Environ Values 13 (2004):461–475

Sandin P, Peterson M, Hansson SO, Rudén C, Juthe A (2011) Five charges against the precautionary principle. J Risk Res 5(4)

Schellnhuber HJ (2010) Tipping elements in the Earth System. PNAS 106(49):20561–20563. doi:10.1073/pnas.0911106106

Shome, D, Marx, S (2009) The psychology of climate change communication—a guide for scientists, journalists, educators, political aides, and the interested public. Center for Research on Environmental Decisions, Columbia University, New York

Stehr N (2015a) Democracy is not an inconvenience. Nature 525:449–450 (Macmillan Publishers)

Stehr N (2015b) Information, Power and Democracy: Liberty is a Daughter of Knowledge. Cambridge University Press, Cambridge

Stern N (2007) The economics of climate change: the stern review. Cambridge University Press, New York and Cambridge, U.K

Sterman J (2000) Business dynamics: systems thinking and modeling for a complex world. McGraw-Hill Education, New York City

Taleb NN (2007) The black swan—the impact of the highly improbable. Random House, New York City

Taleb NN, Read R, Douady R, Norman J, Bar-Yam (2014) The precautionary principle (with Application to the Genetic Modification of Organisms). Extreme Risk Initiative—NYU School of Engineering Working Paper Series. New York

van der Sluijs JP, van Est R, Riphagen M (2010a) Room for climate debate: perspectives on the interaction between climate politics, science and the media. Rathenau Instituut-Technology Assessment, The Hague

van der Sluijs JP, van Est R, Riphagen M (2010b) Beyond consensus: reflections from a democratic perspective on the interaction between climate politics and science. Curr Opin Environ Sustain 2(5–6):409–415

van der Sluijs JP, Turkenburg WC (2006) Climate change and the precautionary principle. In: Fisher E, Jones J, von Schomberg R (eds) (2006) Implementing the precautionary principle, perspectives and prospects, Elgar

Weber EU, Stern PC (2011) Public understanding of climate change in the United States. Am Psychol 66:315–328

World Bank (2012): Turn down the heat—confronting the new climate normal. A Report for the World Bank by the Potsdam Institute for Climate Impact Research and Climate Analytics. Washington DC, USA

The Challenges of Climate Change Communication for Lagos Coastal Communities

Peter Elias

1 Introduction

The reality of climate change impact is confronting African coastal communities in different ways with diverse mitigation and adaptation options. Local evidences are already establishing changes in weather patterns, variations in rainfall onset and cessation and the cycle of the seasons (Fasona et al. 2015). Generally, the consequence of climate change is manifested in increased floods, sea level rise and extreme weather events, low agricultural productivity, environmentally related displacements, diseases and conflicts over natural resources. According to IPCC (2007), Africa is the least contributor to global warming, yet it is likely to warm more rapidly above the global average. The utilization of coal, oil and gas for lighting, heating and transportation are increasing the amount of greenhouse gases (GHG) in the atmosphere and consequently global warming. The impact of climate change will be substantial in Africa due to low adaptive capacity and high dependence on climate-sensitive resources and livelihoods (Elias et al. 2014). Africa also lacks human, technological and financial resources to adapt to climate change (Adelekan 2009; IPCC 2007).

Providing local evidences of climate change could be a good strategy of communicating impacts, mitigations and adaptations. Diverse communities have different perspectives about climate change (Fasona et al. 2015; Leiserowitz et al. 2012) because of differential vulnerability owing to diverse socioeconomic characteristics. How communities are able to adapt depend on how effectively relevant authorities are communicating climate change impacts, mitigations and adaptations. Meanwhile, socioeconomic characteristics can enhance understanding, acceptance and responses to climate change impacts (Elias et al. 2014). Socioeconomic characteristics often determine different views and adaptation responses which could

P. Elias (✉)
Department of Geography, University of Lagos, Akoka-Yaba, Lagos, Nigeria
e-mail: pelias@unilag.edu.ng

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_10

also influence climate change communication. Poor communication can lead to responses that may produce unpleasant outcomes. An effective communication wisely chooses the methods that match the audience socioeconomic characteristics (Leiserowitz et al. 2012; Moser 2010). This guarantees adequate response that produces expected outcomes. There is a general consensus among these authors that by evaluating various alternative methods of communicating climate change adaptation, the responses and effects that follow will help to identify the most effective communication tools and strategy for various communities.

The reality of the impact of climate change in Nigeria and Lagos in particular has become common knowledge as depicted by the 2010 and 2011 flood events. The coastal communities in Lagos are becoming more vulnerable to climate change (Ibe 1990). This is partly because they depict high profile of poor socioeconomic conditions characterized by high levels of poverty, deprivation and/or spatial segregation (Adelekan 2010). There are ongoing global, national and regional efforts to mitigate and adapt to the impacts of climate change in Lagos (Lagos State Ministry of Environment 2012). These efforts are however usually low priority, uncoordinated and even largely indefinite because the communication is often poorly handled in tackling the climate change impacts (Elias and Omojola 2015). The importance of communicating timely and accurate information about climate change impacts to affected communities cannot be over-emphasized. However, communicating climate change impacts, mitigations and adaptations is often problematic owing to poor socioeconomic characteristics of African coastal communities. During the 2010 and 2011 flood events, it was generally difficult for authorities to communicate climate change impacts, mitigations and adaptations in Lagos coastal communities. This underscores the need for knowledge driven climate change communication strategy by analysing local evidences of climate change impacts and the influence of socioeconomic conditions in Lagos coastal communities. This paper focuses on the challenges of communicating climate change impacts and adaptation strategies for Lagos coastal communities. It purposively selected ten Lagos coastal communities based on the intensity of the 2010 and 2011 flood events and the general income group classification of the Lagos State Waste Management Authority (LAWMA). The selected communities are those in the high income (Eti-Osa, Eti-Osa East, Iru/Victoria Island, Lagos Island and Lekki), middle income (Ibeju), low income (Agboyi Ketu. Badagry, Bariga), and low medium (Ikorodu) groups of the Lagos coastal communities (LAWMA 2011). The specific objectives of the paper are to examine (i) the certainties and experiences of flood events in Lagos coastal communities, (ii) how flood events are perceived and understood, and (iii) the coordination of the various responses and responders. The paper adopted an explorative approach to understand the challenge of climate change communication for Lagos coastal communities using historical climate data, existing statistical data, semi-structured interviews of community leaders and expert analysis to explore both actual and perceived vulnerabilities and adaptations by individuals, communities, and government and to understand the socioeconomic conditions which could influence climate change communication. Thus, the scope of this paper is limited to providing differences in local evidences of climate change impacts based on the perceptions of the households and the analysis of diverse socioeconomic characteristics of households as key factors for understanding the challenges of climate change communication in selected Lagos coastal communities.

2 The Context of Climate Change in Lagos

Climate change scenarios postulate that wet regions will experience higher rainfall while dry regions will experience prolonged droughts (IPCC 2007). Current environmental problems in the coastal areas of Nigeria particularly Lagos include flooding which comes from the high rainfall amount, run-off from rivers, and sea level rise (Adeoti et al. 2010). Flood events in Lagos is generally due to natural and human-related factors. It can also result from the inundation of a normally dry area caused by an increase in water level along the river channel. In the view of United States Federal Emergency Management Agency (2012), flood is a natural phenomenon whose impacts can disrupt normal human activities. It further stated that flood can also be regarded as a natural disaster common to low, flat or near flat areas of the world. In developing countries, flood events and impacts are intensified due to poor consciousness of the residents to environmental information and lack of spatial data affecting perception, attitude and responses. Andjelkovic (2001) argued that flood, both its occurrence and impacts, is also anthropogenic in nature.

Flooding in Lagos is not recent but the pattern of its occurrence is giving the public and authorities great concern (Etuonovbe 2011). According to the author, Lagos recorded the first flood in the early 1970s and till date, flood has become a perennial event in the state. The causes and impacts of flooding varies from one part of Lagos to another. There are multi-factors that account for the differences in the events and impacts of flooding in different Lagos locations. Some of these factors were identified as high population density, absence of zoning regulations, lack of flood control, and lack of emergency response infrastructure and early warning systems (Adeaga 2009). Similarly, Adelekan (2009) highlighted major causes of floods to include unrestrained development of impermeable surfaces due to increasing urbanization resulting from increase runoff volume, runoff responses under high intensity rainfall, erection of building on floodplains, lack of storm-water drainage, failure to maintain existing drainage systems and weak institutional capacity of the urban administration. Changes in the intensity and pattern of storms have also been listed as factors that may influence the risk of flooding. According to Smith (1996), flood is the most common of all environmental hazards and it regularly claims over 20,000 lives and adversely affects about 75 million people in different parts of the world.

The physiographic characteristics of Lagos State including its low-lying topography, sediments of the Coastal Plain Sands overlain by alluvial and littoral deposits that are composed mainly of soft clays, stiff clays, silts and loose/dense sands with occasional pebble-beds and interlinked drainage systems makes it highly susceptible to incidents of flooding (Omojola and Elias 2010). The state belongs to the barrier-lagoon complex system with a stretch of curvilinear coastal line that measures approximately 180 km (about 21.1% of the Nigerian coastline) (Ibe 1990). It occupies a total land area of about 3577 sq km, making it the smallest state in the country. It is located within longitude 2° 42′ E and 3° 42′ E, and latitude 6° 22′ N and 6° 52′ N. Lagos state is bounded to the south by the Atlantic Ocean; to the north and the eastern end by Ogun State and Benin Republic on the western end. Lagos State drains two-thirds of south-western Nigeria and is characterized by homogenous albeit locally-differentiated wetlands and a number of basins for major upstream rivers (Ogun, Osun and Yewa) from adjoining states to discharge into the Bight of Benin (Atlantic Ocean). The state is laced with fresh-water creeks, rivers, streams and lagoons. The low-lying areas of the state and the wetlands occupy about 78% of the entire landmass.

2.1 The Changing Pattern of Rainfall

The pattern of rainfall (2002–2013) is analysed with data obtained from Nigeria Metrological Agency (NIMET) which is presented in Fig. 1 below. It shows that the amount of rainfall increased from 2002 and peaked in 2004, 2007, and 2010 respectively. The average annual rainfall for the twelve-year period is 1302.39 mm, the highest rainfall amounts were recorded in 2007 and 2010 with 1615.7 and 1547.8 mm respectively while the lowest (924.2 mm) amount was recorded in year 2005. During this period, the range of rainfall values was 741.15 mm. The location of Lagos within the tropical rainforest zone and the proximity to water bodies such as lagoons and the Atlantic Ocean are some of the factors accounting for high intensity of rainfall amount.

Fig. 1 Total precipitation (2002–2013). *Source* Computed by the author with data from NIMET, Lagos

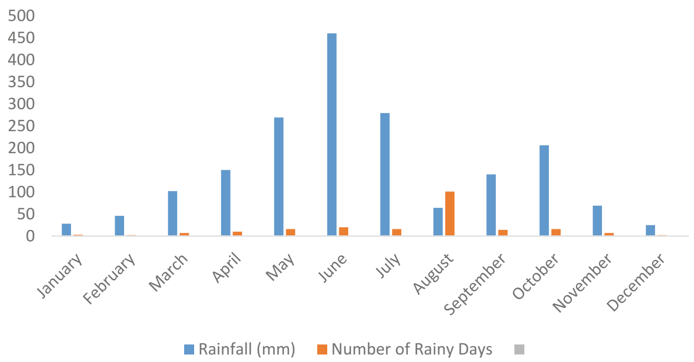


Fig. 2 Pattern of rainfall and rainy days in Lagos. *Source* Author's computation with data from NIMET

Figure 2 compares the pattern of rainfall and rainy days in Lagos. The analysis showed that the amount of rainfall is not determined by the number of rainy days and vice versa. This is evidenced in the months of June and August. The highest amount of rainfall occurred in June with few rainy days compared with August having the highest number of rainy days and low amount of rainfall.

2.2 Frequency of Flood

Flood events are varied for the ten selected Lagos coastal communities. Flood is a common event in all the selected coastal communities but the occurrence, frequency and impacts vary according to their locations. The proportion of the households who have had experience of 2010 and 2011 flood events (Fig. 3) was highest in Ibeju and Lagos Island accounting for 54 and 52% respectively. Except for Badagry, Eti Osa and Lekki, all other coastal communities have the proportion of the households who had experienced flood higher than the state average.

The frequency of flood also indicated some variations among the selected coastal communities. The analysis shows that the proportion of household members who had experienced floods for 1–2 times in the last twelve months was highest in both Lekki and Ikorodu accounting for 63 and 42% respectively. It is noteworthy that only Agboyi Ketu and Lagos Island had proportion of household members below the state average (20%). Similarly, the proportion of household who had floods 3–4 times was highest in Lagos Island (77%) and Ibeju (60%) while there was none in Lekki. The proportion of household members who had experienced floods for 5–6 times were generally above the state average (9%) except for Badagry, Bariga and Ikorodu. Also, the proportion of household members who had experienced floods above 6 times were below the state average (37%) in all the selected coastal communities except for Badagry and Eti-Osa with 62 and 41% respectively.

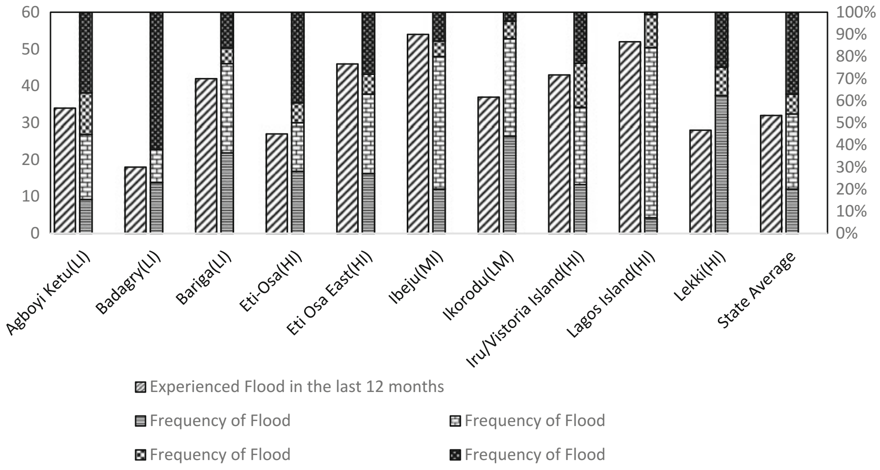


Fig. 3 Frequency of flood in Lagos coastal communities. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

The impacts of flood measured by the height of water level during the 2010 and 2011 flood events in the selected communities vary according to location. The proportion of the household members who experienced height of flood height at the ankle level which was above the state average (50%) were Ibeju (53%), Lagos Island (55%), Ikorodu (64%) and Iru/Victoria Island (67%). Likewise, the proportion of household members who experienced flood height at the knee deep which was also above the state average (35%) were Lekki (38%), Agboyi Ketu (48%) and Badagry (62%). Similarly, the proportion of household members who experienced flood height at the waist level which happened to be below the state average (9%) were Ikorodu (4%), Agboyi Ketu (7%), Eti-Osa East (7%) and Badagry (8%). Meanwhile, the proportion of household members who experienced flood height to be above the waist level which was more than the state average (6%) were Eti Osa East (13%), Bariga (14%) and Ikorodu (20%) (Fig. 4).

2.3 Perception of Flood Impacts and Risk

Household members of the selected communities perceived the 2010 and 2011 flood impacts differently which could have influenced their responses to the communication of climate change. The perception of the impacts, the probability of the impacts and risk of the impacts varied among the communities along income levels. The analysis shows that the low-income communities including Agboyi Ketu, Badagry, and Bariga perceived the flood impacts to be moderate, the probability of the impacts likely and the risk high. Meanwhile, the perception of the flood impacts

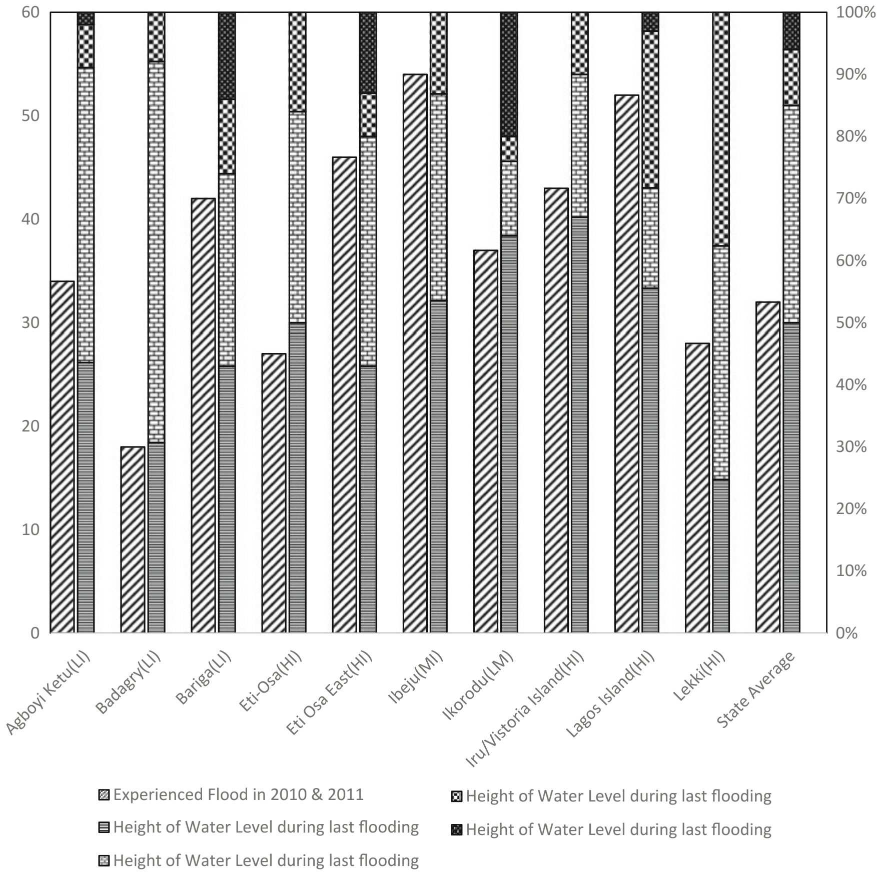


Fig. 4 Impacts of floods in Lagos coastal communities. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

was major, the probability of the impacts likely and the risk very high for Ikorodu. The middle income (Ibeju) and high income (Eti-Osa, Eti-Osa East, Iru/Victoria Isalnd, and Lagos Island) coastal communities perceived the flood impacts to be major, the probability of the impacts very likely and the risk to be very high. The only exception was Lekki where the household members perceived the flood impacts to be major, the probability of the impacts likely and the risk high (Table 1).

The perception of the 2011 flood impacts was analysed as presented in Table 2 which shows that two of the low income coastal communities each had different perspectives with Agboyi Ketu and Ikorodu perceiving the flood impacts to be major, the probability of the impacts to be likely and the risk to be very high while Badagry and Bariga perceived the flood impacts as moderate, the probability of the

Table 1 Perception of flood impacts and risks in 2010

Communities	Income group	Impacts	Probability	Risk
Agboyi Ketu	LI	Moderate	Likely	High
Badagry	LI	Moderate	Likely	High
Bariga	LI	Moderate	Likely	High
Eti-Osa	HI	Major	Very likely	Very high
Eti Osa East	HI	Major	Very likely	Very high
Ibeju	MI	Major	Very likely	Very high
Ikorodu	LM	Major	Likely	Very high
Iru/Vistoria Island	HI	Major	Very likely	Very high
Lagos Island	HI	Major	Very likely	Very high
Lekki	HI	Major	Likely	High

LI—Low income, LM—Low medium, MI—Middle income, HI—High income. *Source* Author's field work, 2012

Table 2 Perception of flood impacts and risk in 2011

Communities	Income group	Impacts	Probability	Risk
Agboyi Ketu	LI	Major	Likely	Very high
Badagry	LI	Moderate	Likely	High
Bariga	LI	Moderate	Likely	High
Eti-Osa	HI	Major	Likely	Very high
Eti Osa East	HI	Major	Very likely	Very high
Ibeju	MI	Major	Likely	Very high
Ikorodu	LM	Major	Likely	Very high
Iru/Vistoria Island	HI	Major	Very likely	Very high
Lagos Island	HI	Major	Likely	High
Lekki	HI	Major	Likely	Very high

LI—Low income, LM—Low medium, MI—Middle income, HI—High income. *Source* Author's Field work, 2012

impacts likely and the risk as high. Meanwhile, all the middle income and high income coastal communities perceived the flood impacts were major but had divergent views on the probability of the impacts and the level of risk.

3 Socioeconomic Characteristics Affecting Climate Change Communication

The context of climate change has moved away from whether climate is happening to implementing strategies to mitigate or adapt leading to increased understanding, funding and action towards behavioural change. The response from the scientific communities to the society has evoked a new understanding of what climate change is and its anthropogenic origin (Monroe et al. 2015). The message is becoming even clearer as evidences are becoming undeniable (Urwin and Jordan 2008). In a publication by Corner (2011) titled ‘The Hidden Heat’ focusing on effective climate change communication in Uganda it identified the challenges and opportunities in climate change communication. The author identified the crucial role of the media in climate change communication and the importance of participation of the poor and the neglected in mitigation and adaptation to the impacts of climate change. Monroe et al. (2015) listed four challenges confronting climate change communication to include the fact that (i) climate change impact is complex, uncertain, and variable; (ii) people learn and remember selectively; (iii) people pay attention to people that are like them; and (iv) climate change communities vary. Similarly, Pike et al. (2010) note that in climate communications, there is need for an understanding and connecting with audiences by proper targeting of audiences and understanding of their values. There is need therefore to emphasize practical examples and impacts to connect local people with the realities and impacts of climate change. This emphasizes the relevance of the socioeconomic conditions of the coastal communities.

3.1 Access to Information

Access to information is determined by the sources of information members of the communities can receive on any issue at any given time. The sources of information are also what determine the content, the clarity and the timeliness which are key issues to be considered in climate change messages. The common sources of information available in modern times include the radio, television, newspaper/magazine, Internet, billboards/flyers/posters and government worker with varying features including the quality, timeliness and amount of information that can be provided. The analysis of the available sources of information (Fig. 5) shows that access vary among the coastal communities by income class. Generally, a moderate proportion of the households studied depend on the radio and the television and sparingly on newspaper/magazine as sources of information. The implication is that the audio-visual communication receives better acceptability among the coastal communities compared to written documents. Unfortunately, the content and clarity of information that can be received via the radio and the television at any given time will be limited by the slot allowed for such information. This may pose some challenge for climate change communication for the coastal communities.

Further analysis of those who could communicate by written documents in English (Fig. 6) reveal an interesting scenario. The proportion of those who could read and write in English also differ in the selected communities but it seems that income level had little influence on the variability. Although, a good proportion of

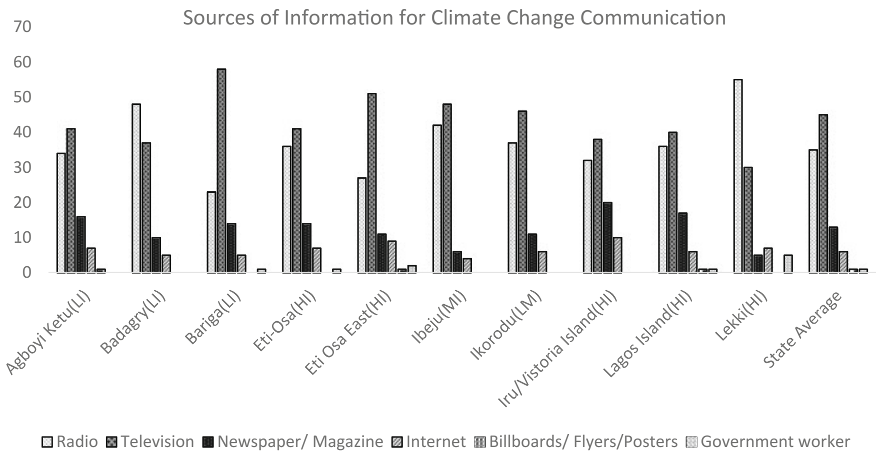


Fig. 5 Sources of information. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

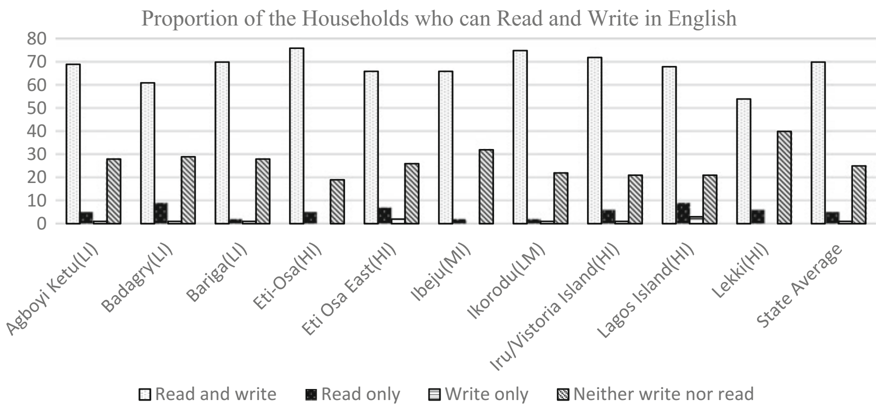


Fig. 6 Proportion who can read and write in english. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

the households in these communities could read and write in English, the percentage of those who could neither read nor write in English was considerable which call for concern for climate change communication. It implies that a good proportion of the households could miss vital information if communication to the households and feedbacks are to be done solely by written documents in English.

A corollary to this relates to the analysis of the proportion of the households who could read and write in other language. The analysis as presented in Fig. 7 shows that a high proportion of the households could read and write in other language yet

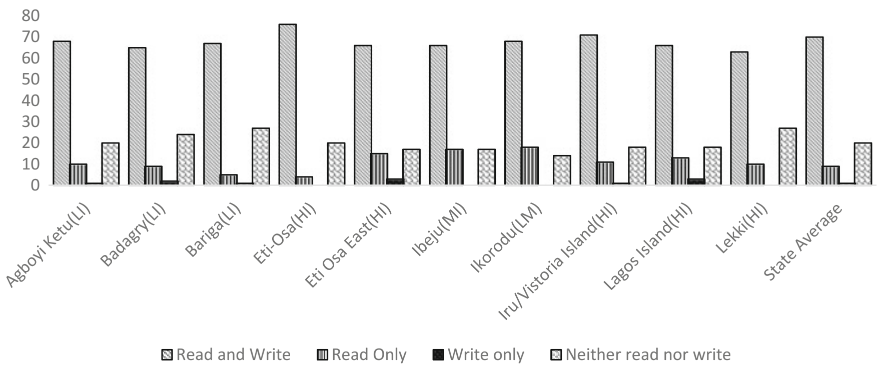


Fig. 7 Proportion who can read and write in other Language. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

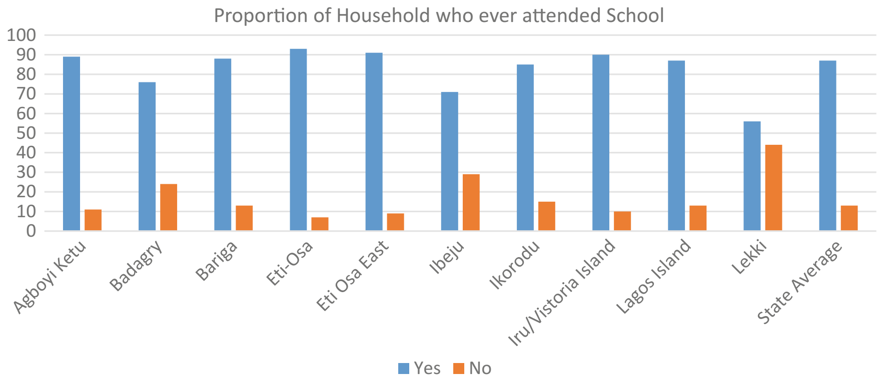


Fig. 8 Proportion who ever attended school. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

there were still a sizeable number who could neither read nor write in other language. Meanwhile, the income group did not affect the variation among those who could read and write in other language. While communication of scientific information via local languages and dialects are highly becoming popular, translation is usually a daunting task which could affect climate change communication.

The analysis of those who had ever attended school (Fig. 8) did not vary much among the selected coastal communities as it appears that income level did not make much difference. This reflects high level of literacy which would enhance communication of climate change for the coastal communities.

3.2 Economic Conditions of Households

An examination of the economic conditions of households of the selected coastal may be necessary to understand the socioeconomic characteristics of households in the selected coastal communities. In the context of current exchange rate (N350 = 1 $ USD) almost half of the households in most of the selected coastal communities are living below the poverty line. This has implications for their ability to afford basic items for accessing information and ability to attend school to acquire basic literacy skills which could affect communication of climate change impacts, mitigations and adaptations (Fig. 9).

3.3 Multi-level Governance Structure for Climate Change Communication

It is noteworthy that climate change information is managed at different levels involving national, regional, local government, community, household and individuals. There is both the vertical and horizontal lines of communication which could lead to negative consequences of competition and conflict but if well managed can produce positive results of cooperation and collaborations. Table 3 identified key responses relating to climate change communication according at different levels of governance. The fact that key responses are shared among different levels of governance could lead to unhealthy consequences as has been observed in climate change communication among the coastal communities. Multi-level governance has been identified as a major drawback to infrastructure planning and delivery (Elias et al. 2014). This relates to bottlenecks associated with revenue mobilization, policy formulation, decision making and programme

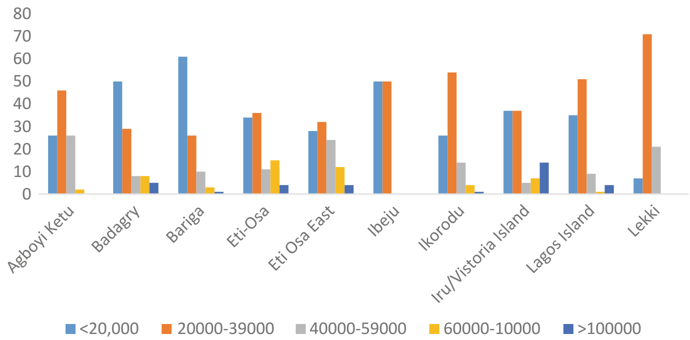


Fig. 9 Household monthly income. *Source* Author's computation with data from Lagos State Ministry of Economic Planning and Budget (2013)

Table 3 Responses and responders of climate change

Responses/Responders	National	Regional	Local government	Communities/ NGOs	Private sector	Individuals/ Households
Policy making and planning	+	+				
Data base creation/management	+	+		+	+	
Vulnerability assessment/mapping	+	+		+	+	
Awareness and education campaigns	+	+	+	+	+	+
Early warning systems design and implementation	+	+	+	+	+	
Design and decision making for infrastructure	+	+	+	+	+	
Risk-reduction, livelihood development and resource management	+	+	+	+	+	+
Capacity building	+	+	+	+	+	+

Source Author's thoughts

implementation. This can be challenging for climate change communication whose effectiveness depend on solid financial, legal and institutional framework.

At the national level, there have been active participation of government in climate change communication while the regional level represented by Lagos State has recently started to act on climate change issues (Elias and Omojola 2015). The aim is to clearly inform the public about the reality and challenge of climate change with some strategies for mitigation and adaptation. The first formal action of the Lagos State was by becoming a member of the C40 Large Cities Climate Leadership network. This has led to the establishment of the climate change unit in the Ministry of Environment.

The established climate change unit has embarked on several mitigation and adaptation responses including communication of vital information, networking, policy formulation and advocacy actions (LAS-CCAS 2012). The most notable of the efforts of the State with respect to climate change communication is the annual climate change summit which started in 2009 (Table 4). The summits have focused on some thematic issues aimed at raising awareness, identifying critical sectors, exploring risks and vulnerability, identifying investment and job opportunities, increasing adaptive capacity and mitigation and building partnerships to strengthen the state's resilience. Participants at these summits are often drawn from the federal, state and local governments as well as communities/NGOs, the private sector, international development partners and households/individuals. The summits recommended a governance mechanisms for climate change mitigation and adaptation to streamline roles and responsibilities of the various responders in fund mobilization, capacity building and public private partnership. The key achievements of these summits with respect to climate change impact communication will not be fruitful without putting in place a climate change information management system.

Table 4 Lagos state climate change summits

Dates	Themes
24th–26th March 2009	"Reclaiming the environment: challenges and consequences of climate change"
4th–7th May 2010	"Trans-boundary effects of climate change." The goal was to share best practices in mitigation and adaptation
8th–10th February 2011	"Charting a road map for combating climate change in Nigeria"
12th–14th April 2012	"Vulnerability and adaptability to climate change in Nigeria: Lagos state agriculture, industry and health sectors in focus"
March 13th–15th 2013	"Vulnerability and adaptability to climate change in Nigeria: Lagos state transportation, housing and infrastructure in focus"
March 18th–20th 2014	'Exploring business opportunities in climate change mitigation and adaptation: Lagos state in focus'
April 21st–24th, 2015	'Celebrating success stories, reviewing challenges and setting future agenda'

Source Author's compilation, 2016

A well developed and fully implemented climate change information system will encourage the cataloguing and dissemination of climate change research outputs in the state at the various levels.

4 Conclusions

This paper has emphasized the importance of analyzing local evidences of climate change impacts and the socioeconomic characteristics of coastal communities for understanding the challenge of climate communication. The paper shows that different coastal communities of Lagos are witnessing the realities of climate change impacts as evidenced in the 2010 and 2011 flood events. Meanwhile, the responses of the coastal communities including the perception of the impacts, probability of flood occurrence and risks differed majorly due largely to differences in locations more than income levels. Similarly, the socioeconomic characteristics of households of coastal communities are significant for understanding, perception and awareness of the impacts of climate change and responses to climate change communication. The paper shows that the sources of information accessible to coastal communities are mainly audio-visual (radio and television) which may be affected by both economic circumstances, literacy level and available languages of communication. A considerable proportion of the households can neither read nor write in English which could affect communication of climate change information using written documents. It is noteworthy that many households can read or write in other language which may be helpful in climate change communication. The identified governance structure of climate change communication is multi-level which means that the channels of climate change communication could be complex. To enhance collaboration and cooperation there is need for proper management of both the vertical and horizontal interactions among stakeholders otherwise it could result in negative consequences of unhealthy competition, conflicts and crisis.

The above lessons of this paper mean that to ensure the prospects of an effective communication of climate change impacts, mitigations and adaptations towards making the Lagos coastal communities more resilient it will be necessary to note the following:

- Recognize the differences in the levels of climate change impacts as evidenced in the 2010 and 2011 flood events for households of the selected Lagos coastal communities.
- Develop an effective climate change communication tool that involve the use of audio-visuals as represented by the radio and television being the dominant sources of information for households of the selected coastal communities.
- Ensure not to lose a significant proportion of the households of the selected coastal communities who neither read nor write when designing a climate change communication tool.

- Evolve a policy for the identification and proper translation of documents to other languages to reach the segment of the selected coastal communities who can read or write in other languages.
- Establish strategies to provide adequate literacy programme for those who never attended school.
- Provide a sustainable framework to take the half of the proportion of the households of the selected coastal communities who are placed below the poverty line of two United States dollars per day.

References

Adam Corner (2011) Hidden heat communicating climate change in uganda: challenges and opportunities. Panos Eastern Africa, Kampala, p 47

Adeaga O (2009) Planning and warning tools for flood disaster management in Lagos Mega City. In: Proceeding of the fifth urban research symposium, Marseille

Adelekan IO (2009) Vulnerability of poor urban coastal communities to climate change in Lagos. In: Proceeding of fifth urban research symposium, Marseille

Adelekan IO (2010) Vulnerability of poor urban coastal communities to flooding in Lagos. J Environ Urban 22(433)

Adeoti AI, Olayide OE, Coster AS (2010) Flooding and welfare of fishers' households in Lagos state. J Human Ecol 32(3):161–167

Andjelkovic I (2001) Guidelines on non-structural measures in urban flood management, IHP-V Technical Documents in Hydrology, UNESCO, Paris, No 50, p 89

Elias P, Omojola A (2015) The challenge of climate change for Lagos. Curr Opin Environ Sustain, 13: 74–78 Available at www.sciencedirect.com, http://dx.doi.org/10.1016/j.cosust.2015.02.008

Elias P, Afolayan O, Babatola O (2014) Local governments as strategic partners for service delivery in Nigeria. J Res Natl Dev, 12(2a). Owerri

Etuonovbe A (2011) The devastating effect of flooding in Nigeria published in bridging the gap between cultures, Morocco, 18–22 May

Fasona M, Oloukoi G, Olorunfemi F, Elias P, Adedayo V (2015) Aspects of natural resource use and adaptation to climate change in the Nigerian Savana. In: Gbadegesin A, Bassey E, Orimoogunje O, Fashae O (eds) Frontiers in environmental research and sustainable environment in the 21st century. Ibadan University Press, Ibadan, pp 323–342

Ibe AC (1990) Global climate change and the vulnerability of the Nigerian Coastal Zone to accelerated sea-level rise: impacts and responses measures. Niger Inst Oceanogr Tech Pap (32). Lagos

IPCC (2007) Impacts, adaptation and vulnerability. In: Parry ML, Canziani OF, Palutikof JP, vander Linden PJ, Hanson CE (eds) Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change, Cambridge University Press, Cambridge, pp 357–390

Lagos State Government (2012) Climate change policy 2012–2014. Lagos State Ministry of Environment, Lagos, p 49

Lagos State Management Authority (2011). Integrated waste management: waste collection and transport. Paper presented at the C40 summit speaking session at Sheraton WTC Convention Center, Curitiba H

Lagos State Ministry of Economic Planning and Budget (2013) Lagos household survey, edition, Lagos, p 1136

Lagos State Ministry of Environment (2012) Climate change policy: 2012–2014. Ikeja, Lagos

LAS-CCAS (2012) Towards a Lagos state climate change adaptation strategy, Lagos State Ministry of Environment, Lagos

Leiserowitz A, Maibach E, Roser-Renof C, Hmielowski J (2012) Global Warming's six Americas. Yale University and George Meson University, Yale project on climate change communication, New Haven

Monroe MC, Claire Layman Bode, Megalos MA (2015) Challenges in communicating climate change to extension audiences. This document is FOR324, one of a series of the School of Forest Resources and Conservation, UF/IFAS Extension. Original publication date May 2015. Visit the EDIS website at http://edis.ifas.ufl.edu

Moser SC (2010) Communicating climate change: history, challenges, process and future directions. Wires Clim Chang 1:32–53. London

Omojola A, Elias P (2010) Physical environment. In: Ogunleye M, Alo B (eds) State of the environment report, Lagos State Ministry of Environment, Lagos, pp 24–34

Pike C, Doppelt B, Herr M (2010) Climate communications and behavior change: A guide for practitioners. The climate leadership initiative. A Publication of Climate Leadership Initiative, Oregon, pp 28–49. Available: http://www.thesocialcapitalproject.org/The-Social-Capital-Project/pubs/

Smith K (1996) Environmental hazards. Routledge, London

United States Federal Emergency Management Agency (2012) Flood after fire fact sheet. National Flood Insurance Programme, Washington, D.C

Urwin K, Jordan A (2008) Does public policy support or undermine climate change adaptation? Exploring policy interplay across different scales of governance. Glob Environ Chang 18:180–191

Seven Strategies of Climate Change Science Communication for Policy Change: Combining Academic Theory with Practical Evidence from Science–Policy Partnerships in Canada

Garrett Ward Richards and Rebecca Carruthers Den Hoed

1 Introduction

We often assume that policy making is a linear and rational process; identification of a clear problem is followed by careful consideration of possible alternatives and implementation of the best solution (see Howlett et al. 2009). Basically, we expect accumulated knowledge about a given issue to precipitate policy action on that issue. But climate change policy, on a global scale, has demonstrably failed to follow this process. Considerable scientific knowledge and expert consensus about climate change is available, but implementation of solutions has been woefully insufficient. Still, there remains a belief that the situation will improve as scientists add additional evidence, improve their data, increase certainty, and arrive at an even stronger consensus. By assuming that policy makers will make the right decisions as soon as enough information is provided to them, this "deficit model" misses that the root of the problem is on the policy side, not the science side (see Lawton 2007). Policy makers are obligated to prioritize their own jurisdiction above others, must respond to public opinion, and are limited by short-term election cycles, all of which may preclude climate action. Given such constraints, scientists will not be able to encourage climate action by merely providing more and better information.

However, scientists do not have any control over the idiosyncrasies of the policy realm (not to suggest that an overhaul of the policy process is even possible). What, then, can scientists do to address the problem? The key is in the space between the science and policy realms—that is, the relationships that scientists cultivate with

G. W. Richards (✉)
School of Environment and Sustainability, University of Saskatchewan, Saskatoon, Canada
e-mail: garrett.richards@usask.ca

R. Carruthers Den Hoed
Department of Communication, Media, and Film, University of Calgary, Calgary, Canada

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_11

policy makers and how they choose to communicate scientific information. Accordingly, the purpose of this chapter is to develop a useful list of climate science–policy messaging strategies that have both theoretical and practical support.

Of course, we are not the first to suggest that communication is a fruitful area through which to improve our efforts in addressing climate change, so let us take a moment to delineate the scope and objectives of the chapter. First, our target audience is climate scientists, not policy makers, so our recommendations will be aimed at the former, not to suggest that there is no room for improvement with the latter. Second, our focus is on communication from scientists to policy makers, not from scientists to the public. Of course, we acknowledge that broader outreach is very important, and that there is overlap between science–policy and science–public communication (see Richards et al. 2013), especially since public opinion informs policy. Third, it is not our goal to revisit general messaging strategies that are useful in most situations (e.g. avoiding jargon, using visuals, encouraging questions), but rather to identify specific approaches that are uniquely suited to climate science–policy communication. Overall, we believe that practitioners in this area will benefit from a list of strategies that: is accessible and ready to use (i.e. demonstrated in practice), has some theoretical justification, and is fairly comprehensive. We do not mean to suggest that these tactics will be particularly novel, but rather that it is important to bring them together in a way that is more useful to scientist communicators, grounded in real-world practice.

The chapter proceeds as follows. First, we review pertinent academic literature on science–policy interfaces and communication theory. The relevant bodies of work have many insights to offer, but also some deficiencies to address—they work best in combination. Second, we elaborate our methods for gathering practical evidence, namely interviews targeting climate science–policy relationships in Canada. Third, we discuss the results of those interviews, identifying seven messaging strategies and supporting them with empirical evidence from interview quotations as well as theoretical evidence from communication theory, grounding a conversation among the literatures. Fourth, we conclude by extracting overall lessons.

2 Background Literature

The scholarly field of science–policy interfaces has an intuitive relevance to the issue of climate science–policy communication. Analyzing a few key pieces of work will show that this field is quite adept at describing barriers between the realms of science and policy, but has room to provide more useful communication recommendations for scientists. Bradshaw and Borchers (2000), for instance, compare the characteristics of scientists and policy makers, especially with regard to views on uncertainty. However, their suggested solutions to this problem are somewhat vague (i.e. communicate more with the public) and impractical (i.e. policy makers should see uncertainty the same way climate scientists do). The conceptual framework of Cash et al. (2002) is perhaps a little more valuable. They argue that scientists traditionally have focused too much on credibility, and not enough on the salience and legitimacy of produced information. They recommend primarily macro-level changes, such as managing boundary organizations for accountability and cooperation. This is not particularly helpful to individual science communicators, especially if no such boundary institution is present. Likens (2010) points out further barriers between the science and policy realms. For example, they have different priorities and speak different languages. His suggestions—that environmental scientists learn about the policy process, explain things carefully, and look for new ways to communicate—are fairly broad. A similar set of science–policy tensions are identified by Mead (2015), but the more novel contribution of his is observing that researchers often make policy recommendations without considering the politics of the issue (i.e. trade-offs with other priorities). Still, the solutions that follow are quite rudimentary; scientists should collaborate with policy makers, speak their language, and be taught about policy during training. This field of work ultimately makes very important observations about science–policy interactions, which serve as a crucial background to challenge of climate change communication, but few specific messaging strategies with immediate relevance to individual scientists are suggested.

Theories of deliberative rhetoric also provide relevant insight on science–policy exchanges. The emerging strategies are more coherent and precise than those offered by the literature on science–policy interfaces, but less attention is paid to the unique nature of climate scientists as generators and transmitters of knowledge. Dating back to Aristotle, theories of deliberative rhetoric deal with the issue of translating truth claims into persuasive messages for policy-making audiences (Kock 2014; Timmerman 2002; Yack 2006). These theories distinguish between communicating necessary knowledge, or certainty, and contingent knowledge, or uncertainty (Danisch 2010). While the first is associated with philosophy and science, communities that build knowledge about what is true, the second is associated with politics and expedient choice, deliberation about what is most likely to secure 'the good life' for citizens in the future (Kock 2014). Specifically, messages should aim to persuade listeners that a proximate, imminent threat to 'the good life' requires attention, and that one proposed 'best course' of action is most likely to meet this threat for now, given local contingencies and priorities (Danisch 2010; Kock 2014; Timmerman 2002, p. 89; Yack 2006). Messages typically revolve around two imagined futures: one to be averted because it threatens harm (see O'Leary 1993, 1997), and one to be sought because it promises advantages (Yack 2006). The objective is to evoke a reaction of 'civic fear' (see Innocenti 2011; Pfau 2007). Science communicators may be more successful if they see reasoning as "a contest for attention and allegiance" requiring that they "compete to advise" policy makers about "how to pursue our common good" (ibid., p. 427). These theories provide much more specific messaging advice than the literature on science–policy interfaces, but do not acknowledge the unique challenges of climate change messaging, and may come across as overly 'philosophical' to scientists that are looking for practical strategies, and are not scholars of communication or politics.

A final relevant field is contemporary environmental communication (i.e. in contrast to the rather ‘ancient’ theories of deliberative rhetoric). Some exemplary pieces will demonstrate that this field is perhaps the most capable of suggesting practical messaging strategies for climate scientists, although the focus seems to be primarily on general (i.e. science–public) communication, and there is some nuance that may be difficult to translate into concrete tactics. Schwarze (2006) observes that melodramatic messaging tends to get criticized as a simplistic approach that only perpetuates controversies. However, it may be beneficial in situations where a problem is unrecognized or poorly defined (e.g. new environmental challenges), and can serve as a call to action. Foust and Murphy (2009) add that, for climate change, the ‘comic’ (i.e. positive and opportunistic) frame is likely to be more useful than the ‘tragic’ (i.e. negative and dramatic) frame at this point, but should not be used to justify the status quo and paint the problem as mere inconvenience. Specifically, they propose framing the issue as urgent but manageable, promoting human agency, and linking climate change to other important issues (e.g. energy independence). Acknowledging that fear appeals can, at the same time, make climate change seem important as well as leave the audience feeling unable to do anything about it, O’Neill and Nicholson-Cole (2009) recommend emphasizing local impacts and actions, with only some attention given to the global context. The collective theme of these pieces is that communicators are faced with the challenge of finding a balanced messaging approach. It should not be too negative, which may disempower the audience or be dismissed as alarmism, and not be too positive, which may facilitate apathy (also see Russill and Nyssa 2009). This is an extremely useful concept, emerging among some specific and practical strategies from the field, but practitioners may still be unclear on what such balanced messages would look like in the reality of communicating with policy makers. As well, there is an opportunity to synthesize the various techniques into a more comprehensive ‘handbook’ form (i.e. works in this field tend to cover only one or a few strategies each).

Ultimately, while these three areas are highly relevant to the challenges of climate science–policy communication, none of them, on its own, embodies the trifecta of specific messaging strategies, attentiveness to climate change, and focus on policy making audiences. Also, because they are all comprised of academic literature (as opposed to best practice documents or grey literature), there is room for more attention to practice. This is not to suggest that the existing suggestions are necessarily ‘impractical’ but rather that they are not reaching their full potential of accessibility and usability for scientists. In order to facilitate some conversation and synthesis among the literatures, and to ground their recommendations in practice, this chapter treats a case study of climate science–policy relationships as a starting point. We investigate which messaging strategies are used by science communicators in practice (i.e. who are not necessarily familiar with the academic literature), and then show how those same tactics have theoretical support from the collective scholarly work, necessitating some combination and application of the relevant literary areas. The empirical evidence suggests *that* such emerging strategies can be successful, while the theoretical analysis provides insight on *why* this is so.

3 Methods

This chapter is part of a larger research project (see Richards 2015) that seeks to determine how science–policy partnerships can be designed to bridge the gap between consensus climate science and the insufficient policy response. One aspect of a productive science–policy partnership is the use of effective messaging strategies by scientists. Thus, while the larger project embodied a number of research questions, the particular one relevant to this chapter is: What science messaging strategies are useful for communicating with policy makers about climate change? As stated in the previous section, we wanted to take a problem-based approach to this question, grounded in practice, so we did not start with any specific hypotheses from the above literature—the research approach was exploratory and inductive. In short, both scientists and policy makers involved in climate science–policy partnerships were interviewed about their interactions, including the messaging strategies employed therein.

Although this study was exploratory, it was also meant to provide some solid empirical evidence for effective messaging strategies. Consequently, multiple Canadian cases were examined in order to ensure the investigation was sufficiently broad as well as conscious of the unique contexts surrounding individual scenarios of climate communication to policy makers. The first selected case was the local-level relationship between municipalities in British Columbia (BC) and the Pacific Climate Impacts Consortium (PCIC), a University of Victoria research institute that focuses on regional climate impacts and adaptation. The second case chosen was the regional-level relationship between the BC provincial government and the Pacific Institute for Climate Solutions (PICS), a research network centred at the University of Victoria, which studies both climate impacts and remedies (e.g. mitigation policy). The third case was the national-level relationship between the federal government of Canada and the Canadian Foundation for Climate and Atmospheric Sciences (CFCAS), a research funding institution. The Canadian focus was due to both the location of the investigators and the fact that science–policy interfaces have been understudied in Canada (i.e. compared to Europe, the US, and Australia).

The interviews took place between January and April 2014. Altogether, we interviewed 7 experts from the science side, 11 representatives of the policy side, and 2 intermediaries. These were semi-structured, audio-recorded, one-on-one interviews conducted in person or by telephone. The open-ended questions relevant to climate messaging included:

- How often does communication occur?
- How is communicated information generally used by the groups that receive it?
- How effectively do you think climate science is translated into policy action?
- What is needed to ensure a productive translation?

Of course, since the questions were open ended, they were followed by specific prompts for further information and general catch-all questions (e.g. What other successes or challenges are associated with the dialogue?). The interviews ultimately functioned as flexible discussions, such that the interviewee was able to 'teach' the interviewer about the most relevant aspects. The findings from these interviews are reported in the next section.

4 Results and Discussion

We were able to extract seven distinct climate science–policy messaging strategies from the collective interviews. This is not to say that each strategy was reported by every interviewee (especially since messaging strategies were not the primary focus of the interviews—see above). Rather, these are techniques reported and well explained by at least one participant (often more), with relevant insights from at least a few others. In this section, we elaborate each strategy with evidence and rationale from the interviews, and add our own application of the scholarly literature. We draw primarily on the theories of deliberative rhetoric, in order to provide a common thread for the discussion, but ultimately apply all three of the above literary fields. This approach results in a set of strategies that are grounded in practice, but also have theoretical justification. Specifically, the seven strategies emphasize: risks of inaction, everyday impacts, short-term effects, success stories, local solutions, political tractability, and audience ownership.

4.1 Risks of Inaction

There is no escaping the plain fact that climate data is complex and uncertain. Focusing too much on this uncertainty in an effort to be transparent, however, can be counterproductive, because policy makers have little tolerance for it (see Bradshaw and Borchers 2000 and the "double bind" in Russill and Nyssa 2009). One municipal planner argued that it is difficult to prioritize uncertain future considerations over immediate matters. The problem is elaborated in this comment from a CFCAS scientist:

> When you have scientists talking, there will always be a certain degree of uncertainty attached to it—and the message sent—the general public pick up on the uncertainty as the message as opposed to the higher probability. So it is a real danger, when we talk about science, because the scientist wants to be exact and clear, but what I think happens is they obfuscate the message more often than not.

The suggestion here is that lower uncertainty and higher probability are perceived differently, even though they mean essentially the same thing. This implies that "we predict a flood in the next five years, but there is a 30% chance we are wrong" is less effective than "we predict a 70% chance of a flood in the next five years"—the latter highlights the risks of not acting. Another municipal planner added that if liabilities and risks are communicated correctly, organizations like PCIC can make it almost impossible not to act.

The importance of highlighting the risks of not acting—and the higher probability of a threatening future—becomes clear when considered from the perspective of deliberative rhetoric. Persuading an audience that policy action is required hinges on the audience perceiving a clear, imminent threat to the public good that warrants attention. Crafting a message that clearly characterizes this threat and makes it salient for the audience helps focus their attention on the very problem that demands a policy solution. This does not mean fabricating false, exaggerated, or manipulative appeals to fear, but rather speaking to what Pfau (2007, p. 221) calls 'civic fear', which helps the audience collectively perceive risks to the community and motivates them to deliberate and take appropriate and timely action (also see Schwarze 2006). Indeed, messaging that invokes 'civic fear' is a crucial first step towards mobilizing policy action, as it is "designed to open up political debate" and incline people towards deliberation (Pfau 2007, pp. 220–221). Innocenti (2011, pp. 277–278) adds that fear appeals, when used in this way to encourage "collective foresight" rather than "compliance," function as "civically responsible" emotional appeals.

4.2 Everyday Impacts

Highlighting potential day-to-day impacts can make climate science seem more practical for policy makers. Interviewed representatives of government reported that they generally hear too much about the science and not enough about the "so what"—that is, economic and social implications, as well a visible impacts (see Cash et al. 2002; Likens 2010). Witness this quote from a federal civil servant:

> The public is seeing more extreme weather events—and we all know you can't relate any one particular extreme weather event, with certainty, to climate change… My friends in the scientific community—they're too careful not to go too far. But sometimes… you have to take an opportunity to really push something forward, and even though you want to choose your words carefully… I think that these extreme weather events are tell-tale… I think one has to be a little bit opportunistic about getting out, in reaching to the public so that the public's concern will, in the end, put more pressure on government.

That is, scientists are trained to let data speak for itself, but other audiences require context and framing in order to see the significance of that data. A softer example, pointed out by a CFCAS scientist, would be highlighting the impact of climate change on outdoor skating rinks, which will limit future opportunities for Canadians to play hockey, a treasured national pastime.

This strategy helps audiences collectively perceive climate change as a clear and imminent threat to 'the good life', which warrants policy attention and deliberation. To prompt the 'civic fear' required for policy makers to categorize climate change as a legitimate and pressing threat, the object of that fear (e.g. harmful climate impacts) must be actively and strategically characterized as likely to cause people pain or agitation in their day-to-day lives. As Pfau (2007, p. 222) argues, the destruction and inconvenience of the threat must be characterized as "near at hand—both temporally and spatially" and "likely to affect oneself". Effective messaging can make the impacts of climate change salient—even sensate—through careful wording and framing. Of course, too much melodrama can be counter-productive (see Foust and Murphy 2009; Russill and Nyssa 2009), so winter sports decline may be a better example of everyday impact than deadly storms.

4.3 Short-Term Effects

While climate change science is complex and involves several dimensions, part of communicating effectively is knowing which dimensions to emphasize, that is, which information to make salient (even though all of the information is important) in order to promote a perception of potential harm and motivate action. One strategy is to highlight the short-term impacts over the long-term ones, even though the broad climate action argument has traditionally been dominated by the latter. A CFCAS scientist explained further:

> Climate change and the implications of climate change—they're long-term in essence. It's difficult to get people to focus on it unless they start seeing it happening, and where you start to see it happen is in the more frequent severe events, whether that's droughts, floods, or whatever, or ice storms. That's when people start to say "wait a minute, something is happening here—this is not the weather I would normally expect, so what's happening?"—that's when you start to get their attention a little more.

A good example of a short-term effect that could be highlighted, prevalent in the municipal case, is the expanding range of the Mountain Pine Beetle (i.e. normally kept in check by cold winters), which has already caused whole forests to turn red and die. This very visible present-day impact helped spur adaptation planning in the community of Prince George. There are also political reasons for the short-term emphasis, given the nature of electoral cycles.

Emphasizing short-term over long-term impacts is another way to make the harmful potential impacts of climate change appear close at hand, a prerequisite to inciting the 'civic fear' required to prompt public deliberation and policy debate (see Pfau 2007, p. 221). As O'Leary (1993) contends in his theory of apocalyptic rhetoric (which revolves around anticipated risk), for a future to be perceived as a threat to the community, it must be perceived as temporally proximate. Impacts must be perceived to be looming or even *present*, even though they will result from an imagined (if highly likely) *future*. They must be given a kind of imminence, in order to persuade audience members that those impacts "will concern them directly" (ibid., p. 405). However, as discussed above, it is important to avoid messaging that is too dramatic.

4.4 Success Stories

Another strategy for moving away from the hard science and making the implications more 'real' for policy makers is to focus on positive success stories of adaptation or mitigation, instead of adopting a largely negative tone (see "comic frame" in Foust and Murphy 2009). Consider the remarks of a municipal intermediary, who was very experienced with conversations between scientists and policy makers:

> A lot of the stuff that we're talking about, with the science presentations, is sometimes hypothetical and based on computer models and all this other stuff. But stormwater systems people get—the community engineer knows all about it, and you start to put some of these numbers in front of them and they go "oh geez, that could be a problem"—but to have an example of where there's been some success stories would be very valuable for other communities to see, and maybe some light-bulbs go off.

Different audiences can make sense of different emphases, but success stories tend to get traction with any type of audience. The best example, mentioned by several interviewees, was the community of Castlegar successfully weathering a flood because they had done prior adaptation planning and simply (and inexpensively) increased the frequency of culvert maintenance.

This 'flip-side' of communicating climate information reflects the fact that deliberative rhetoric revolves around two imagined futures: one that is fearsome, should 'the best course' *not* be taken; and another that is more hopeful and filled with the promise of safeguarding (even improving) 'the good life' of citizens, should 'the best course' be taken (see Yack 2006). In theory, both futures are necessary: the first (fearful) opens up policy debate (see Schwarze 2006), while the second (hopeful) guides policy action. Balanced messaging invokes both, taking care to characterize not just the dark future that compels action, but the brighter future that suggests a solution is possible (and to suggest a trajectory for shaping the future). As Pfau (2007, p. 223) argues, "there must be some hope of being saved" for deliberative rhetoric to persuade; fears must appear surmountable (see "human agency" in Foust and Murphy 2009 and "self-efficacy" in O'Neill and Nicholson-Cole 2009). An effective communicator avoids "overwhelming the audience with 'things fearful beyond human strength'" and demonstrates what can be achieved that is within the audience's power to realize (ibid.; quoting Aristotle). Similarly, O'Leary (1993, p. 393) argues that public discourse revolving around anticipated risk must oscillate between fear and hope—between "terror and triumph"—to exhort people to action. Without a hopeful destination and "a specific danger *that can be assessed and guarded against*" (O'Leary 1997, p. 294; emphasis added), the audience will likely remain paralyzed by fear or prone to inaction (O'Leary 1993, 1997).

4.5 Local Solutions

Another strategy related to privileging particular dimensions of climate information is to focus on local solutions over global solutions (see O'Neill and Nicholson-Cole 2009), even though the latter are still extremely important. Witness this characterization of the issue, from a federal civil servant:

> There are two aspects to the problem, or two aspects to the solution, and one is to mitigate greenhouse gas emissions… it only affects global greenhouse gas concentrations and global climate—so that's not a particularly detailed or fine decision that you have to make at a local or regional scale. The other aspect of the solution is adaptation… something that happens locally… You can start thinking about what stormwater-handling infrastructure around your town might look like, change building codes accordingly.

The implication is that it is easier to motivate action on local adaptation than global mitigation, especially when specific information about regional climate impacts is available. This is because global climate mitigation is a tragedy-of-the-commons situation, whereby jurisdictions that take action only capture a tiny fraction of the benefits they produce, but local climate adaptation is more of a straightforward policy problem. Of course, it would be irresponsible to completely ignore mitigation, but an interviewed intermediary surmised that communicating about adaptation can subsequently make policy makers more receptive to the problem of mitigation. Indeed, in smaller municipalities, it is likely the same person who would be responsible for both adaptation and mitigation.

This call for more focus on local solutions reflects the extent to which, within deliberative rhetoric, the threats compelling deliberation must be perceived as 'close-by' to persuade the audience they are 'real' (Pfau 2007, p. 222), just as solutions need to be perceived as 'close-by' to appear feasible. Audiences are more likely to act on proposals that involve their immediate spatial proximity: their person, their home, their domain. Not only is such proximate space more likely to be perceived as within their immediate power to control and influence, but it is more likely to be familiar and of interest. In deliberative rhetoric, wherein communicators must compete with each other for the "attention" and "allegiance" of the audience (see ibid., p. 427), appeal to spaces that are familiar and easily called to mind are more likely to fix and retain the audience's focus.

4.6 Political Tractability

Another dimension that can be considered, in order to increase messaging effectiveness, is the policy sector being targeted, or the type of outcomes being emphasized. That is, while the broad climate action argument often focuses foremost on environmental outcomes (e.g. coral bleaching, biodiversity loss, forest health), these may not be relevant to the mandate of a given government. Consider the comments of a provincial civil servant:

> No amount of facts or evidence is going to convince a government… you're not going to convince them with an academic paper. So I think the willingness is the first necessary condition, unless it was… around a co-benefit that that government did care about that could then show them how climate fit in… all the things government does care about like their deficits, and risk management, and health, and communities are all things that are intimately woven with climate. Often there's a bit of a shift to talking about healthy communities instead of talking about climate.

If the environment is not a particular priority for a government (see Mead 2015), it is important for climate scientists to frame the issue as not just an environmental one (see Foust and Murphy 2009). Depending on the current policy priorities of that jurisdiction, they could highlight economic impacts (e.g. crop vulnerabilities), health impacts (e.g. heat stroke), or social impacts (e.g. reduced tourism). The policy process can be quite chaotic and seemingly arbitrary, after all.

This alignment of messaging with audience priorities resonates nicely with theories of deliberative rhetoric, which insist that political deliberation prioritize civic issues, the public good, and good government over issues of truth (Kock 2014). Political decisions aim to secure 'the good life' of citizens through prudent choice, but what counts as a 'good' choice invariably depends on the needs and priorities of the particular political community or constituency. As Timmerman (2002, p. 91) argues, "the issue of expediency drives public affairs" and deliberative rhetoric tries to influence judgments about which future choices and actions are most expedient for the public in question; all other factors are "incidental". Effective messaging, then, highlights how outcomes intersect with the most pressing concerns in the community and how desirable outcomes conveniently align with existing policy priorities and processes.

4.7 Audience Ownership

Given the complications involved, it is no surprise that policy makers may be resistant to climate science information. The strategy of facilitating audience ownership targets this challenge directly. One federal civil servant elaborated:

> You can imagine going through a negotiation, and if the negotiation turns into a battle of experts, it's not going to go very far—whereas if the starting point for the negotiation is an understanding of the science that has received a sign-on from the participants in the negotiation, then there's, in principle, a common basis of understanding.

He went on to identify the IPCC as an example, but various other interviewees suggested that the same principle applies to similar cases at smaller scales. Collaborations between scientists and government on research or monitoring projects will increase the receptivity of policy makers to the resulting information (see Mead 2015). More simply, the government's own data or reports can be incorporated (e.g. cited) in scientific studies. Another approach is for scientists to liaise with one contact from government, discuss the information, and then get that person to present it to others in the relevant department. Finally, individual workshops or presentations can start with some audience input (e.g. personal observations of weather anomalies).

This final messaging strategy reflects the kind of communication required when dealing with complex, contingent knowledge (rather than absolutes). As Danisch (2010, p. 174) observes, "wherever deliberation occurs (even in scientific and technical contexts), contingency serves as a backdrop". This means that deliberative rhetoric traffics in propositions that might or might not be true—propositions that are then linked up in chains of reasoning along with accepted truths and a host of contested and uncertain claims. All of this makes for rather unstable communication. Within such a communicative context, lacking absolutes to guide reasoning, communicators and audiences must work together to both establish and then draw on a body of common knowledge to guide "reasoned judgments about public affairs" (ibid., p. 175). In a way, then, deliberative rhetoric rests on a body of common knowledge that emerges from "consensus and collaboration" between communicators and their audiences, and "requires that the audience co-produce it" (ibid., p. 176). Effective messaging ensures that such a body of common knowledge is established and in place before proceeding.

5 Conclusion

Combining the experiences of experts at the climate science–policy interface with the support of robust concepts from the field of communication theory has allowed us to propose seven well-supported messaging strategies, for use by scientists in communicating with policy makers about climate change. The emerging theme of the identified strategies is that climate messaging should be direct and relevant, acknowledge the audience's perspective and psychological tendencies, and balance positive and negative framing. In coming to these conclusions, we addressed some gaps in the individual bodies of prior literature, which are most useful when combined and grounded in practice. Of course, we should acknowledge the excellent work of other contemporary authors that are helping to bridge such gaps. Jarreau et al. (2015), for instance, propose some similar strategies based on environmental psychology and a case study in the US, but not specifically in the context of climate change. Nunes et al. (2016) provide a detailed and practical (but academic) account of successful climate science–policy messaging in Brazil, drawing primarily on tactics emphasizing the local and economic impacts of climate change (i.e. our fifth and sixth strategies). We hope that our own work, combined with studies like these ones, will be useful to climate science communicators. The abstract foundation of communication theory lends flexibility to our strategies so that they might be applied in contexts besides Canada, and at multiple scales of government.

We would like to close with some notes about the limitations of this study and potential further work. First, the empirical support for our seven strategies is based on the opinion of a small number of practitioner experts, and there is still room for more rigorous testing (e.g. actual experiments that solicit responses from policy makers to hypothetical climate messages, more systematic investigations into the variety of strategies that are used across a large number of cases). Recall that this was primarily an exploratory study, so its purpose was to generate a strong and persuasive hypothesis about climate science–policy messaging (i.e. the list of prospective strategies), not to extensively test such a hypothesis, which may be a useful focus for a future study. Second, a broader observation emerging from the interviews is that the success of messaging (and science–policy interaction as a whole) depends heavily on the general relationship that has been established between the scientist communicators and the government audience (see the literature on science–policy interfaces, such as "boundary organizations" in Cash et al. 2002). A lot of messaging power comes from connections, time, and experience. Having a good informal rapport will afford some elasticity to the messaging. That is, even if a particular strategy falls flat, the information might get uptake anyway. Similarly, a bad or hostile relationship (e.g. where the same scientists have been publicly critical of government) may preclude even the most thoughtful messages getting through. Indeed, scientists may have to choose between 'influence from within' (direct communication and a good relationship with government) and 'influence from without' (indirect interaction through encouraging the public to put pressure on government). Scientist communicators should keep these limitations in mind but also consider the seven strategies. If they do so, we believe they stand a better overall chance of translating climate scientific consensus into the necessary policy action.

References

Bradshaw G, Borchers J (2000) Uncertainty as information: narrowing the science–policy gap. Ecol Soc 4(1). www.ecologyandsociety.org

Cash D, Clark W, Alcock F, Dickson N, Eckley N, Jäger J (2002) Salience, credibility, legitimacy and boundaries: linking research, assessment and decision making. Faculty research working paper. Harvard University JFK School of Government, Cambridge MA

Danisch R (2010) Political rhetoric in a world risk society. Rhetoric Sci. Q. 40(2):172–192

Foust C, Murphy W (2009) Revealing and reframing apocalyptic tragedy in global warming discourse. Environ. Commun. 3(2):151–167

Howlett M, Ramesh M, Perl A (2009) Studying public policy: policy cycles & policy subsystems, 3rd edn. Oxford University Press, Don Mills

Innocenti B (2011) A normative pragmatic model of making fear appeals. Philos Rhetoric 44 (3):273–290

Jarreau P, Altinay Z, Reynolds A (2015) Best practices in environmental communication: a case study of Louisiana's coastal crisis. Environmental Communication (online article)

Kock C (2014) Aristotle on deliberation: its place in ethics, politics and rhetoric. In: Van Belle H, Rutten K, Gillaerts P, Van De Mieroop D, Van Gorp B (eds) Let's talk politics: new essays on deliberative rhetoric. John Benjamins Publishing Company, Philadelphia

Lawton J (2007) Ecology, politics and policy. J Appl Ecol 44(3):465–474

Likens G (2010) The role of science in decision making: does evidence-based science drive environmental policy? Front Ecol 8(6). www.frontiersinecology.org

Mead L (2015) Only connect: why government often ignores research. Policy Sci 48(2):257–272

Nunes F, Rajão R, Soares-Filho B (2016) Boundary work in climate policy making in Brazil: reflections from the frontlines of the science–policy interface. Environ Sci Policy 85(1):85–92

O'Leary S (1993) A dramatistic theory of apocalyptic rhetoric. Q J Speech 79(4):385–426

O'Leary S (1997) Apocalyptic argument and the anticipation of catastrophe: the prediction of risk and the risks of prediction. Argumentation 11(3):293–313

O'Neill S, Nicholson-Cole S (2009) Promoting positive engagement with climate change through visual and iconic representations. Sci Commun 30(3):355–379

Pfau M (2007) Who's afraid of fear appeals? Contingency, courage and deliberation in rhetorical theory and practice. Philos Rhetoric 40(2):216–237

Richards G (2015) Climate change action through co-productive design in science–policy partnerships at municipal, provincial, and national levels of government. Ph.D. dissertation, University of Victoria, Victoria

Richards G, Belcher K, Noble B (2013) Informational barriers to effective policy–public communication: a case study of wind energy planning in Saskatchewan, Canada. Can Public Policy 39(3):431–450

Russill C, Nyssa Z (2009) The tipping point trend in climate change communication. Glob Environ Change 19(3):336–344

Schwarze S (2006) Environmental melodrama. Q J Speech 92(3):239–261

Timmerman D (2002) The Aristotelian fix. Rhetoric Soc Q 32(3):77–98

Yack B (2006) Rhetoric and public reasoning: an Aristotelian understanding of political deliberation. Polit Theory 34(4):417–438

Climate Change Communication: Community Knowledge and Preparedness

Sri Hartini Rachmad

1 Background

Taking action against climate change and its effect have been agreed and stated in the 13th Goals of SDGs been declared by UNs High Meeting in New York on 25–27 September 2015 and attended by more than 168 countries in the world. Thus, in the 13th goals of indicators 13.2, it is stated that Action Index of Climate Change Indicator needs to be developed into 14 indicators". In terms of to support the 13th Goals of SDGs, the availability of information on disaster prone areas is important and high demand for anticipating and handling of rehabilitation particularly of infrastructure in disaster and for the emergency response to the victim. To anticipate victim of both living and non-living things, data and information on natural disasters are urgently needed. The data are used as a decision making tool by the Government and other stakeholders who are involved within.

Sumatra island is part of a big thousand islands in Indonesia, during 2011 Langkat City of North Sumatra was recorded as the city with the highest score for Disaster Risk Index (DRI) of flood with 70 points (BPS 2012a, b). There were 236 districts/cities that have high score for DRI of flood. For earthquake and tsunami, Banda Aceh had the highest score of DRI with 68 points. There were 25 districts/cities that have high score for DRI of earthquake and tsunami.

Flood is a natural disaster that is common in Indonesia with highest number of recorded victims accordingly compared the other kinds of disaster. Regarding BPS (2012a, b) reported that flood happened as much as 990 times in 2010, decreased to 554 in 2011, and the last condition in 2015 become 375 occurences reported by BNPB (National Agency for Disaster Management 2016). The second and third bigest number occurance of natural disaster are waterspout and landslides.

S. H. Rachmad (✉)
Researcher at BPS Statistics Indonesia and Lecturer at Statistics Institute,
Directorate Analysis and Statistics Development, Jakarta, Indonesia
e-mail: shrachmat@yahoo.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_12

The number of natural disasters during the year 2010–2015 is fluctuated and almost distributed evenly in Sumatra, Java and Eastern Region of Indonesia. Natural disasters include flood, flood and landslide, tidal wave/abrasion, earthquake, earthquake and tsunami, forest fires and land, drought, volcanic eruption, waterspout, landslide and tsunami. These natural disaster stated are classified as disaster mainly caused by climate change, referring to statistical measurement glosary.

A better understanding of the impact of vulnerability and resilience to environmental changes may help policymakers and practitioners assess the degree to which people need to move, what forms of movement are likely, and their ability to avoid harm in the presence or absence of mobility. Therefore, the provision of Disaster Preparedness Index as a measurement related to evaluation-monitoring program development, particularly adaptation to vulnerable people links to climate change effect of which resulted by disaster in the peak disastrous region of Indonesia, namely Padang City, would be expected to facilitate the measurement of disaster knowledge level of community leads to anticipate reducing the size of disaster victims.

2 Objective

This research paper purposes to examine the urgency of creating measurement related to evaluation-monitoring program development, particularly adaptation to vulnerable people links to climate change effect of which resulted by disaster in the peak disastrous region of Indonesia, namely Padang City. Study on the impact of vulnerability and resilience towards climate change effect in terms of environmental damage and disaster occurances whereas as an action of resilience and adaptation aims to reduce the high risk number of disaster victim. The high frequent of natural disasters in Indonesia had provoke demanding to implement disaster risk reduction and preparedness as an effort to strengthen the resilience against unexpected disaster. Ultimately, the Disaster Preparedness Index would be expected to facilitate the measurement of disaster knowledge level of community preparedness. Finally, the result of this analysis will be very useful for policy demand and support to guide meaningful action for adaptation of climate change effect related to knowledge transfer to local community as resilience–adaptation capacity building.

3 Data Source

The data used are primary data and secondary data. The primary data is obtained from pilot survey of KAP 2013 (Knowledge Attitude and Practice 2013), whilst, the secondary data are mainly derived from BPS-Statistics Indonesia, namely: Village Potential Data (2010), Population Census 2010, and Environment Statistics Report. The data are also derived from the National Agency of Disaster Management

(BNPB) of which data in registration administration type based on the disaster report (victims and handling system). Some other sources are derived from the literature studies that help refine the analysis by combining simultaneously the both quantity and quality data in the study and coincidently as a previous literatures study for references. The Population Census 2010 can provide variables of demographic characteristics (size, distribution and composition of population) and households' facilities. Moreover, the Village Potential Data (2011) can be derived the geography, topography and environment; health-education infrastructures and public services infrastructure.

4 Literature Studies

4.1 Padang's Geographic

West Sumatra Province where Padang City laid on is located in Sumatra Island, with total area of 42.200 km^2 and approximately 2.21% of Indonesia's total area. The boundaries of West Sumatra province are North Sumatera (North), Riau Province (East), Jambi Province (South) and the Indonesian Ocean (west). West Sumatera has a tropical climate with the average temperature ranging between 21.51 and 31.52 °C, with the average level of humidity at 87.03% (BPS of West Sumatra in Figure 2012).

Indonesia consists of 153 regencies/cities and laid on the prone zone of very high risk of disaster predicted 60.9 million people. Among 232 regencies/cities in the high zone risk of disaster estimated 142.1 million people. Whilst, among 127 regencies/cities in the very high zone of tsunami over 5 m about 3.2 million people. In further, 46 regencies/cities in the high zone of tsunami ranging 3–5 m about 758 thousand people. The last estimation is about 26 regencies/cities in the medium risk zone of tsunami ranging 1–3 m estimated 109 thousand people.

President's RI commands during *Breakfast Meeting at* Bogor Palace on 16th April 2012, among others: Regarding the earthquake 8.5 RS in 2012 in Padang

City should be conducted an early warning system evaluation of tsunami and integrated anticipation. BNPB along with related Ministries and/or other Institutions should as soon as possible construct Masterplan of reducing the disaster risk of eartquake and tsunami. The ministries and/or other Institutions involved within should work together in order to support BNPB duty. Shelter development should be built in 2013–2014 in order to save community whom are under tsunami threats. Lastly, preliminary masterplan should be completed and handed over in short terms about 1–2 months and the head of BNPB been asked to present the result of the masterplan in the Cabinet Board Meeting.

4.2 Index

Recent catastrophic events have made a greater awareness for disaster preparedness across all sectors, public to private. There have been efforts to measure aspects of disaster including preparedness, resilience, mitigation efforts, social vulnerability, and hazard exposure. There are potential benefits from measuring disaster related themes, such as a clearer understanding of community preparedness, and providing a means to encourage communities that are more vulnerable and less prepared to improve their preparedness efforts. Better measurement may also lead to a more efficient allocation of scarce resources, and assist in the pricing of risk more effectively and accurately. Use of an "index" has been a popular methodology for evaluating relative levels of some state of being, whether economic health, quality of life, or something similar. In some cases, there have been indices that attempt to capture levels of social vulnerability to natural hazards. Indices are usually comprised of a set of indicators and through some mathematical combinations an index number is derived for a community which can be used to make comparisons with other communities.

An index is a composite representation of numerical measurements, manipulated in some manner to give a single value, often called an "index score" or rank. It is number derived from a series of observations, used as an indicator. number derived from a series of observations, used as an indicator. A classical definition of an index number can be described as a statistical value that is modified, and its variations signify a change of magnitude, but are not subject to accurate measurement that would not be easily observed and has the influence to affect the values (Kenney and Keeping 1962).

Index numbers were originally developed by economists for measuring commodities prices, and to gage the average percentage change from one period in time to another. While the commodities approach and its particular definition of index numbers has been directed towards prices, it has also been applied to other themes with differential values. These applications have involved such comparisons as those between two geographical places or comparisons between the magnitudes of a group of elements under any one set of circumstances (Persons 1921). Many of the efforts to define and quantify preparedness still remain unsatisfactory

(Kirschenbuam 2002). As the perceived value and possible applications has risen, their use has spread to fields outside of economics and into the social sciences.

Indices have become more widely applied in social capital and capacities, and measure such things as quality of life (QOL), human development, and social vulnerability. An index will usually be composed of several different indicators that relate to the quality of life, human development, vulnerability, emergency preparedness or what ever the topic of the index might be. These indicators tend to be socially constructed and are used in indices that measure conditions and changes over time, for different populations (Land 1983). Social indicators and monitoring social phenomena became widely used by social scientist and policy makers beginning in the 1960's (Sheldon and Parke 1975).

Indices are attractive because of their ability to summarize a considerable amount of technical information in a way that is easy for lay persons to understand (Davidson and Lambert 2001). Some indexes, such as the United Nations Human Development Index (HDI), do not provide the entire picture, but they are more beneficial then just examining one indicator such as income because they will incorporate into the index other variables, such as education and health (United Nations 2005). By examining multiple indicators, the level of bias can be reduced and the picture that is provided by investigating just one indicator is much clearer, providing a wider perspective (Cobb and Rixford 1998). This is an especially useful feature for the emergency preparedness community—bringing together a wide array of professionals. Indices are also very attractive to the policy community because they provide a set a metrics that allow for comparison of vulnerability between different communities (Cutter 2003).

Vulnerability can only be measured with a clear definition that can be operationalized. Blaikie et al. define vulnerability as "the characteristics of a person or group in terms of their capacity to anticipate, cope with, resist, and recover from the impact of a natural hazard" (Blaikie et al. 1994, p. 9). These indicators provide a way of specifying discrepancies between present and desired circumstances. In the case of disaster preparedness or human vulnerability the goal for communities is to maximize their preparedness potential and minimized their vulnerability.

Indexes are generally constructed by the summing or multiplying of several indicators relating to item being measured. Indicators that go into creating an index will have different units such as dollars, miles, degrees, population per square mile, or similar. Various methods are used, such scaling, to create "unit-less" variables. For example, a linear method of scaling was used for the Hurricane Disaster Risk Index (Davidson and Lambert 2001) and the Earthquake Disaster Risk Index (Davidson and Shah 1997). Data can also be standardized and made unit-less by using Z-scores and then summing the values—a method used for the Social Flood Vulnerability Index (Cutter 2003).

Other mathematical procedures, such as weighting techniques, are also incorporated into an index value in order to identify the varying levels of importance for each indicator. Weighting is a subjective process, and indicators that are considered to be of most importance to the index, can be assigned a higher "weight" to indicate the importance of the specific indicator (Kaly et al. 1999).

Once an index number has been derived, there are several questions that should be asked. One considerable shortcoming of using composite indexes is that there is no simple way to get scientific validation of a particular index (Davidson and Shah 1997). The absence of validation is a major concern. In many circumstances, the index relies on empirical data that is far from being perfect. It is assumed by many users of the information that just because some numbers have been derived, it is a valid and reliable method.

5 Research Methods

5.1 Data Collection Method

Padang city was chosen as survey pilot area sample with high consideration that more than 19.41% of its region identified as a prone disaster of high tsunami region. The sample size of survey covered approximately 250 households in the areas exposed to the disaster. The catastrophes are among other: floods, floods and landslide, landslides, earthquakes, tornados, land and forest fire, droughts, tidal waves/abrasion, and transportation accidents. The programs of disaster preparedness should be developed by humanitarian workers in order to minimize the loss of life and properly, and help the people who live in earthquake and tsunami prone areas. This data survey is the cornerstone of effective emergency preparedness, conflict prevention, emergency relief, and the rehabilitation and reconstruction process. Furthermore, in the acute phase this data will be very crucial for implementing and targeting effective responses.

By applying a purposive sampling method, 10 villages been selected among 25 villages with categories as high prone disaster region in Padang city of which determined by BNPB. In the each of selected village sample was selected purposively a census block. Subsequently, in each of census block sample selected 25 households to implement the Survey KAP 2013 in systematically method of listing PKAPS13-P.

5.2 Determining the Key Variables, Measures and Metrics

Using a collaborative and consensus-based process among identified experts in the field—the individual measures will be determined and weighted. These is identified below as functional measures of preparedness (FM). The functional measures (FM) will be based on its measuring. The number of measures can be as extensive as feasible data collection and synthesis allows.

Once the measures have been determined and agreed upon, they can then be scaled and normalized to fill in the following equations, first determining the preparedness index score. First, as an overall measure of community capacity, the derivation of a preparedness (Pi) score for a given location (x) will use the following:

$$P_{ix} = (w_1 FM_1 + w_2 FM_2 + \ldots w_n FM_n)$$

where:

P_i = community preparedness (P) index
x = location of community
w_n = weight for a given measure
FM_n = functional measure/indicator
n = number of measures.

The next step is to determine the measures of preparedness (FM), by deriving a score that measures its parameter. LIPI and UNESCO (2006) have made a framework of disaster preparedness. Preparedness is grouped to be four parameters such as Knowledge and Attitude (KA), Emergency Planning (EP), Warning System (WS) and Resources Mobilization (RM). International Federation of Red Cross and Red Crescent Societies (2000) on Disaster Preparedness Training Programme, has conducted a comprehensive disaster preparedness strategy that includes 9 elements. The elements are (1) Hazard, risk and vulnerability assessments; (2) Response mechanisms and strategies; (3) Preparedness plan; (4) Coordination; (5) Information management; (6) Early warning systems; (7) Resource mobilization; (8) Public education, training, and rehearsals; (9) Community based disaster preparedness.

Here, we modify five indicators to measure disaster preparedness index. Preparedness is a series of activities carried out in an effort to eliminate and/or reduce the threat of disaster. The calculation of DPI is done to see the level of community preparedness in anticipation of disaster. The calculation of the parameters is made by asking the households' respondent using a weighting method. The questions are grouped as parameters of Disaster Knowledge (KD), Disaster Preparedness Policy (DPP), Emergency Response Plan (ERP), Disaster Early Warning (DEW) and Resource Mobilization (RM) with the score of 1 for "yes" and 2 for "no". Then each question that has been grouped by parameter is multiplied by the weight score (Tables 1 and 2).

Table 1 Response to each question

Parameter	Number of response
(1)	(2)
Knowledge on Disaster (KD)	19
Disaster Preparedness Policy (DPP)	9
Emergency Response Plan (ERP)	5
Disaster Early Warning (DEW)	8
Resource Mobilization (RM)	3
Total	44

Table 2 Preparedness Index (PI) parameter

Parameter	Weight
(1)	(2)
Knowledge on Disaster (KD)	35
Disaster Preparedness Policy (DPP)	10
Emergency Response Plan (ERP)	15
Disaster Early Warning (DEW)	25
Resource Mobilization (RM)	15
Total	44

Table 3 Preparedness index classification

Value	Classification
(1)	(2)
<60	Low
60–80	Moderate
>80	High

$$P_{ix} = (35KD + 10DPP + 15ERP + 25DEW + 15RM)$$

with the following scores:

- KD: the proportion of "yes" to the questions of Disaster Knowledge parameter.
- DPP: the proportion of "yes" to the questions of Disaster Preparedness Policy parameter.
- ERP: the proportion of "yes" to the questions of Emergency Response Plan parameter.
- DEW: the proportion of "yes" to the questions of Disaster Early Warning parameter.
- RM: the proportion of "yes" to the questions of Resources Mobilization parameter.

The total number of households' answers to each parameter is multiplied by the weighting scores. The preparedness index scores then are classified as follows (Table 3).

6 Result

Padang city is mainly located in the coastal area and has experienced several catastrophic earthquakes and tsunami. The high frequent of natural disasters in Indonesia had provoke the local, regional and national administration of Indonesia Government to implement disaster risk reduction and preparedness as an effort to strengthen the resilience against unexpected disaster. Therefore, the provision of Disaster Preparedness Index would be expected to facilitate the measurement of disaster knowledge level of community, as consequent, reducing the size of disaster victim can be anticipated. Regarding the pilot survey result in 2013 was trying to portray on knowledge level, mindset and behavior of the people towards disaster where the type of disaster mostly as an effect of climate change, thus it is very urgent to do monitoring-evaluation.

6.1 Knowledge Attitude and Practice of Respondent

Mostly respondents had experiences on the type of eartquake disaster in their life. Among respondents who had experiences on eartquake disaster they tend to having more than one experiences on eartquake disaster. The high percentage of respondents (more tahn 60%) gave response on the most likely their residential area have a high risk to be threated by natural disaster of earthquake and tsunami, it portrays that community already had remarkable knowledge on disaster (Table 4).

More than 45.2% of respondents claimed that their area have already built tools/preparedness facilities and/or disaster mitigation. The high frequence of tools can be seen are evacuation signs estimated 37.3% (Fig. 1).

Findings show of the nine types of disasters, flood is the most frequent occurrence, which is 32 times or 48% in the period 2000–2012. The number of people that died as the result of the earthquake in the year 2000–2012 amounted to 774, while 79,016 units of house were severely damaged. Many people who evacuated with a private vehicle that raises the 'high traffic' in several points and is very dangerous when a tsunami occurs. Another point to be noted is the lack of an early warning system coordinated by relevant agencies. In sum up, understanding of the hazard, exposure and vulnerability to disasters will be useful for the community in identifying the main risk factor, to help develop appropriate strategies for risk reduction.

Dissemination of information on the disaster can be done by looking at the habits of the people in obtaining information resources. Through media that are familiar to

Table 4 Knowledge attitude and practice of respondent

Type of disaster	Having experience (%)	Never had experience (%)
Earthquake	99.2	0.8
Volcanic eruption	28.4	71.6
Tidal wave	14.0	86.0
Tornado	10.4	89.6
Earthquake and Tsunami	8.0	92.0
Landslide	6.0	94.0
Flood	3.2	96.8
Land and forest fire	2.0	98.0
Drought	1.2	98.8

Fig. 1 Traffic jammed at all road leads to main road simpang alai

the community, it is expected that dissemination of disaster information can be carried out efficiently. Figure 2 shows the results of KAP pilot survey on information sources accessed by members of the household. It shows that, in terms of the activity to access the information sources almost half of the respondents used television. The percentage of respondents who watched television was 42.6. In addition to television, the internet was also quite widely used (by 17.7% of the respondents), social media (16.8%), and newspapers (13.0%). Meanwhile,

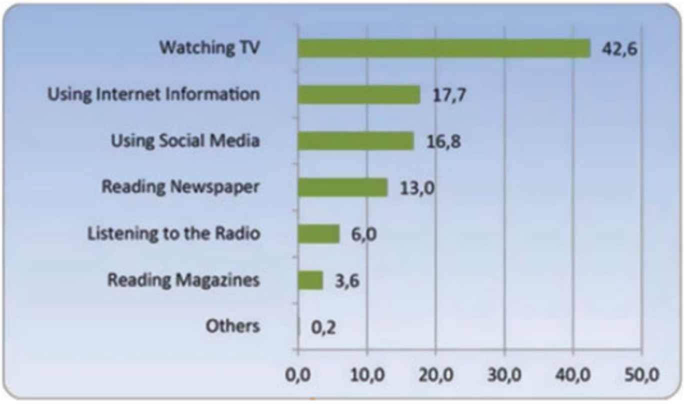


Fig. 2 Percentage of respondent household members by type of activity accessing information sources

other media such as the radio and magazines were relatively not much used; i.e., 6.0 and 3.6%, respectively.

Figure 3 shows that television was also the most widely used by members of households in getting information on rescue during natural disasters. In addition, friends, neighbours, family and relatives were also sources of information on how to escape from the disaster. Based on this survey result, it can be concluded that the dissemination of information on rescue from disaster can be done amicably, by disseminating the knowledge about rescue from disaster to people in close proximity such as family, relatives, neighbours, and friends.

One of the indicators of community resilience against disasters is their understanding of disaster information. The better people understand about a disaster, the less risk arising from the event of disaster in the future. Understanding of disaster can be derived from the experience of the people themselves. Disasters that have occurred in the past should be valuable lessons learned for the community to be aware of the signs and to determine the steps to take as anticipation. This knowledge is passed down from generation to generation and has become a local wisdom (Table 5).

Although nearly all respondents said that they had experienced an earthquake, however, as shown in Table 6 only about a quarter of them knew the signs of imminent earthquakes. It is quite reasonable as an earthquake is a natural catastrophe that occurs unexpectedly despite the fact that the stricken area has great potential for experiencing an earthquake. Unlike the case with earthquake, about half of the respondents already knew the signs of impending the earthquake and tsunami. It should be noted though that there was still almost the other half who did not know the signs of the disaster in spite of the fact that their dwelling area (Padang) is an area highly prone to earthquake and tsunami disasters. In addition,

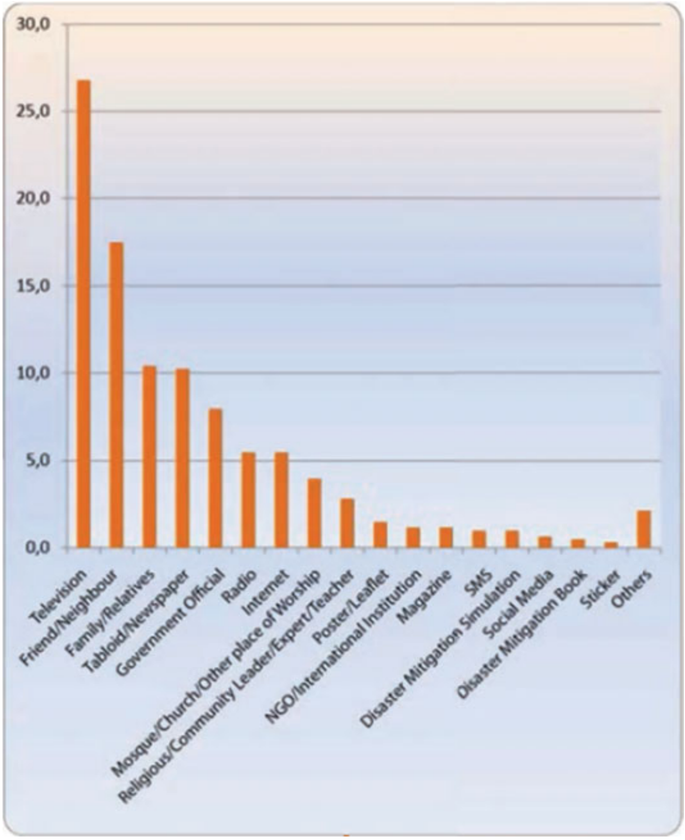


Fig. 3 Percentage of information resources used by households in receiving information on how to save oneself in a disaster

many respondents did not know the signs of disaster that should have been predictable from the outset with such occurrence as volcanic eruptions, floods, landslides, droughts, tidal waves, and land and forest fires. It has therefore become a huge task to enhance the community preparedness in the future.

Disaster management consists of four stages, i.e., emergency response, recovery, prevention and mitigation, and preparedness. Mitigation is one of the steps to reduce the disaster risks. This step should be taken if the imminent danger is already identified while the relocation of people cannot be done. In disaster mitigation the people are familiarized with disaster early warning or alarm such as the sound of siren to alert them to the possible influx of tsunami. Disaster warnings can be transmitted through several media in the community as well as by government officials, religious leaders, military or the police. To support the community

Table 5 Percentage of households that have experienced disasters and knowledge of disaster symptoms by type of disasters

Type of event	Experience of disasters		Type of event	Knowledge of disaster symptoms	
	Have experienced (%)	Have never experienced (%)		Know (%)	Don't know (%)
(1)	(2)	(3)	(1)	(2)	(3)
Earthquake	99.2	0.8	Earthquake	25.2	74.8
Volcanic eruption	28.4	71.6	Earthquake and Tsunami	53.2	46.8
Tidal wave	14.0	86.0	Volcanic Eruption	26.4	73.6
Tornado	10.4	89.6	Flood	54.4	45.6
Earthquake and Tsunami	8.0	92.0	Landslide	30.0	70.0
Landslide	6.0	94.0	Drought	37.6	62.4
Flood	3.2	96.8	Tidal wave	22.0	78.0
Land and forest fires	2.0	98.0	Tornado	10.8	89.2
Drought	1.2	98.8	Land and forest fires	11.2	88.8

Table 6 Component parameters of disaster knowledge

Disaster knowledge component
(1)
Disaster knowledge in general
Knowledge of saving oneself from disaster
Experience in joining training/seminar/simulation/meeting on disaster preparedness
Experience of natural disaster
Knowledge of residence which is a disaster-prone area
Family knowledge about natural disasters
Local wisdom Knowledge on disaster mitigation

preparedness and as part of the efforts to rescue people from disaster, government and related parties have also put up several alerting facilities and equipment such as evacuation signs, evacuation route maps, evacuation routes, sirens and other equipment. This facility is commonly used and put into practice to familiarize the people with evacuation activities, and furthermore to ensure that the equipment and facilities will function properly at any time a disaster occurs.

Figure 4 reveals that in the opinion of more than half (73.6%) of respondents, the efforts that had been made by the government to inform the public about the possibility of the occurrence of natural disasters were in the form of notification via

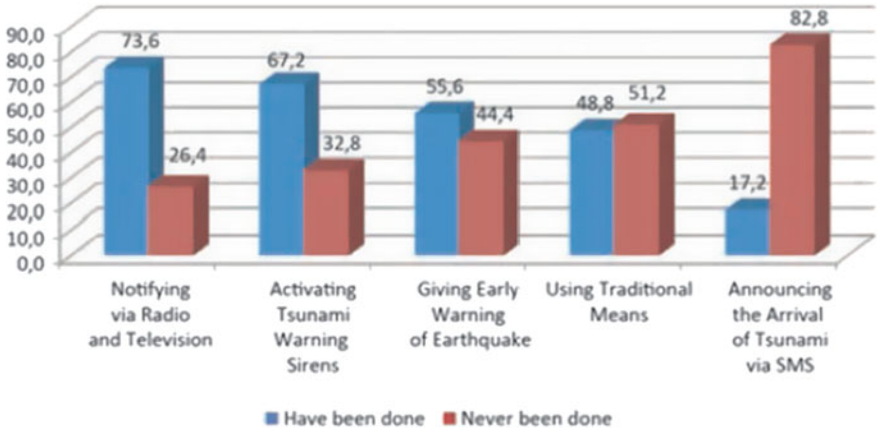


Fig. 4 Percentage of households by public knowledge about governments efforts to provide information on the possibility of disasters

radio and television, activating tsunami warning sirens, and early warning of earthquakes. These data indicate that people had already been familiarized with the notification made by the government in terms of the possibility of disaster. Government's endeavours to create a society that is resilient in the face of disaster can be done by making people aware of the risks that exist around them, capable to prevent disasters, willing to cope with the disaster that hit, and recuperate to normal life if affected by disaster. This attitude formation can be done by training and simulation directly to people living in disaster-prone areas. Mentawai megathrust earthquake that was feared would occur in West Sumatra region with magnitude of 8.9 RS necessitated training or simulation for the community. Training and simulation that had been attended by most of the respondents were pertaining to the earthquake disaster and the earthquake plus tsunami. This was also reflected in the number of people who already knew how to save themselves from the earthquake disaster and the earthquake plus tsunami.

6.2 Household Preparedness Index

Preparedness is all efforts and activities carried out prior to the occurrence of natural disaster to reduce the risks and impacts that will befall, and rapidly and effectively respond to the hazard events or conditions. The household disaster preparedness index will measure the level of disaster preparedness of the respondent households. The index is derived from five different parameters, i.e., Disaster Knowledge (DK), Disaster Preparedness Policy (DPP), Emergency Response Plan (ERP),

Table 7 Parameters value of disaster knowledge per village

Village	Knowlegde on Disaster (KD)
(1)	(2)
Belakang Tangsi	19.2
Olo	21.2
Purus	21.8
Ulak Karang Utara	22.8
Air Tawar Timur	23.4
Air Tawar Barat	22.7
Lolong Belanti	19.4
Gurun Laweh	20.6
Surau Gadang	8.7
Kurao Pagang	8.4

Table 8 Component parameters of disaster preparedness policy

Disaster preparedness policy component
(1)
Efforts made by local government in improving disaster preparedness
Parties responsible for disaster preparedness
Efforts made by local government in disaster risk reduction
The role of media in disaster preparedness
Management approach to disaster

Table 9 Parameters value of disaster preparedness policy per village

Village	Disaster Preparedness Policy (DPP)
(1)	(2)
Belakang Tangsi	8.0
Olo	8.2
Purus	8.4
Ulak Karang Utara	8.2
Air Tawar Timur	8.9
Air Tawar Barat	8.3
Lolong Belanti	9.0
Gurun Laweh	9.0
Surau Gadang	2.8
Kurao Pagang	1.7

Disaster Early Warning (DEW), and Resources Mobilization (RM). DK parameters (listed in Table 6) in the KAP pilot survey were set forth in 19 questions in the questionnaire (Tables 7, 8, 9, 10, 11, 12, 13, 14 and 15).

Table 10 Component parameters of emergency response plan

Emergency response plan component
(1)
Preparation of securing valuables
Availability of evacuation route
Preparation of disaster survival plan
Availability of evacuation route
Preparation of disaster survival plan
Management approach to disaster

Table 11 Parameters value of emergency response plan per village

Village	Emergency Response Plan (ERP)
(1)	(2)
Belakang Tangsi	11.1
Olo	11.7
Purus	12.2
Ulak Karang Utara	11.6
Air Tawar Timur	12.3
Air Tawar Barat	11.1
Lolong Belanti	11.7
Gurun Laweh	11.5
Surau Gadang	11.3
Kurao Pagang	11.0

Table 12 Component parameters of disaster early warning

Disaster early warning component
(1)
Source of Information and media
Knowlegde of term in disaster management
Government efforts in disaster early warning
Availability of early warning facilities

Based on the value parameters that have been mentioned earlier, the household disaster preparedness index (IKB) is measured using the following weighting formula:

$$P_{ix} = (35KD + 10DPP + 15ERP + 25DEW + 15RM)$$

The disaster preparedness indices obtained were then grouped as shown in Tables 3 and 4. Results of measurement and the grouping of preparedness index classification are presented in the following Table 16 (Fig. 5).

Table 13 Parameters value of disaster early warning per village

Village	Disaster Early Warning (DEW)
(1)	(2)
Belakang Tangsi	12.8
Olo	14.8
Purus	14.5
Ulak Karang Utara	14.6
Air Tawar Timur	18.2
Air Tawar Barat	14.1
Lolong Belanti	14.0
Gurun Laweh	11.8
Surau Gadang	16.1
Kurao Pagang	11.3

Table 14 Component parameters of resources mobilization

Resources mobilization
(1)
Assets owned in case of disaster
Experience of participating in training/seminar/simulation/meeting on disaster
Constraints to participate in training/seminar/simulation/meeting on disaster

Table 15 Parameters value of resources mobilization per village

Village	Resources Mobilization (RM)
(1)	(2)
Belakang Tangsi	2.9
Olo	2.6
Purus	2.9
Ulak Karang Utara	2.3
Air Tawar Timur	3.6
Air Tawar Barat	3.0
Lolong Belanti	2.3
Gurun Laweh	2.4
Surau Gadang	11.3
Kurao Pagang	11.0

Results showed that among five parameters of disaster preparedness the parameters on Disaster Knowledge (DK), Disaster Early Warning (DEW), and Emergency Response Plan (ERP) were regarded as good, while the other two

Table 16 Parameter scores of preparedness and preparedness index per village

Village	Preparedness index	Conclusion
(1)	(2)	(3)
Belakang Tangsi	53.4	Low
Olo	57.8	Low
Purus	59.1	Low
Ulak Karang Utara	58.5	Low
Air Tawar Timur	65.7	Moderate
Air Tawar Barat	58.6	Low
Lolong Belanti	55.8	Low
Gurun Laweh	54.8	Low
Surau Gadang	60.7	Moderate
Kurao Pagang	52.4	Low

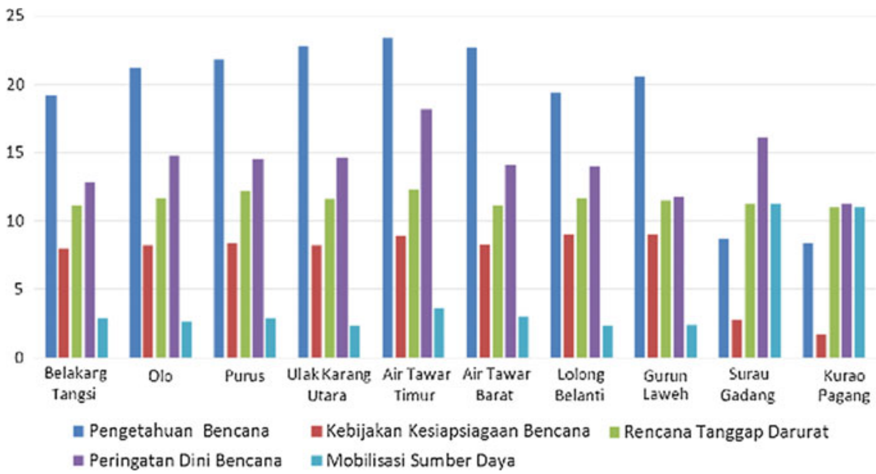


Fig. 5 Household prepadness indices parameters per village

parameters, namely the Disaster Preparedness Policy (DPP) and Resource Mobilization (RM) were still somewhat inadequate.

Figure 6 shows that the index values of household preparedness to disaster of all villages in the survey areas were categorized as moderate. Even the two villages with the moderate values of household disaster preparedness indices had only a slight difference from the category boundary. In view of the above results, therefore, it is a common task for all pertinent parties to improve the values of the household preparedness.

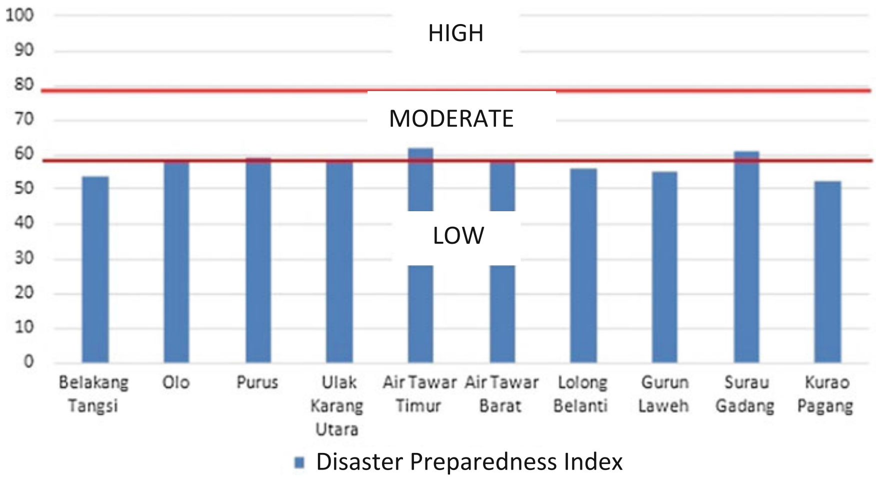


Fig. 6 Household prepadness index parameters per village

7 Conclusion and Perspective Recommendation

People who have experiences in frequent earthquakes becomes lessons learnt and tend to be more vigilant. In the mean time, in order to increase their awareness and knowledge of resilience and adaptation of the community should be improved through participation in training or simulations of earthquakes. The Padang people who were selected in the respondents survey already have a considerable knowledge of the earthquake disaster which is demonstrated by their level of awareness that the area of their residence is an earthquake-prone region.

On the contrary, the high knowledge of the respondents' survey whose located in the earthquake disaster is not accompanied by the availability of equipment or facility preparedness. Worstly, the availability of assets owned by the respondents' survey that can be used in case of disaster is still inadequate in terms to support the resilience and adaptation. Almost half of the respondents' survey who are aware of the occurrence of natural disasters through notification via radio and television activate tsunami warning sirens and early warning of earthquakes. These facts had indicated that people have started to recognize the notification made by the government in terms of the possibility of disaster occurrence.

The respondents' survey have attended training and simulation of a catastrophic earthquake and tsunami disasters that they had already know how to save themselves during a disaster occurrence. In summary, out of ten villages in the survey selected area only two villages, namely the villages of Air Tawar Timur and Gurun Laweh are categorized as having a moderate preparedness against disasters, while the rest have low level preparedness.

Acknowledgement Appreciation is expressed to all the experts involved in the pilot study, either during the pilot study or during the administered survey. Without their commitment to completing the questionnaires, this study would not have possible. Specific acknowledgement go to Mr. Sentot as a Director of Statistical Analysis and Development; and Mr. Sukardi as a Director of Labor and Demography Statistics who have granted permit to authors to participate in this conference; Mr. Indra Murty Surbakti, Mr. Dendi Handiyatmo, and Mr. Ali Said including all colleagues at Indicator Statistics Division who support and share thought on this matters deeply. Finally, acknowledgement should go to World Bank who given a travel grant to authors in order to attending and presenting this research paper for better critical review of conference participants. The work presented in this paper is merely opinion and interpretation of author and do not represent the institution thought.

References

Bappenas, National Development Planning Board (2010) Achievement of millennium development goals report. The Republic of Indonesia, Jakarta

BNPB, Bps Statistics Indonesia and UNFPA (2014) National guidance on data use of population in the disaster management. BNPB (National Board of Disaster Management of Republic of Indonesia), Jakarta, Indonesia

BNPB, Bps Statistics Indonesia and UNFPA (2013) Pilot survey: knowledge, attitude and practice of disaster preparedness in Padang City. BNPB, Jakarta

BNPB, Bps Statistics Indonesia, OCHA, UNFPA, WFP and UNDP (2014) Indonesia province infographic. BNPB, Jakarta

BNPB, BPS, UNFPA, UNHCR (2014) National guidance on data use of population in the disaster management (2014). Coo-work and coordinated by BNPB (National Board of Disaster Management of Republic of Indonesia), BPS Statistics Indonesia, UNFPA and UNHCR. Jakarta, Indonesia

BNPB—National Board of Disaster Management of Republic of Indonesia (2014) Reducing disaster risk and regional building resilience. Gema BNPB. September 2014. Vol 5(2). Jakarta

BPS West Sumara Provincial Statistics (2010) Regional statistics of West Sumara. BPS West Sumatra Statistics Province. Indonesia

BPS Statistics Indonesia (2012a) Environment statistics of Indonesian. BPS Statistics Indonesia. Jakarta

BPS Statistics Indonesia (2012b) Human development index in gender. BPS Statistics Indonesia. Jakarta

BPS Statistics Indonesia (2013) Statistics of social capital. BPS Statistics Indonesia, Jakarta

Blaike P et al (1994) At risk: natural hazard, people's vulnerability, and disasters. Routledge, London

Blaikie P et al (2004) At risk: natural hazards, people's vulnerability, and disasters, 2nd edn. Routledge, Newyork, NY, p 464

Cobb CW, Rixford C (1998) Lessons learned from the history of social indicators. Redefining Progress, San Francisco

Cutter SL et al (2003) Social vulnerability to environmental hazard. Soc Sci 84(2):242–261

Davidson RA, Lambert KB (2001) Comparing the hurricane disaster risk of US, Coastal Counties. Nat Haz Rev 2(3):132–142

Davidson RA, Shah Haresh (1997) An urban earthquake disaster risk index. Stanford University, California

Dewi AK et al (2014) Community competency around the ITB (Institute Technology Bandung) environment in terms facing earthquake. Disas Manag J 5(1), Jakarta

Global Initiative for UNs (2014) Indicators and a monitoring framework for sustainable development goals launching a data revolution for the SDGs. Sustainable Development Solution Network (SDSN). The Leadership Council of the SDSN. NY, USA

Joewono DJ (2003) Mobilitas Penduduk Dalam Wilayah Jabodetabek. (Population Mobility Inter Jabodetabek) Postgraduate Thesis at Bogor Agriculture Institute (Unpublished)

Kaly UL, Briguglio L, McLeod H, Schmall S, Pratt C, Pal R (1999) Environmental Vulnerability Index (EVI) to summarise national environmental vulnerability profiles. SOPAC Technical Report 275. Report to NZODA

Kenney JF, Keeping ES (1962) Mathematics of statistics, Pt 1, 3rd edn. Van Nostrand, Princeton, NJ, pp 66–67

Kirschenbaum A (2002) Measuring the effectiveness of disaster management organizations. Int J Mass Emerg Disas 22(1):75–102, March 2004

Land KC (1983) Social indicators. Ann Rev Sociol 9:1–26

Lee E (1970) A theory of Migration. In: Demko JG, Harold MR, Schneel AG (ed) Population geography: a reader. New York: McGraw-Hill Book Company, NY

Mabogunje A (1970) System approach to a theory of rural-urban migration. Geogr Anal 2(1):1–18

Mitchel JS (1961) The causes of labour migration, migrant labour in Africa South of the Sahara. C.C.T.A, Abidjan

Norris RE (1972) Migration as spatial interaction. J Geogr 71(5)

Paltseva E, dan Roine J (2011) Resource curse: what do we know about it? free policy brief series. Diakses dari http://freepolicybriefs.org/2011/11/21/are-natural-resources-good-or-bad-for-development/,tanggal. 20 Juli 2013

Persons W (1921) Fisher's formula for index numbers. Rev Econ Stat 3(5):103–113. Retrieved from http://www.jstor.org/stable/1928524. doi:1

Pramudhiarta N, Permanasari AE, Cahyono A (2014) Implementation of knowledge management system on web basis in order to support decision makers to reduce disaster risk in Indonesia. Disas Manag J 5(1), Jakarta

Saputra W (2014) Economic development and human rights threat of society. The Perkumpulan Prakarsa, Jakarta

Sheldon EB, Parke R (1975) Social indicators. Science 188:693–699

Szabo Sylvia (2014) How climate change will drive migration. The World Economic Forum. The World Bank, Washington DC

Tan G et al (2013) Competitiveness analysis and development strategies for 33 Indonesian provinces. Lee Kuan Yew School of Public Policy, National University of Singapore, Singapore. Tersedia dan bisa di unduh dari (www.worldscientific.com)

UNs ESCAP (2010) Asia-Pacific must increase social spending to turn rebound into recovery. Press Release UNESCAP News Services. Available: http://www.unescap.org/unis/press/2010/may/g22.asp. 6 May 2010

UNs DESA (2013) DESA's division for sustainable development in action. DESA Newsletter 17(11)

UNs DESA (2013) A reporting service for environment and development negotiations 32(5). Monday, 2 December 2013

World Bank (2009) New World Bank report calls for greater economic integration as key to inclusive growth. Available: http://www.worldbank.org/id

Author Biography

Sri Hartini Rachmad is a senior researcher on Social-Economic Demography and Statistics Applied at BPS Statistics Indonesia; lecturer and research adviser at Statistics Institute, Jakarta. Consultant and sources person for Indonesia Government Institutions and NGOs. Graduated from Statistics Institute and the Australian National University, Canberra-Australia. Her research interests are International and Population Development: climate change and vulnerability, disaster and water management, data assurance & quality, MDGs-SDGs, poverty, employment, migration, education, health, gender and family planning. She is also a member of board advisor of the National magazine of Financial and entrepreneurship. Her research interests are International and Population Development: climate change and vulnerability, disaster and water management, data assurance and quality, MDGs-SDGs, indicators measurement, human development, poverty, employment, migration, education, health, gender and family planning. Some selected research been conducted are: Researcher for Human Development Report for UNDP's Provincial (2013). Principle investigator for pilot project on Disability measurement improvement for Developing country in Indonesia funded by UNs' coalition (2012/3). A book chapter (2013), Amazon, "Gendered patterns of urban commuting with better connectivity in Jakarta megapolitan area" in the [Gender, Roads, and Mobility in Asia]. Principle investigator on "Gender Overview on Earthquake Disaster in Padang-West Sumatra" coordinated with Oxfam International (2010). Researcher of IDHS (Indonesia Demographic and Health Survey) in 2002/2004. Currently (2017) on progress doing research on "Asia disability: Review Data System". https://id.linkedin.com/in/sri-rachmad-6a5a472a.

University Student's Perceptions About Climate Change: The Case of Interior Design and Architecture Students of a Brazilian University

Fátima Alves, Leonor Bacelar Nicolau, Dula Lima, Ulisses M. Azeiteiro and Paula Bacelar Nicolau

1 Introduction

Global Climate Change is a matter of global concern and a challenge to societies. Climate Change (CC) is one of the five priority areas of the Strategy 2020 of the European Commission and the United Nations Sustainable Development Goals reinforce its current priorities in this regard (e.g., SDG 13 *Take urgent action to combat climate change and its impacts*).

CC is a Global Problem at a time when we are educating a "climate change generation" (grew up with more information and less scientific uncertainty about climate change and global warming) (Feldman et al. 2010) and thus, formal, non-formal and informal education need to engage and be active in the search for regional and local solutions (Alves et al. 2013). Education should contribute to overcome scepticism and misconceptions on climate change by intervening in

F. Alves
Departamento de Ciências Sociais E Gestão, Universidade Aberta E CEF Universidade de Coimbra, Lisbon, Portugal

L. B. Nicolau
Instituto de Medicina Preventiva E Saúde Pública & ISAMB, Faculdade de Medicina, Universidade de Lisboa, Lisbon, Portugal

D. Lima
Universidade Da Amazónia UNAMA, Brasil & Centro de Ecologia Functional Da Universidade de Coimbra, Lisbon, Portugal

U. M. Azeiteiro (✉)
Departamento de Biologia & CESAM, Universidade de Aveiro, Aveiro, Portugal
e-mail: ulisses@ua.pt

P. B. Nicolau
Departamento de Ciências E Tecnologia, Universidade Aberta E CEF Universidade de Coimbra, Lisbon, Portugal

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_13

pedagogy, curriculum, teaching practices and value informal education settings and opportunities (Azeiteiro and Leal Filho 2017).

Educational institutions for university level higher education need to play a more important role in preparing the next generation to face CC challenges and opportunities (Morgado et al. 2017; Basanta 2016; Santos et al. 2016; Wachholz et al. 2014; Leal Filho 2010), and to the effective communication of climate change social and environmental agenda and the need to engage in its practice. Higher Education Institutions (HEIs) must be able to support the long-term implementation of global and local climate change policies (by research, education and knowledge transfer missions) (Leal Filho 2010). HEIs also have a critical and urgent role in climate change adaptation delivering professional with the necessary multidisciplinary and intersectoral competencies to face this Global Change and Societal Challenge (Morgado et al. 2017; Santos et al. 2016; Leal Filho 2010) and participate in the local community (education, research and pilot projects to build their resilience) (Leal Filho et al. 2016a; Viegas et al. 2016) and enable local communities to access clean technology to mitigate the impact of climate change (Leal Filho et al. 2016b; Setti et al. 2016; Yoko and Audrey 2015).

The role of architecture in climate change is an actual topic (see Kibert 2016) and should be integrated in curriculum development in these areas to produce graduates versed with various aspects of CC adaptation and mitigation. The purpose of this study was to investigate HEI students' perceptions of CC and Global Warming.

This is the first study conducted within Amazonia University in Brazil Design Students and Architecture.

2 Research Methodology

2.1 Surveyed Courses

This survey was carried out, from May to October 2016, with students enrolled in two first cycle studies of higher education—Architecture & Urbanism and Interior Design, at University of Amazonia—UNAMA, Brazil. The Architecture & Urbanism course has as its main purposes: to promote and to develop, in its students, the conscience of the relation between buildings and the multiple and complex urban/social spaces, which are the context where constructions must fit in; to stimulate the creativity about spatial organization; to deepen the studies about cultural, historical, social and economic foundations of the profession; and to simulate the use of technical resources, applied to the projects. Essentially, after ten semesters (3.600 h) the graduated student is able to: elaborate inside and outside projects; develop industrial projects; landscaping; constructing and restoring building; lighting; and urbanism. In the Interior Design course, the student is prepared to plan, create and execute indoor design projects for homes or business, using techniques and finding solutions to fulfil the needs, functionality, and the improvement in the quality of life of their clients. The course as a duration of four semesters (1.680 h) and its graduated student is a Design Interior Technologist.

2.2 Sample

The convenience samples were recruited online through email invitation to 150 students enrolled in the course in Architecture & Urbanism and 150 students enrolled in the Interior Design course, at University of Amazonia—UNAMA, Brazil. The invitation to participate in the study included a short presentation of the study, its aims, responsible researchers, and assured an informed consent from participants, followed by a link to the questionnaire itself. Response rates were 33 and 71% for the Architecture & Urbanism course, and Interior Design course, respectively, corresponding to subsample sizes of 49 and 106 respondents.

2.3 Questionnaire

The questionnaire was composed of 30 closed-ended questions and two open questions aiming at characterizing students from the socio-demographic, and from their perceptions, motivations, attitudes and knowledge relating to CC. The questionnaire was pre-tested among faculty students, not enrolled in its application, and the results were used to refine it. The time required for filling in the questionnaire was 10 min. The questionnaire was adapted from Wachholz et al. (2014) and Manolas et al. (2010) and already published by Santos et al. (2016), Azeiteiro et al. (2017) and Morgado et al. (2017). Google Drive was used to host the questionnaire and allow for the online survey. Students were assured that their responses remained anonymous and took part in the survey willingly. The questionnaire was adapted to Brazilian Portuguese language local specificities by the Brazilians co-authors.

2.4 Statistical Analysis

Two subsamples, corresponding to the students enrolled in each course (Architecture & Urbanism, and Interior Design), were analysed and compared. Crosstabs by course were built for all survey questions, with observed counts, column percentages, adjusted residuals and pairwise comparisons of column percentages (with Bonferroni correction). Additionally, homogeneity Chi-square tests or Fisher exact tests, were computed (the latter whenever more than 20% of all cells presented expected values under 5). This analysis was complemented with Chi-square measures of association contingency coefficient, Phi and Cramer's V (not presented here, since the results were coherent with the homogeneity Chi-square tests and Fisher exact tests applied).

These results are mentioned in the results section, when characterizing sub-samples. Data were analyzed using the IBM SPSS Statistics 21® software. A significance level of 5% was used whenever statistical tests were applied.

3 Findings

3.1 Socio-demographic Characterization

The survey respondents were 32% enrolled in the Architecture & Urbanism course and 68% enrolled in the Interior Design course. The great majority (95%) was Brazilian and a minority (5%) was Portuguese. The respondents enrolled in the Architecture & Urbanism course had completed their previous training largely, and also, in Architecture & Urbanism area (98%). Respondents enrolled in the Interior Design course had mostly completed their previous training in Design area (82%), although some (12%) had training in other areas.

Globally, the respondents were 74% female and 26% male. Students enrolled in both courses were mainly female, being 65 and 78%, respectively, in Architecture & Urbanism and in Interior Design. Male students represented, respectively, 35 and 22% of those enrolled in the Architecture & Urbanism and Interior Design courses. These differences in sex distribution between courses were not statistically significant (p-value = 0.086 > 0.05).

Regarding age, respondents were 25 years old (average ±9 years), and were grouped as follows: 41% were "20 years old or less", 39% were "between 21 and 30 years old", and 20% were "older than 30". Age distribution was similar across gender groups, but differed when considering the course in which the respondents had enrolled. In the Architecture & Urbanism course, most respondents fell into the "20 years old or less" and "between 21 and 30 years old" groups (49 and 43%) and only few were "older than 30" (8%). In the Interior Design course respondents were more equally distributed among age groups (i.e., 37, 38 and 25% were, respectively, "20 years old or less", "between 21 and 30 years old" and were "older than 30"). Significant differences in age distribution regarding the enrolled courses are essentially due to the fact that 87% of respondents over 30 years old were enrolled in the Interior Design course, while this percentage fells to 66 and 62% of respondents aged "21–30 years old" and "20 years or less", respectively. This effect is mitigated by the smaller number of older respondent within the general sample.

3.2 Perceptions Relating to Climate Change and Their Impacts (Table 1)

Globally, most respondents (94%) believed that CC were happening. The perception that CC was happening was significantly influenced by their age group, i.e., all

Table 1 Climate change perception and their impact, by gender, age group and enrolled course

			Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
CC is happening?	Yes		94	95	93	98^{*}	91^{*}	95	89^{**}	100^{**}
	Not sure		5	5	4	2	6	5	7^{*}	0^{*}
	No		1	0	1	0	1	0	2^{*}	0
The topic of CC has …	Interest	Very much	47	50	45	57^{*}	42^{*}	46	44	52
		A lot	45	40	47	41	47	48	44	42
		A little	7	10	6	2^{*}	9^{*}	6	8	7
	Importance	Very much	57	65^{*}	55^{*}	59	57	57	56	61
		A lot of	37	30^{*}	40^{*}	41	36	40	38	32
		A little	4	5	4	0^{*}	6^{*}	3	3	7
	Concern	Very much	45	38^{*}	48^{*}	55^{*}	41^{*}	49	38^{*}	52
		A lot	45	53^{*}	42^{*}	39	47	40	49	45
		A Little	9	10	9	6	10	11	10	3^{*}
Perception of CC impacts on …	Human communities in one's country	Now	79	70^{**}	83^{**}	74^{*}	82^{*}	75^{*}	74^{*}	100^{**}
		In 10 years	10	15^{*}	8^{*}	10	9	14^{**}	10	0^{**}
		In 25 years	5	8	4	12^{**}	1^{**}	5	7	0^{*}
	Human communities other's countries	Now	81	83	81	82	81	78	80	90^{*}
		In 10 years	12	13	12	10	13	18^{*}	8^{*}	10
		In 25 years	3			6^{*}	2^{*}	3	5	0
	Biotic communities in one's country	Now	84	78^{*}	86^{*}	84	84	83	82	90^{*}
		In 10 years	7	10	6	6	8	10^{*}	5	7
		In 25 years	3	10	4					
	Biotic communities other's countries	Now	85	90^{*}	84^{*}	90^{*}	83^{*}	86	77^{**}	100^{**}
		In 10 years	8	8^{*}	8^{*}	6	9	11^{**}	8	0^{**}
		In 50 years	3	1	3	0^{*}	5^{*}	2	7^{*}	0

(continued)

Table 1 (continued)

		Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
Believe on human ability to mitigate CC	We can and we will	12	15	10	14	10	10	15^{*}	10
	We can but it's not clear if we'll succeed	48	53	46	55^{*}	44^{*}	48	44	55
	We can but people do not have the will	38	33	40	31^{*}	42^{*}	43^{*}	34	36
	We will not succeed	1	0	2	0	2	0^{*}	3^{*}	0
Perception of scientific community and CC	Most scientists believe that climate change is happening	76	73	77	82^{*}	73^{*}	78	72	77
	There is much disagreement among scientists	12	20^{**}	9^{**}	14	10	5^{**}	16^{**}	16
	Most scientists do not believe that climate change is happening	1	3^{**}	0^{**}	0	1	2^{*}	0	0
	I do not know enough to have an opinion	12	5^{*}	15^{*}	4^{**}	16^{**}	16^{*}	12	7^{*}
Human activities are a major cause of CC		98			100^{*}	97^{*}	98	97^{*}	100

**Statistically significant, see section Research Methodology
*Statistically nearly significant, see section Research Methodology

respondents (100%) above 30 years old believed that CC were happening, while only 89% of respondents between 21 and 30 years old believed it was happening. Also, among the respondents, those enrolled in Architecture & Urbanism course showed a trend for greater believe in CC (98%) than those in Interior Design course (91%). Gender did not affect the respondents believe that CC was happening.

The respondents expressed mostly "very much" interest (47%) and concern (45%) with the topic of CC, or indicated "a lot" of interest and concern with CC (45%). A greater proportion of respondents perceived the topic of CC as very much important to them (57%). Very few had "little" interest, concern, or perception of its importance (4–9%), and a minute number had "no" interest, concern or perception of its importance (1%).

The respondent's gender did not significantly influence their "interest" on the topic of CC, but the data appeared to indicate that female respondents were more "concerned" with CC than male (48 vs. 38%), while for male respondents the topic was of greater "importance" ("the issue of CC was very much important" to 65 vs. 55%, respectively for male and female). Interest with or perception of the importance of the issue of CC were not influenced by the age group of the respondent, but concern with CC appeared to be lesser (38%) for respondents between 21 and 30 years, than in the younger or in the older aged groups.

Different levels of interest and concern with CC also appeared to be related to the course in which the respondents enrolled, i.e., Architecture & Urbanism students were much interested (57%) and concerned (55%) with the topic of CC than Interior Design students (42 and 41%, respectively, for interest and concern with CC), even though its importance was similarly perceived (57–59%).

There was a generalized, and similar, perception that biotic communities were already being impacted by CC (84–85%), irrespective of their location (one's country or abroad). Also, most respondents similarly perceived that CC impacts were already being felt in human communities (79–81%, in one's country and abroad). Female respondents appeared to perceive, at present, greater impacts in both human and biotic communities (83 and 86%) in their one country than male respondents (70 and 78%, respectively). On the other hand, male respondents appeared to perceive, at present, greater impacts in biotic communities abroad (90%) than female did (84%).

The respondent's age significantly affected perception of CC impacts in present-day communities—human or biotic—being much greater for people over 30 years old (90–100%).

Students from Interior Design perceived more immediate impacts in human communities in their own country (82%) than Architecture & Urbanism (74%). On the contrary, respondents from Architecture & Urbanism course perceived more immediate impacts in biotic communities abroad (90%) than students from Interior Design (83%).

Globally, most students (76%) similarly expressed that "the scientific community assumed that CC was happening", although a considerable proportion expressed that "there was much disagreement amidst the scientists relating to the subject" (12%). In this issue, there were significant differences related to gender and to age group, i.e., male respondents perceived more disagreement among scientists than female (20 and 9%, respectively), and younger students perceived less disagreement among scientists than older students (5 and 16%, respectively, for "younger than 20" and "over than 21 years old"). Nearly all students (97–100%), regardless of their age, gender or enrolled course, also perceived that human activities were an important cause of CC.

When inquired on the capacity of humanity to mitigate CC, the vast majority of the respondents expressed that humans could mitigate effects of CC (98%), although only a small number (12%) expressed that "humans would successfully manage to mitigate the effect of CC". There appeared to be a more optimistic perception of the capacity for humankind to successfully mitigate CC effects, related to the Architecture & Urbanism course than to the Interior Design course. There also appeared to be a more optimistic perception on the same subject related to respondents in the age group "between 21 and 30 years old" and a less optimistic perception of respondents 220 years old or less". However, these were not statistically significant and further studies are needed to confirm the trends.

3.3 Training and Knowledge of CC (Table 2)

Most respondents attributed "very much" importance to CC in their academic training (81%), as well as they recognized the "very much" importance of CC technical knowledge in their future professional practice (79%). The importance of CC both in their present academic training and for their future career tended to be greater for students from Architecture Urbanism (90 and 86%) than for those in Interior Design (77 and 76%), the latter hinting that CC was only important in some professional areas (4%). In the age group "21–30 years old" CC issue was of lesser importance to the respondents future career (69% "very much important"; 26% "moderately important"; 5% "none"; statistically significant) when compared to other age groups.

Nevertheless, most respondents self-perceived their "technical knowledge on CC" as moderate (65%) or minimum (28%); with a minority expressing they had extensive or professional knowledge (5 and 1%). Also, concerning the "knowledge of how one's actions/behaviour influence CC", most respondents perceived having a moderate (60%) or minimum (23%) knowledge, and some respondents expressed having extensive knowledge on CC (15%). When inquired about their knowledge on particular aspects of their professional practice, i.e., (i) functional aspects of housing and living spaces that will be directly affected by CC, or (ii) the implications of heat waves for human habitat, most respondents expressed they had knowledge (74 and 83%, respectively), although the majority still felt they needed more information (54 and 53%, respectively).

Regarding all aspects of self-perceived knowledge, the gender factor (significantly) influenced it, with male respondents self-perceiving their knowledge higher than female (see Table 2, for details). Still on the self-perceived knowledge, the

Table 2 Academic training and knowledge of CC, and Governance and actions to mitigate CC

			Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
Academic training and knowledge of CC	Technical knowledge on CC …	Minimum	28	18^{**}	32^{**}	25	30	29	31	23
		Moderate	65	75^{**}	61^{**}	65	64	65	61	71
		Extensive	5	8	4	10^{*}	3^{*}	6	5	3
		Professional-level	1	0	2	0	2	0	2	3
	Knowledge of how one's actions influence CC	Minimum	23	23	23	16^{*}	26^{*}	21	26	19
		moderate	60	53^{*}	63^{*}	59	60	59	59	65
		Extensive	15	22^{*}	12^{*}	25^{**}	10^{**}	19^{*}	10^{*}	16
		Professional-level	1	3^{**}	0^{**}	0	1	0	2^{*}	0
	Ever calculated you ecological footprint?	No	67	53^{**}	73^{**}	53^{**}	74^{**}	68	66	68
		Yes, in-training	9	15^{*}	7^{*}	8	9	10	10	7
		Yes, informally	16	23^{*}	13^{*}	31^{**}	9^{**}	11^{*}	18	19
	Need for more information on CC?	A lot more information	23	23	24	22	24	30^{*}	18^{*}	19
		More information	53	50	54	55	52	44^{**}	62^{**}	52
		A little more information	20	23	19	20	20	24^{**}	16	19
		No	4	5	4	2	5	2^{*}	3	10^{*}
	"Ozone hole is a main cause of CC"…	Is a true sentence	66	73^{*}	64^{*}	69	64	76^{*}	49^{**}	77^{**}
		Is a false sentence	17	20	17	22	15	11^{**}	30^{**}	7^{**}
		I do not know	17	8^{**}	20^{**}	8^{**}	21^{**}	13^{*}	21^{*}	16

(continued)

Table 2 (continued)

			Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
Current academic training and future professional practice	My course focused on CC …	Sufficiently	26	28	25	28	25	27	25	26
		Not enough	50	48	50	49	50	38*	59*	55
		That was not noticeable	10	5*	12*	4*	13*	14*	7*	10
		No, I got information informally	14	20*	12*	18	12	21**	10*	10
	Importance of CC in my current academic training	Very much	81	80	82	90*	77*	80	82	84
		Moderately	16	18	15	10*	18*	19	12	16
		none	1	0	1	0	1	0	2*	0
		Only for some professional areas	3	3	3	0	4	2	5*	0
	Importance of CC technical knowledge in future professional practice	Very much	79	78	79	86*	76*	84*	69*	87*
		Moderately	18	20	17	14	20	14*	26*	10*
		Little	2	1	1	0	2	2	0	3
		None	3	0	3	0	3	0*	5**	0
	Knowledge about various functional aspects of housing and living spaces that will be directly affected by CC	Yes	19	30**	16**	16	21	18	23	16
		Yes, but I need more	54	48	56	61*	50*	54	46*	68**
		No	27	20*	29*	22	28	29	30	16*
		I am fully informed	1	3*	0*	0	1	0	2*	0

(continued)

Table 2 (continued)

			Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
	Knowledge and implications of "heat waves" for human habitat	Yes	27	38**	23**	35*	23*	32*	26	16*
		Yes, but I need more	53	43*	57*	49	55	48*	49	71**
		No	17	13	19	12*	20*	21	16	13
		I am fully informed	3	8**	2**	4	3	0	8	0
Governance and actions to mitigate CC	Who should take main mitigation actions?	Governments	47	55*	44*	53*	43*	41*	56**	39*
		Private companies	8	0	9	8	10	16**	3**	10
		Non-profit organisations	1	0	1	2*	0*	2*	0	0
		Individuals	43	25**	50**	37*	46*	41	41	52*
	Without an international agreement the effort to mitigate CC is a waste of time?	Yes	33	40*	30*	29	34	29	28	48**
		No	54	43*	57*	65**	48**	60	51	45*
		Not sure	14	18	13	6**	18**	11	21**	7*
	I would support measures to reduce green house effect …	Yes	65	83**	58**	67	63	70*	57*	68
		No	7	0**	10**	6	8	2**	13**	7
		Not sure	28	17**	32**	27	29	29	30	26
	Actions to mitigate CC	I believe CC, but one's actions are not enough	21	15*	24*	18	23	19	28*	13*

(continued)

Table 2 (continued)

			Total (%)	Male (%)	Female (%)	Urbanism (%)	Design (%)	20 years old or less (%)	21–30 years old (%)	More than 30 years old (%)
		I believe CC, but haven't decided on the best actions	31	30	31	35	29	29	33	32
		I have decided, but not acted	16	13	17	20^{*}	13^{*}	19^{*}	13	13
		I took actions, but they're difficult	13	13	13	16	11	14	10	16
		I took action	16	23^{*}	14^{*}	10^{*}	19^{*}	14	15	23^{*}
	Reducing my contribution to CC would …	Increase a lot my quality of life	56	40^{**}	60^{**}	63^{*}	52^{*}	62^{*}	49^{*}	55
		Increase a little my quality of life	21	33^{**}	17^{**}	20	23	14^{**}	26^{*}	26
		Have no impact in my quality of life	5	13^{**}	2^{**}	6	4	5	7^{*}	0
		Decrease life quality	19	15	20	10^{*}	23^{*}	19	18	19
	My relational community acts to mitigate CC	Yes	13	23	10	12	13	11	16^{*}	10
		Partially	52	48	53	41^{**}	57	51	48	61^{*}
		No	34	30	35	47^{**}	27^{**}	37	33	29

**Statistically significant, see section Research Methodology
*Statistically nearly significant, see section Research Methodology

data also shows a tendency (statistically significant on one issue) for respondents from Architecture and Urbanism course to be more confident about their knowledge, than students from Interior Design. The respondents age also influenced their self-perceived knowledge of CC in particular aspects of their professional activity i.e., in the older aged group (above 30 years old) there was an increased perception (statistically significant) of less knowledge and of "need for more information" (68 and 71%), when compared with the younger aged groups (46 and 48%). In general terms, when queried directly on the subject, the older aged groups differed (significantly) from the younger aged group (below 20 years old) in that they a expressed a greater "need for more information on CC" (62 and 44%, respectively).

In line with these results, globally, most respondents shared the opinion that their training "had not focused enough on CC issues" (50%), and some (26%) felt that "it had not focused sufficiently". Still, a few weren't aware of having studied it during training (10%), or they had not studied the topic in training "but had obtained their knowledge informally" (14%). This was particularly noticed (and statistically significant) in the age group "21–30 years old", in which 59% expressed that their training "had not focused enough on CC issues", and for 21% of the "younger than 20 years old" for whom the course had not focused enough on CC and who "had got the information informally".

Also, in what concerns their ecological footprint, most students had not calculated it (67%), and from those who had calculated their footprint, some did it informally (16%), and only a minority had done it in-training (9%). In this issue, female students had significantly greater negative responses (73 vs. 53%, respectively female and male). Interior Design students had also significantly greater negative responses than Architecture and Urbanism students (74 and 53%, respectively), and significantly greater positive responses of calculating their ecological footprint, informally (31 and 9% respectively).

Finally, when asked about the cause effect of the ozone hole on CC, only a minority (17%) acknowledged that this was not a main cause of CC. There was a greater tendency, in male respondents, for wrongly perceiving the ozone hole as a main cause of CC (73 and 64%, respectively, for male and female). There was also a significantly greater number of students in the age group "21–30 years old" who perceived correctly that ozone hole was not a main cause of CC (30%, compared to 11 and 7% in other age groups).

3.4 Governance and Actions to Mitigate CC (Table 2)

Global opinions on who should take the main actions in mitigating CC divided between the "Governments" and the "Individuals" (47 and 43%, respectively). These were strongly, and significantly, dependent on the respondents gender, with female expressing that it should mainly relay on Individuals (50 vs. 25% for male respondents) and less on Governments (44 vs. 55% for male respondents). The age factor was again important in this issue, with respondents in the age group

"21–30 years old" (significantly) attributing to Governments the main responsibility in mitigating CC (56%, compared to 41 and 39% in other age groups). In the younger age group, even though to a smaller extent (16%), Private companies were also (significantly) pointed as main actors in mitigating CC, when compared to other age groups.

The course in which students enrolled also appeared to influence their opinion regarding the main actors in mitigating CC: Architecture and Urbanism students chose to greater extent "Governments" (53 vs. 43% for Interior Design students) and "Individuals" to a lesser extent (37 vs. 46% for Interior Design students).

Also, without an international agreement, e.g., Kyoto's protocol successor, most students (54%), felt there would be still a way to mitigate CC, although many felt that such an international agreement was essential (33%) or they "were not sure" (14%). In this issue, the older age group was significantly less confident, 48% expressing that in the absence of an International agreement "the effort to mitigate CC would be a waste of time" (28 and 29% for other age groups).

Regarding the behaviour of the respondents' relational communities, the global perception of most respondents (52%) was that their relational communities acted partially to mitigate CC; still a considerable proportion (34%) expressed that their relational community did not act to mitigate CC, and only a small number (13%) perceived that they did so. In this issue, among Architecture and Urbanism students there was a more negative perception of their relational community (47%, compared to 27% of Interior Design students.

As individuals, even though they believed CC were happening, only 29% had taken some actions to mitigate CC (among these, 13% considered the measures taken were difficult to implement). A trend for more action-taking to mitigate CC appeared to exist for male respondents (23 and 14% for female respondents), for students of the Interior Design course, and for the older age group (see Table 2).

When inquired if they were to reduce their contribution to CC, most respondents expressed that it would increase their quality of life (73%). Among these, female respondents were significantly more positive than male respondents (60 and 40%, respectively, expressing "increasing a lot my quality of life"). Students enrolled in Architecture and Urbanism were also more positive in the effect of their actions increasing their life quality, comparatively to those in Interior Design (83 and 75%, respectively). The age group also influenced students perception of the level to which they would increase their quality of life, i.e., younger students were more confident about increasing a lot their quality of life (62%).

4 Discussion

This paper provides results from a survey carried in Brazil, at Amazonia University, with university students of Architecture & Urbanism and Interior Design. The main aims of this study were to improve our understanding about young adults perceptions and attitudes towards CC in specific contexts and highlight the importance of different geographical and multicultural contexts; commit universities with society in order to incorporate their decisive role in the environmental crisis we face today; and to improve our policy and politics of CC and also our actions, as teachers, scientists, citizens and as individuals acting and communicating climate change.

This study also provides data from a university and students in a special ecological context, the world's greatest rainforest known for its biodiversity (and interface between biodiversity and indigenous communities), the Amazonia in Brazil and then assuming a particular significance in several dimensions (climate change, biodiversity, environmental education and communication for biodiversity).

Generally, our analysis showed that CC is considered real to the majority of our respondents, largely human-induced, and causing concern, which is in accordance with previous studies (Morgado et al. 2017; Santos et al. 2016). Yet, students in the sample hold misconceptions about the basic causes and consequences of climate change. Globally, students expressed their interest and concern with CC and perceived CC as a very important topic, and that is in accordance with previous research (Morgado et al. 2017; Santos et al. 2016; Wachholz et al. 2014). Meanwhile, the percentage of students with 'little' interest, concern or perception expression of its importance is low, but still expressive in the context of a globalized environment crisis (4, 9, 1%). The 'little concern' with CC found in this sample (9%) is only comparable with the results obtained in a Mexican sample (10%) in the study of Morgado et al. (2017). In that study, Portuguese and Mozambican reflected less 'little concern' (1–0% respectively) with CC. Another interesting information is that our respondents, even though they believed CC was happening, only 29% had taken some individual actions to mitigate CC (among these, 13% considered the measures taken were difficult to implement). This is a very concerning area of research for social sciences directed to social and behavioural changing, and the need to understand why conceptions and practices do not match, as Giddens highlight with his concept of Giddens (2009) Paradox. Our data evidence that although students are familiarized with CC on their curricula assignments, this knowledge does not reflect into concrete practices, actions and behaviours that mitigate CC, as previous works highlight (Morgado et al. 2017; Santos et al. 2016). In fact, it is not always clear the correlation between levels of knowledge and behavioural change to address CC (Morgado et al. 2017; Santos et al. 2016; Wachholz et al. 2014), and there is indication that behavioural engagement can occur in the absence of a complete understanding of the problem (e.g., Ortega-Egea et al. 2014).

Students perception of the impact of CC in biotic communities (84% in their own country; 85% abroad) and human communities (79% in their own country; 81%, abroad) also show some agreement in their recognition. Nearly all students (97–100%), regardless of their age, gender or enrolled course, also perceived that human activities were an important cause of CC. The same results were found in previous works (Morgado et al. 2017). Analysis shows that most respondents (76%) expressed the assumption that "the scientific community assumed that CC was happening". However the proportion that points the disagreement among scientific community is considerable: "there was much disagreement amidst the scientists relating to the subject" (12%), which also is reflected already in previous studies (Morgado et al. 2017). When inquired on the capacity of humanity to mitigate CC, almost all of our respondents express that humans could mitigate the effects of CC (98%), although only a small number (12%) expressed that "humans would successfully manage to mitigate the effect of CC". It is quite interesting to point, however, that the expressed believe on human ability to mitigate CC is low (48% pointing that 'we can, but it's not clear if we'll succeed' and 38% believe that 'we can, but people do not have the will'). In fact, respondents agreed that humankind have the capacity to mitigate CC, but believe on the ability to mitigate CC is not so obvious. Similar results were obtained in previous studies (Morgado et al. 2017).

CC is also considered very important in the academic training (81%) and technical knowledge is recognized as very important in their future professional practice (79%). However, few express self-perceived extensive (5%) or professional (1%) knowledge about it. In fact, more than half of the respondents, refers that their self-perceived "technical knowledge on CC" is moderate (65%) or minimum (28%). This minimum technical knowledge on CC is the higher rate found when compared with previous studies. Morgado et al. (2017) found rates between 3–5% in a study with Mozambicans, Mexicans and Portuguese samples. The same tendency is expressed by data concerning the "knowledge of how one's actions/behaviour influence CC" with very few respondents (15%) referring to have extensive knowledge on CC, and 23% referring to have minimum knowledge, also reflecting similar results as the obtained among Mozambicans (27%) in Morgado et al. (2017).

When considering the knowledge of particular aspects of their professional practice, namely "functional aspects of housing and living spaces that will be directly affected by CC" and "the implication of heat waves for human habitat", the majority felt unsatisfied with their information on CC and also felt they needed more information (54 and 53%, respectively). That is why most of the respondents consider that their training "had not focused enough on CC issues" (50%), and some (26%) felt that "it had not focused sufficiently" and a few weren't aware of having studied it during training (10%), or they had not studied the topic in training "but had obtained their knowledge informally" (14%). Research has been showing that high levels of concern do not correspond to high levels of knowledge (e.g., Carvalho et al. 2014). Here, we found a window to reinforce the CC agenda in curricula of graduation students. Also, the role of informal education seems to be of importance (because it somehow balances the lack of information in formal context) and must be integrated also in the future research.

In what concerns ecological footprint, most students had not calculated it (67%), situation observed already in previous works (Morgado et al. 2017). Also, when asked about the effect of the ozone hole on CC, only a minority (17%) acknowledged that this was not a main cause of CC, which reveals the lower proportion found in the previous studies (Morgado et al. 2017) with university students of other nationalities, like Mozambique (50%); Portugal (37%) and even Mexican (23%).

Globally, the perception of the behaviour of their relational communities towards mitigation of CC is not fully positive. As a matter of fact, the majority consider that their relational communities acted partially (52%) to mitigate CC or did not act (34%) at all to mitigate CC. This data show some similitude with previous research (Morgado et al. 2017).

The differences found among samples (Architecture and Urbanism Students and Interior Design Students) generally are not significant, however in the following paragraphs we will try to evidence the influence of sex, age and courses in the results obtained.

What variables are sensitive to gender? The respondent's sex did not significantly influence their "interest" on the topic of CC. However, data appeared to indicate that female respondents were more "concerned" with CC than male (48 vs. 38%), while male respondents referred more that the topic was of greater "importance" ("the issue of CC was very much important" to 65 vs. 55%, respectively for male and female). Female respondents appeared to perceive, at present, greater impacts in both human and biotic communities (83 and 86%) in their one country than male respondents (70 and 78%, respectively). On the other hand, male respondents appeared to perceive, at present, greater impacts in biotic communities abroad (90%) than female did (84%). We also found some differences related to sex and age among the proportions of respondents that points the disagreement among scientific community in what concerns the assumption that CC was happening. Male respondents perceived more disagreement among scientists than female (20 and 9%, respectively), and younger students perceived less disagreement among scientists than older students (5 and 16%, respectively, for "younger than 20" and "over than 21 years old"). Regarding all aspects of self-perceived knowledge, the gender factor (significantly) influenced it, with male respondents self-perceiving their knowledge higher than female.

Global opinions on who should take the main actions in mitigating CC divided between the "Governments" and the "Individuals" (47 and 43%, respectively). These were strongly, and significantly, dependent on the respondent's sex, with female expressing that it should mainly relay on Individuals (50 vs. 25% for male respondents) and less on Governments (44 vs. 55% for male respondents). Also, a trend for more action-taking to mitigate CC appeared to exist for male respondents (23 and 14% for female respondents), for students of the Interior Design course, and for the older age group. When inquired if they were to reduce their contribution to CC, most respondents expressed that it would increase their quality of life (73%). Among these, female respondents were significantly more positive than male respondents (60 and 40%, respectively, expressing "increasing a lot my quality of life").

Previous studies highlight gender as a factor affecting CC views and that women are more willing to acknowledge the need for more information on CC and more positive about increasing their life quality as a result of actions taken to mitigate CC, demonstrating always greater levels of concern (Wachholz et al. 2014; Santos et al. 2016). Since the 90's, studies point that gender differences are very important in order to understand their environmental attitudes (Davidson and Freudenburg

1996). Basically, explanations since then emphasize gender socialization and the different roles women and men tend to perform (McCright 2010), as a key to understand the different perceptions, attitudes and behaviours.

What variables are sensitive to age? Our respondent's age group significantly influenced the perception that CC was happening, with more expression in the oldest respondents. In fact, respondents above 30 years old believed that CC was happening, while only 89% respondents above 21 and 30 years old believe in that. Concern with CC appeared to be lesser (38%) for respondents between 21 and 30 years, than in the younger or in the older aged groups. The respondent's age significantly affected perception of CC impacts in present-day communities—human or biotic—being much greater for people over 30 years old (90–100%). The respondents age also influenced their self-perceived knowledge of CC in particular aspects of their professional activity i.e., in the older aged group (above 30 years old) there was an increased perception (statistically significant) of less knowledge and of "need for more information" (68 and 71%), when compared with the younger aged groups (46 and 48%). In general terms, when queried directly on the subject, the older aged groups differed (significantly) from the younger aged group (below 20 years old) in that they expressed a greater "need for more information on CC" (62 and 44%, respectively). In the age group "21–30 years old", in which 59% expressed that their training "had not focused enough on CC issues", and for 21% of the "younger than 20 years old" for whom the course had not focused enough on CC and who "had got the information informally", this was statistically significant.

What variables are sensitive to course? Analysis showed some differences between courses and generally reveals that Students of Architecture & Urbanism are more aware and more sensitive to the CC problem. For example, the believe in CC was greater in the Students of Architecture & Urbanism course (98%) than in the Interior Design course (91%). Also, the level of interest and concern with CC of Architecture & Urbanism students is higher, referring much interested (57%) and concerned (55%) with the topic of CC, than the Interior Design students (42 and 41%, respectively), even though its importance was similarly perceived (57–59%). However, students from Interior Design perceived more immediate impacts in human communities in their own country (82%) than Architecture & Urbanism (74%). On the contrary, respondents from Architecture & Urbanism course perceived more immediate impacts in biotic communities abroad (90%) than students from Interior Design (83%). There appeared to be a more optimistic perception of the capacity for humankind to successfully mitigate CC effects, related to the Architecture & Urbanism course than to the Interior Design course. Still, on the self-perceived knowledge, the data also shows a tendency (statistically significant on one issue) for respondents from Architecture and Urbanism course to be more confident about their knowledge, than students from Interior Design. The importance of CC both in their present academic training and for their future career tended to be greater for students from Architecture Urbanism (90% and 86%) than for those in Interior Design (77 and 76%), the latter hinting that CC was only important in some professional areas (4%). The course in which students enrolled also appeared to influence their opinion regarding the main actors in mitigating CC:

Architecture and Urbanism students chose to greater extent "Governments" (53 vs. 43% for Interior Design students) and "Individuals" to a lesser extent (37 vs. 46% for Interior Design students).

5 Conclusions

Higher education system has a very important role to play in training and educating future generations, promoting active citizenship in order to cope with the environmental crisis and the CC challenges that we face nowadays. In view of the potential significance of CC to society, education about this issue is a very important field of research. However, few studies assess higher education students' knowledge and attitudes, about CC and the contribution of their graduate course to the deepening of this knowledge and to the change of attitudes and behaviours. CC has become a reality in the curricula of some graduate and postgraduate courses at universities, but perceptions and attitudes are also constructed in contexts beyond formal education. The informal contexts, where education and formation happen, contribute decisively to the configuration of conceptions (the way we conceive, interpret and explain phenomena) and practices (the way we act and interact with the same phenomena). That fact, per se is reflected in our results.

Future studies should bring to the analysis more inquiries (e.g., the sample size) improving their representativeness, and consider qualitative methodologies in order to understand more deeply the context and the socio-cultural aspects of the phenomenon.

The results leave much unknown about the progression of university students understanding of CC worldwide. More research is required that uses inferential statistical procedures to understand the reasons behind trends in these student's perceptions. Also, the application of qualitative methodologies also offers the potential for better appreciation of the social and cultural contexts in which CC perceptions are evolving.

References

Alves F, Leal Filho W, Azeiteiro U, Araújo MJ (2013) Crossing borders and linking plural knowledge—biodiversity conservation, ecosystem services and human well-being. Int J Innov Sustainable Dev (IJISD) 7(2):111–125(15)

Azeiteiro UM, Bacelar-Nicolau L, Santos P, Bacelar-Nicolau P, Morgado F (2017) Assessing high school student perceptions and comprehension of climate change. In: Leal Filho W, Manolas E, Azul AM, Azeiteiro UM (eds) Handbook of climate change communication, volume produced as part of the "Climate Change Management Series" published by Springer (no prelo)

Azeiteiro UM, Leal Filho W (eds) (2017) Climate literacy and innovations in climate change education. Int J Glob Warming. Inderscience Publishers. IF 1.043 (2015/16) Q2

Basanta P (2016) The role of higher education in awareness of climate changes: a case study of North-Eastern States. Int J Curr Res 8(03):2864–2867

Carvalho A, Schmidt L (2014) Santos Filipe Duarte, Delicado Ana. Climate change research and policy in Portugal. WIREs. Clim Change 5:199–217. doi:10.1002/wcc.258

Davidson DJ, Freudenburg WR (1996) Gender and environmental risk concerns. Env Behav 28:302–339

Feldman L, Nisbet MC, Leiserowitz A, Maibach E (2010) The climate change generation? survey analysis of the perceptions and beliefs of young Americans. Yale Project on Climate Change Communication, Yale University and George Mason University available at http://environment.yale.edu/climate-communication-OFF/files/YouthJan2010.pdf

Giddens A (2009) The politics of climate change. Polity Press, Cambridge, UK, ISBN-13: 978-0-7456-4692-3, p 264

Kibert CJ (2016) Sustainable construction: green building design and delivery, 4th edn. ISBN: 978-1-119-05517-4, p 600

Leal Filho W, Alves F, Caeiro S, Azeiteiro UM (eds) (2014) International perspectives on climate change: Latin America and Beyond. Springer, 316, p 69 illus ISSN 1610-2010 ISSN 1610-2002 (electronic) ISBN 978-3-319-04488-0 ISBN 978-3-319-04489-7 (eBook) doi:10.1007/978-3-319-04489-7 Springer Cham Heidelberg New York Dordrecht London Library of Congress Control Number: 2014934670

Leal Filho W (ed) (2010) Universities and climate change—introducing climate change at University Programmes. ISBN: 978-3-642-10750-4. Springer, Berlin

Leal Filho W, Adamson K, Dunk R, Illingworth S, Azeiteiro UM, Alves F (eds) (2016a) Implementing climate change adaptation in cities and communities integrating strategies and educational approaches. Volume produced as part of the “Climate Change Management Series” published by Springer 1st edn. X, 375 p 69 illus., 57 illus. in color. ISBN 978-3-319-28591-7 ISBN 978-3-319-28589-4. doi:10.1007/978-3-319-28591-7 http://www.springer.com/gp/book/9783319285894

Leal Filho W, Azeiteiro UM, Alves F (eds) (2016b) Climate change and health: improving resilience and reducing risks. Volume produced as part of the “Climate Change Management Series” published by Springer 1st ed. 2016, XX, 532 p. 119 illus., 19 illus. in color. ISSN 1610-2010 ISSN 1610-2002 (electronic) ISBN 978-3-319-24660-4 ISBN 978-3-319-24658-1 (eBook). doi:10.1007/978-3-319-24660-4 Library of Congress Control Number: 2016931373 http://www.springer.com/us/book/9783319246581

Leal Filho W, Manolas E, Azul AM, Azeiteiro UM (eds) (2017) Handbook of climate change communication. Volume produced as part of the “Climate Change Management Series” published by Springer http://www.springer.com/series/8740 (this volume)

Manolas EI, Tampakis SA, Karanikola PP (2010) Climate change: the views of forestry students in a Greek university. Int J Environ Stud 67(4):599–609. doi:10.1080/00207233.2010.499208

McCright AM (2010) The effects of gender on climate change knowledge and concern in the American public. Popul Env 32:66–87. doi:10.1007/s11111-010-0113-1

Morgado F, Bacelar-Nicolau P, Rendon-Von Osten J, Santos P, Bacelar-Nicolau L, Farooq H, Alves F, Soares A, Azeiteiro UM (2017) Assessing University student perceptions and comprehension of climate change (Portugal, Mexico and Mozambique). Int J Clim Change Strat Manag IF: 0.708 20154/16 Q2

Ortega-Egea JM, García-de-Frutos N, Antolín-López R (2014) Why do some people do ‘‘More’’ to mitigate climate change than others? Exploring heterogeneity in psycho-social associations. PLoS ONE 9(9):e106645

Santos P, Bacelar-Nicolau P, Pardal MA, Bacelar-Nicolau L, Azeiteiro UM (2016a) Assessing student perceptions and comprehension of climate change in Portuguese Higher Education Institutions. In: Leal Filho W, Adamson K, Dunk R, Illingworth S, Azeiteiro UM, Alves F (eds) (2016) Implementing climate change adaptation in cities and communities integrating strategies and educational approaches. Volume produced as part of the “Climate Change Management Series” published by Springer 1st ed. 2016, X, 375 p. 69 illus., 57 illus. in color.

ISBN 978-3-319-28591-7 ISBN 978-3-319-28589-4, pp 221–236. doi:10.1007/978-3-319-28591-7_12 http://www.springer.com/gp/book/9783319285894

Setti AFF, Ribeiro H, Azeiteiro UM, Gallo E (2016b) Governance and the promotion of sustainable and healthy territories in the experience of Bocaina, Brazil RGCI—Revista de Gestão Costeira Integrada/JICZM. J Integr Coast Zone Manag16: http://www.aprh.pt/rgci/pdf/rgci-612_Setti.pdf|http://dx.doi.org/10.5894/rgci612

Viegas V, Azeiteiro UM, Alves F (2016) Lay rationalities on climate change: an exploratory study among the Artisanal Fishers in Peniche (Portugal). In Filho WL et al (eds) Climate change adaptation, resilience and hazards. ISBN 978-3-319-39879-2, pp 305–327. doi:10.1007/978-3-319-39880-8_19. http://www.springer.com/gp/book/9783319398792

Wachholz S, Artz N, Chene D (2014) Warming to the idea: university students' knowledge and attitudes about climate change. Int J Sustain High Educ 15(2):128–141. doi:10.1108/IJSHE-03-2012-0025

Yoko M, Audrey B (2015) Climate change education in the context of education for sustainable development: rationale and principles. J Educ Sustainable Dev 9(1):4–26

The Grounding for a Fossil Fuel Free World: Integrating Climate Change Education into Secondary Schools

Gina Lovett, Claire Lambert, Eric Chu and Joyeeta Gupta

1 Introduction

After the diplomatic success of the Paris Agreement to the Climate Convention (Paris Agreement 2015), attention has turned to translating ambition into action. If countries are to limit warming to a rise of no more than 1.5–2 °C in relation to pre-industrial levels, they must radically decarbonise. This requires dramatic changes in individual and collective behaviour and values, as well as transforming ways of producing, distributing and consuming (Galgóczi 2016). Implementing the climate change regime hinges on a shared basis of public awareness, norms, knowledge and engagement (Averchenkova and Bassi 2016).

Populations need to be knowledgeable about their biophysical environment, aware of what they can do and motivated to work towards effective solutions (Stapp et al. 1969). Educating those currently at school about climate change can shape and sustain future policymaking, through stimulating concern, sharing knowledge and developing a relevant skills base (Stern 2007).

As of 2016, there are numerous international environmental education frameworks and programmes (Table 1). However, levels of awareness and engagement

G. Lovett (✉) · C. Lambert
Department Geography, Planning and International Development Studies,
University of Amsterdam, PO Box 15629, 1001NC Amsterdam, The Netherlands
e-mail: ginalovesit@icloud.com

E. Chu
Planning and Human Geography, School of Geography, Earth and Environmental Sciences,
University of Birmingham, B15 2TT Birmingham, UK

J. Gupta
Amsterdam Institute for Social Science Research, University of Amsterdam,
Nieuwe Achtergracht 166, 1001NC Amsterdam, The Netherlands

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_14

Table 1 Summary observations and comparison

	France	England	Netherlands	Wallonia/Belgium
Key Actors	Ministry of Education, regional committee network, school directors	Teachers (but lack of clear ministerial responsibility)	Primarly the Ministry for Economic Affairs, non-state actors, interested teachers, youth lobby	School directors, regional committees, interested teachers
Vision	To foster understanding of human-environment interaction and interdependence, and stimulate responsibility towards the environment through behaviour	Need to master past climate, climate science and climate evidence before anthropogenic climate or social dimensions of climate change	Climate change is a symptom of an unsustainable system, comes under sustainability and education for sustainable development	Environmental education understood as responsible citizenship, no specific vision for climate change education
Integration	– Broader focus of ESD – Infusion into curriculum subjects – Risks, history, social and scientific dimensions of climate change – Levels of action: individual, community, political – Voluntary E3D Eco-schools label – Network of eco-delegates in middle and high schools	– Topic–based mainly formal channels – Curriculum learning targets – Data collection, monitoring, mapping – Chemistry for 11–14 year olds (statutory) – GCSE geography (elective) – No public funding for non-state actors – Closure of regional training hubs	– ESD methodology – Social innovation and learning – Formal and informal channels – No formal targets – Elective subject in geography and sciences – ESD teaching materials on diverse topics – Some public funding and basic support for non-state actors delivering ESD programmes	– Trans-disciplinary education taking into account local social, economic and cultural contexts – Citizenship – Non-specified learning goals – Extra-curricular projects – ErE and ESD methodology – Formal and informal channels – Funding for non-state actors – No specified targets

with climate change vary significantly across and within countries (IPCC 2014). Western countries are regarded as relatively advanced in their awareness of climate change, but societal involvement in mitigation is far lower and unevenly distributed across populations (Whitmarsh et al. 2012). Most people have heard of climate change, many are uncertain of its implications and some are climate skeptics. Only a minority are engaged in mitigation in their personal or professional lives (Whitmarsh et al. 2012; Mower 2012).

While there is ample literature on the changing visions and appellations of environmental education (Sauvé 1996; Gough and Gough 2010), teaching (Gough and Gough 2010; Stevenson 2007), learning directives (Huckle 2008; Gayford and Dillin 1995) and pedagogy (Kopnina 2014a, b; Chawla and Cushing 2007), there are few empirical studies on national climate change education activities. There is even less attention given to how climate change is integrated into policy, textbooks or classroom settings.

Hence, this chapter asks: how is climate change learning being integrated in secondary school education? It builds on a literature review, content analysis of policies and empirical data from England, the Netherlands, France and French-speaking Belgium. These neighbouring states have played prominent roles in international climate change policy, are advanced in climate awareness and education, but still demonstrate differing levels of climate knowledge and engagement across the population (IPCC 2014; Mower 2012; Whitmarsh et al. 2012).

The chapter first reviews the literature and global mandate of environmental education (see Sect. 2), before outlining the method and critical policy framework (see Sect. 3). It then applies the method to the case studies (see Sect. 4), while the concluding section brings together the results in a comparative table and analysis.

2 Policy Framework and Literature Review

2.1 A Global Mandate

Environmental and sustainable development education has a clear global mandate and legal basis, supported by treaties and conventions since the 1970s (see Box 1 below). These have recognised the role of information, knowledge and education in fostering environmental protection, and have called for changes in knowledge, values and attitudes to enable a more sustainable, just and equal society.

Box 1. The Evolution of Major Global Policy Frameworks Supporting Environmental Education

1972—Declaration of the UN Conference on the Human Environment, Stockholm

- Education in environmental matters essential in fostering "enlightened opinion" and "responsible conduct"

1975—The Belgrade Charter: A Framework for Environmental Education

- Create awareness of and concern for ecological, economic, social and political interdependence

1977—The Tbilisi Declaration of The Intergovernmental Conference on Environmental Education

- Declared the importance of environmental education in providing knowledge, skills and attitudes to remedy environmental problems

1992—UN Conference on Environment and Development, Rio de Janeiro

- The resulting Agenda 21 voluntary action plan emphasised development issues and public awareness and training

2005—UN Decade of Education for Sustainable Development (DESD)

- To acquire the knowledge, skills, attitudes and values necessary for sustainability
- Focus on development issues including poverty reduction, sustainable consumption and climate change

2014—UNESCO World Conference on Education for Sustainable Development, Nagoya

- Celebrated and identified lessons learnt from DESD
- Set future action under the Global Action Programme

2014—The Global Action Programme on Education for Sustainable Development

- Advancing policy and integrating whole-institution approaches to integration of ESD in education and training
- Mobilising youth

2014—The UNFCCC Lima Ministerial Declaration on Education and Awareness-Raising

- Stressed the importance of public awareness and education in achieving the UNFCCC aims

- Called on governments to include climate change in school curricula, climate awareness into national development plans, and climate change into national education and development policies and plans

2015—UNESCO International Conference on Education as a Driver for the Sustainable Development Goals, Ahmedabad

- Recognised education as critical to achieving the SDGs
- ESD communities declared important in determining education role in meeting specific goals

While UNFCCC agreements including the Kyoto Protocol in 1997 (Article 10) and the Paris Agreement in 2015 (Article 12) make provisions for education, training, public awareness, public participation and access to information, capacity building efforts are mostly targeted towards developing countries, where the gains of education are more readily recognised (UNCC: Learn 2013). However, we are now moving towards a broader understanding of education in the context of sustainable development. The UN Sustainable Development Goals (2015) bolster UNFCCC aims, weaving action on climate change into global development, acknowledging the interdependence of policy drivers and impact. Climate change influences ecological and human systems, while at the same time society's priorities influence both its GHG emissions and exacerbate vulnerability. Hence, climate policies are considered more effective when consistently embedded within broader strategies designed to make development pathways more sustainable (IPCC 2014).

Education for Sustainable Development, led by UNESCO and the UNECE, has a Steering Committee comprising members from UNESCO, OSCE, Council of Europe, UNIDO, the European Environmental Agency, academic institutions, regional environmental centres and NGOs. National ESD focal points report on their progress through annual reports and meetings, discussing challenges and best practice. ESD is a methodology that develops competencies in systems thinking or social learning, and applies this learning across different sectors and topic areas, such as soil, water, energy, and public health (UNESCO 2015a, b). However, the integration of ESD into education is contingent on national education politics rather than the authority of the UNECE or UNESCO. Hence ESD goes beyond national education systems and incorporates "informal" learning outside of the classroom through NGO and civil society partnerships and media campaigns (UNESCO 2015a, b).

2.2 The Role of Communication and Education

The central objective of environmental education is to stimulate people's active involvement in solving environmental problems, to foster awareness, knowledge, concern for the environment, and to develop skills to achieve this goal (Tbilisi 1977). Climate change education and communication share aims in creating awareness and influencing behaviour, but they differ in purpose, delivery and temporal scale (Wibeck 2014). Communication strategies tend to be instrumental in nature, teaching individuals to behave in a way that is better for the environment. The assumption is that behaviour can be influenced through identifying target groups and designing interventions (Wals et al. 2008). An emancipatory approach, which may be more aligned with a critical education, strives to engage learners through active dialogue, placing emphasis on the co-creation of shared meanings. The rationale is that self-initiated learning and self-initiated change resonates on a deeper level, and hence, is more desirable (Wals et al. 2008). Despite this difference, international frameworks have tended to aggregate education and public communication, treating them as synonymous in meeting international obligations.

2.3 Policy Foundations

Climate change education (CCE) is sometimes addressed as part of education for sustainable development (ESD), rather than as a separate education initiative. The assumption is that CCE is redundant under ESD (Bangay and Blum 2010). However, CCE is dependent on the relationship between sustainable development and climate change policy, which can vary from country to country (Laessøe and Mochizuki 2015). Furthermore, there may be major trade-offs between climate change and development and between the economic, social and ecological aspects of sustainable development. Neither CCE nor ESD are likely to be driven by a policy imperative or definitive regulation (Læssøe and Mochizuk 2015).

The national discourses of education—i.e. in terms of STEM, human capital, the knowledge economy, competition, innovation, performance and standards—take precedence over CCE or ESD in core subjects and exams (Gayford and Dillin 1995). When educational mandates focus on testing and performance, this not only de-prioritises sustainability education, but discourages an ethic of environmental and social care through a reliance on individual attainment and competition (Huckle 2008; Aikens et al. 2016). The focus of mainstream discourses excludes alternatives such as de-growth, post-extractivism or bioregionalism.

2.4 Curriculum Development and Integration

Curriculum development and pedagogy are concerned with the extent to which CCE and ESD are integrated into the curriculum—how it is "infused" into subjects or if it ought to be a discrete topic. The complexity and inter-disciplinarity of environmental issues means that EE, ESD and CCE do not easily sit within the boundaries of any one subject (Gough and Gough 2010). They span both a science curriculum, comprising earth systems, and a socially critical curriculum reflecting on society, values, roles and responsibilities (Gough and Gough 2010).

The critical analysis advocated by EE compels political action, yet in terms of mainstream education this can be contentious (Gough and Gough 2010). However, action can be taken preferably within immediate environments, changing organisation conditions and operations. Practicing and applying knowledge in the immediate school environment is known as the "whole-school approach" (Eernstman and Wals 2011). Environmental education often relies on the enthusiasm of motivated teachers and educators because of vague and absent policies (Stimpson 1997 cited in Aikens et al. 2016). Commitment from teachers in implementation tends to be low or eclipsed by national education priorities (Gayford and Dillin 1995).

While there is no formal benchmark for the content and pedagogy of CCE, scholars point out a need to include wider environmental processes, local environmental conditions and tactics to reduce disaster risk, alongside climate knowledge (Bangay and Blum 2010). CCE is a process of learning to know (climate science, mitigation, sustainable consumption and production), learning to do (thinking critically and preparing for green jobs) and learning to live together (fostering universal values such as peace and tolerance) (Mochizuki and Bryan 2015). CCE must also respond to social inequalities and common but differentiated responsibilities (Aikens et al. 2016), going beyond simple environmental education "problem-solver" narratives (Van Poeck and Lysgaard 2015).

To summarise, a rounded climate change education should encompass:

- Climate science—understanding of how the climate system works, causes and impacts of anthropogenic climate change
- Global to local social dimensions, implications and responsibilities;
- Instilling values (peace, social justice, environmental concern);
- Developing skills and capabilities for action;
- Enabling different levels of responses—personal, organisational, political and community behaviours.

3 Methodology

Case study research, carried out through 2016, consisted of document analysis of education bills, white papers, legislative frameworks, government websites, national curricula, and policy reports from multilateral organisations. This was supplemented by 28 semi-structured interviews with ministry representatives, teacher unions, environmental NGOs and EE professionals. We selected the cases of France, Belgium, Netherlands and England because they share broad similarities in their industrial history and development and demonstrate a nuanced range of political and education models, from centralised, top-down education to freedom of education. The focus was on upper primary to lower secondary school because this age group (roughly ages 11–16 years) presents an opportunity to reach all school-going students, and is an age where a greater complexity of environmental problems can be raised.

We took a critical policy approach to analysing documents and coding interviews, examining stakeholder dynamics, visions and goals of climate change education, and integration through content, curriculum and pedagogy. Our focus was to understand context such as history and resources, as well as actor motivations, and policy enactment through translation, interpretation, roles and activities (Ball et al. 2011; Braun et al. 2010). The vision and integration approach for each country was linked to a particular CCE outcome, which was then compared with the CCE benchmark, outlined above.

4 Comparative Approaches to Climate Change Education

4.1 England

In England, under the New Labour government (1994–2010), CCE was high on the political agenda to the extent that it had a strong statutory basis for both curricular knowledge and methodologies to apply this knowledge. Local authorities, educational groups and NGOs delivered on national targets. However, recent Conservative governments have cut funding, support to local authorities, regional bodies and training centres, educational support groups and NGOs. Climate change remains in the curriculum, but there are no longer statutory targets (such as "all schools a sustainable school by 2020") on sustainability frameworks that help apply knowledge and foster skills and values. Eco-Schools, which was and continues to provide the framework for schools to reduce environmental footprints while incorporating these actions into everyday learning, is now dependent on corporate partnerships and the revenue from schools paying for its certification. Of the regional training hubs and organisations, there remains The Sustainable Schools Alliance and Global Learning, but uptake across the country has been mixed.

On a ministerial level, there are no significant actors driving climate change education in England. That climate change is mentioned in the curriculum is regarded as sufficient in meeting UNFCCC CEPA provisions. Within the government, there is reluctance towards climate change education stemming from climate denial within government ranks. Climate change is downplayed to avoid division on the matter. Therefore, in the curriculum, the emphasis is on science as objectivity—understanding meteorology and climatic cycles, and avoiding ecology or social aspects with their normative associations (Department for Education National Curriculum 2016).

Without major proponents in government, and with the energy and resources of non-state and civil society actors disabled, teachers are the main actor group delivering climate change education. They are, however, limited in their negotiating power since the Minister for Education assumes overall curriculum control and has set an agenda to drive performance in maths, science and technology (Department for Education 2016). With an academisation programme underway, and a major focus on exams, climate change and the environment is of low priority for many over-stretched teachers (Department for Education 2016). The main opportunity for students to learn about climate change is at Key Stage 3 (ages 11–13). In Chemistry, the focus is on atmospheric gases, while in geography attention is given to carbon cycling and past climate. In upper primary level (KS2, up to 11), learning is focused on the difference between weather and climate. For students who do not choose geography at GCSE Key Stage 4 and beyond, there is a limited focus on climate change. Only 35% of students elect to take exams for KS4 geography for GCSE level (Department for Education National Curriculum 2016).

The vision for climate change education in England has been negotiated between civil society campaigning to keep climate change in the curriculum, while science-policy institutes have advised a climate-reluctant government on learning needs. The resulting vision rests on the premise that there is a need to understand climate, climate science and climate evidence before learning about anthropogenic climate change or the associated social dimensions. In this vein, the main methods for acquiring climate knowledge are rooted in the natural sciences, and include data collection, observing, monitoring and mapping. Extra-curricular activity such as eco-clubs, which could supplement climate change learning, through project- or action-based learning, is eclipsed by curriculum demands of increasing educational attainment in STEM subjects.

4.2 Netherlands

The Netherlands provides a contrasting picture of climate change education. Here, there is lukewarm government support for a holistic education around sustainability, which climate change sits within. However education for sustainable development is non-statutory, mainly informal, and delivered outside of the main school system by a diverse range of civil society and non-state actors. At the ministerial level, responsibility for climate change education is in principle shared between the Infrastructure and Environment Ministry, the Ministry for Economic Affairs and the Department for Education, Culture and Science, though the latter has little to say on environmental education matters. The Infrastructure and Environment Ministry prepares responses to UNFCCC directives, but regards CCE as low priority relative to its adaptation and EU mitigation targets. It regards the ESD work by the Ministry for Economic Affairs as sufficient to fulfil these international CEPA obligations.

The Ministry for Economic Affairs is responsible for ESD, working with the UNECE and UNESCO. Its programme, Duurzaam Door (Continuing Sustainability), brings together projects and activities under themes of energy, water, biodiversity, natural resources and food, and is delivered by regional networks (Duurzaam Door 2016). With a small annual subsidy, these run competitions and projects, conferences, and develop communication and teaching materials. The Dutch ESD team authors reports developing indicators on social learning, and they are motivated by building their reputation and standing among international peers.

The ESD networks are focused on the specific tracks of the Dutch education system. They run on an open-access, voluntary basis, often led by entrepreneurs, consultants or volunteer boards. Annual subsidies from government are not guaranteed and can vary from year to year. Networks must deal with this by remaining lean and flexible, impacting how strategic and long-term they can be. While there are many projects and networks, the challenge is to consistently connect these and drive more committed participation to have real impact. Dutch local authorities, local organisations, scouts groups, women's institutes and other civil society groups also support broader environmental education, generating lesson plans, projects, and activities for schools, and running city farms and gardens.

Notably, the Dutch youth lobby, comprising up to 40 organisations including Groene Generatie and Studenten voor Morgen, is a significant voice within the environmental education space. They are currently calling for the implementation of ESD into national learning goals, and have managed to obtain cross-party agreement on it (Brein 2015; Groene Generatie 2013). The main challenge is in overcoming objections to statutory obligations in education on grounds that these would limit the autonomy of schools that the Dutch constitutional right of "Freedom of Education" guarantees.

The Dutch vision of climate change education stems from the understanding that climate change is a symptom of an unsustainable system. The ESD competence-based framework advocated by the Ministry for Economic Affairs and the Dutch youth lobby approaches sustainability as a "whole system", from which topics such as renewable energy or food and agriculture can be given greater focus. Speakers from NGOs and charities visit schools, while networks and agencies run extra-curricular programmes that encourage sustainable behaviour such as walking or cycling, saving water or eating less meat, as well as fostering a problem-solving mentality. Such efforts are an opportunity to activate climate skills and values but there tends to be less clarity around climate knowledge and science or the social dimensions of climate change.

Climate change features in the Dutch curriculum, though it remains one of several global environmental issues to choose from. Mainstreaming CCE hinges on ESD policy, but since there are no statutory targets on effectiveness or reach this is a weak driver of integration. In addition, climate change is often regarded as a public campaign challenge, such as communicating the dangers of alcohol. Schools can choose to specialise in sustainability, placing it at the core of their daily operations as well as embedding it into teaching practice (also known as the whole-school approach). Geography offers the greatest opportunity for learning about climate knowledge and its various dimensions but as an elective subject it reaches only a percentage of students, and is declining in popularity among secondary pupils (SLO Curriculumspiegel 2015a). Climate change tends to be a popular topic for "field werkstukken"—group projects that are specialised and cross-cutting. However, these are also only just a percentage of all students.

4.3 France

Until very recently, there were few national policies or school activities on environmental issues in France. However, increasingly, the presence of members of the Green Party within the current government, and hosting the UN COP21 in Paris in 2015, compelled France to introduce wide-ranging measures to integrate sustainable development into all school curricula from September 2016.

The Ministry of Education has led this, interpreting the vision and role of ESD, determining how best it should be integrated into the school system. It oversees a network of regional committees, who in turn connect school directors with the Ministry unit in charge of ESD. The Ministry of Education subsidises specialist ESD associations such as the Réseau Écoles et Nature and the Union Nationale des Centres Permanents d'Initiatives pour l'Environnement to support school directors in delivering ESD activity. A voluntary E3D labelling of "eco" schools is awarded when there is different levels of activity across the classroom, the school and the integration of the school into society. The target is to double the number of E3D labelled schools in each school district between 2015 and 2017 (Ministère de l'Éducation nationale 2015a, b). The French Ministry of Education has also introduced a scheme to reward the best environmental educational projects, and stimulated interest in ESD through a network of "eco-delegates" in middle and high schools (Ministère de l'Éducation nationale 2015a, b).

Like the Netherlands, education around climate change in France is embedded in the broader context of sustainable development. The French vision for ESD is to foster understanding of human-environment interaction and interdependence, and stimulate responsibility towards the environment through behaviour. The main modes of integration are through the curriculum, supported by interdisciplinary teaching focused on "ecological transition and sustainable development". Climate change is mostly taught as part of the geography curriculum, but also appears in science classes in middle school (Ministère de l'Éducation nationale 2015a, b).

Climate change is also taught in the context of "global change", development, urbanisation, deforestation and land use change, as well as the risks induced by climate change and the impact on humans (Ministère de l'Éducation nationale 2015a, b). Learning is focused on differentiating the natural climate change cycles and climate change due to human activity, which indicates an acknowledgement of anthroprogenic climate change (Ministère de l'Éducation nationale 2015a, b). The curriculum encompasses notions of adaptation, mitigation, vulnerability and resilience examining the contribution of local, regional and national policies (Ministère de l'Éducation nationale 2015a, b).

While CCE is rounded and addresses all the dimensions outlined in the CCE benchmark, some of the content is only taught in optional trans-disciplinary classes, such as in the case of climate impacts on biodiversity (i.e. linking life and earth sciences, technology and language classes) or the history and debates around the notion of climate change (i.e. life and Earth sciences linked with physics, chemistry, history, geography, mathematics, French and education to media and information). This comprehensiveness may stem from France's increasing recognition of the importance of CCE, however a strongly "top-down" approach may stifle heuristic learning.

4.4 Wallonia, Belgium

Environmental and climate change education in French-speaking Belgium (i.e. the Walloon Region) is embedded in broad learning goals that allow schools to pursue their own specialisations and teaching practice. The terminology most widely used is "Education related to Environment" (Sauvé 1997), where environmental education is understood as responsible citizenship. This is realised through a trans-disciplinary education taking into account the local, social, economic and cultural circumstances (Réseau 2011).

Partnership and coordination between non-state actors, education associations and regional networks defines Belgian environmental education. Non-state actors and businesses all propose pedagogical tools, activities and excursions. Most are involved in projects around nature, sustainable development and water. The Federation of Wallonia-Brussels (FWB) certifies registered associations for up to five years, providing funding on grounds that they maintain a number of projects and activities (FWB 2009). Regional public services also support environmental education through activity days, where students can learn about waste or water management, through school visits or other activities. Municipalities are focused on outdoor and nature education, providing green spaces, vegetable gardens or composting.

Like the Netherlands, climate change is alluded to in the curriculum, but with resource use and energy as the major starting points. The learning goals for upper primary school geography state that "pupils should become aware of societal and environmental issues; their responsibility as a citizen and the active role they need to have in the society", and "be open to the world and develop their critical thinking" (FWB 2013a, b). Topics include the transformation of landscapes, climate zones, forests, mountains or water cycles, including management and conservation. In secondary school, learning objectives are divided across sciences like biology and geography. Competencies include understanding "the multiple factors maintaining environmental balance", "ethical issues about the environment", "the impacts of human activities on pollution" or "the impacts of daily actions on the environment". Geography outlines knowledge on "climatic and biogeographic environment", including climate cycles and water resources management, as well as deforestation, irrigation, pollution, natural disasters, and sustainable development.

Teachers are the main drivers of environmental education activities, and are often motivated by their own environmental values and commitment to helping students become future citizens (FWB 2014). Around 71% of projects in secondary school are instigated by teachers (FWB 2014). School directors also play a crucial role in the conception and implementation of projects, approving content, or bringing in external actors. The major challenge for EE professionals, however, is to rationalise the growing number of diverse and unconnected projects all asking for class time (Réseau 2011)

5 Discussion

The four case examples demonstrate how different approaches and implementation strategies favour particular competencies, knowledge, values or behaviour around climate change education. None, however, provide the full scope as outlined by the CCE "benchmark". In the case of England, the focus on climate science provides clarity on climate evidence and natural cycles, but there is little opportunity to explore the social dimensions. With the constraint of exams, the possibilities to apply climate knowledge or to create values for engagement are limited. The Dutch case demonstrates a range of knowledge and competences, including systems and critical thinking, yet this is hindered by an overload of unaudited information. With overall government commitment lacking, CCE and ESD are deemed low in terms of national priorities. In contrast, France's turnaround to integrate ESD sends a clear signal about its national concerns. However, the top-down, hierarchical approach to integration may stifle heuristic learning. In the case of Belgium, responsible citizenship taking into account the local social, economic and cultural circumstances offers opportunities for emancipatory, self-learning. Yet without clarity around goals and definitions, climate change is likely to become lost in a complex mass of undefined environmental issues.

Across the four case examples, both centralised and decentralised approaches to integration are evident (see Table 1 for summary). In three of the cases (Belgium, France and Netherlands) mainstreaming CCE hinges on ESD policy. But without statutory targets on effectiveness this is a weak driver of integration. A successful decentralised integration approach depends on the commitment of teachers, their values, knowledge and capabilities. Without proper support, this is unlikely to be effective. In addition, non-state actors—including education networks, local authorities and civil society groups—play a significant role in bringing to life curricular knowledge through activities outside of the classroom. However, without on-going commitment, supervision and proper coordination with formal education from the national level, their work may remain ad hoc, rather than as a crucial means of supporting a long-term education strategy.

6 Conclusion

This chapter has aimed to understand how climate change learning is integrated into secondary education in England, Netherlands, France and Belgium. We did this using comparative case studies and viewing states through a critical policy lens, evaluating CCE approaches in terms of actors, vision, goals, pedagogy and resources.

We draw three major conclusions regarding how CCE is integrated into school curricula.

First, centralised policy approaches are more effective in widespread implementation of CCE. Decentralised policy approaches, which rely on the commitment of teachers, demand coordination, binding goals and comprehensive support schemes for teachers.

Second, partisan and ideological battles at the national level, playing out in the curriculum, can prevent transformative action as CCE is relegated to incremental processes such as awareness-building, knowledge co-production, and coalition-building. In addition, a rounded CCE demands political consciousness, yet this is incompatible with a formal education that generally accepts the status quo.

Third, without sustained development and oversight, and without consistent cross-ministerial efforts, the multi-dimensional CCE necessary to achieve societal transformation is unlikely to materialise. Without leadership, CCE is likely to stagnate, lack in overall purpose and add to public confusion.

All of this has wider significance: with an emphasis on capacity building and how best to implement the Paris Agreement, there is a need for CCE to be taken more seriously as part of climate governance in developed countries as much as developing ones. This entails greater clarity on global CCE goals and finding ways to ensure outcomes balance knowledge, awareness, values, skills and motivation. To this end, ministries must regard CCE with greater gravity, and environmental educators must engage politically, finding a voice in the policymaking process.

These findings open up a number of avenues for further research. While this chapter adopts a national perspective on CCE, investigation into CCE enactment at the school level would bring further weight and depth to arguments about governance stagnation and fragmented implementation. Another strand of research might investigate how CCE can evolve under conditions such as austerity and a lack of top-down leadership.

Educating those currently at school about climate change can stimulate concern, share knowledge and develop a relevant skills base. By striving for consistency in CCE outcomes across and between countries, the shared baseline of knowledge, concern and engagement needed to lay the foundations for transforming institutions and capacities can be achieved.

References

Aikens K, McKenzie M, Vaughter P (2016) Environmental and sustainability education policy research: a systematic review of methodological and thematic trends. EER 22(3):333–359

Averchenkova A, Bassi S (2016) Beyond the targets: assessing the political credibility of pledges for the paris agreement. Grantham Research Institute on climate change and environment, February. http://www.lse.ac.uk/GranthamInstitute/wp-content/uploads/2016/01/Averchenkova-and-Bassi-2016.pdf. Last accessed 7 Mar 2016

Ball SJ, Maguire M, Braun A (2011) How schools do policy: policy enactments in secondary schools. Routledge, London

Bangay C, Blum N (2010) Education responses to climate change and quality: two parts of the same agenda? Int J Educ Dev 30(4):359–368

Braun A, Maguire M, Ball SJ (2010) Policy enactments in the UK secondary school: examining policy, practice and school positioning. J Educ Policy 25(4):547–560

Brein G (2015) KennisKaart Circulaire Economie

Chawla L, Cushing D (2007) Education for strategic environmental behaviour. EER 13(4):437–452

Duurzaam Door (2016) https://www.duurzaamdoor.nl/. Last accessed 22 Oct 2017

Eernstman N, Wals A (2011) Learning from each other: second evaluation report of the implementation of the UNECE education for sustainable development strategy. UNECE, Geneva

Fédération Wallonie-Bruxelles (1997) Écret définissant les missions prioritaires de l'enseignement fondamental et de l'enseignement secondaire et organisant les structures propres à les atteindr. http://www.gallilex.cfwb.be/document/pdf/21557_023.pdf. Last accessed 20 Apr 2016

Fédération Wallonie-Bruxelles (2009) Décret fixant les conditions d'agrément et d'octroi de subventions aux organisations de jeunesse, parlement de la communauté française. http://www.gallilex.cfwb.be/document/pdf/34206_001.pdf. Last accessed 11 Sept 2016

Fédération Wallonie-Bruxelles (2013a) Référentiels de compétences - les socles de competences. http://www.enseignement.be/index.php?page=24737&navi=47. Last accessed 10 Mar 2016

Fédération Wallonie-Bruxelles (2013b) L'Education à l'environnment et au developpement durable dans le system éducatif de la FWB, AGERS. http://webcache.googleusercontent.com/search?q=cache:6eD_cJFmABIJ:www.enseignement.be/download.php%3Fdo_id%3D10335%26do_check%3D+&cd=2&hl=en&ct=clnk&gl=fr&client=firefox-b. Last accessed 29 Mar 2016

Fédération Wallonie-Bruxelles (2014) Evaluation des pratiques d'éducation relative à l'énvironnement et au développement durable dans les établissements scolaires de l'enseignement fondamental, secondaire, ordinaire et spécialise. http://assises-ere.be/matinee-multiacteurs/index-pdf/Rapport-inspection-01-juillet-2014.pdf. Last accessed 8 Mar 2016

Galgóczi B (2016) After COP21: the EU needs to revise its climate policy targets. Social Europe, 18 February https://www.socialeurope.eu/2016/02/cop-21-eu-needs-revise-climate-policy-targets/. Last accessed 22 Feb 2016

Gayford CG, Dillin PJ (1995) Policy and the practice of environmental education in England: a dilemma for teachers. EER 1(2):173–183

Gough N, Gough A (2010) Environmental education. In: Kridel C (ed) Encyclopedia of curriculum studies, vol 1. Sage Publications, Inc, Thousand Oaks, pp 339–343

Hetgoenebrein (2016) http://hetgroenebrein.nl/. Last accessed 22 Oct 2017

Ministère de l'Éducation nationale (2015a) Bulletin officiel numéro 5 annexe 5: encourager la création de coins nature, Janvier 29. http://cache.media.education.gouv.fr/file/6/59/4/ensel1684_annexe1_E3D_demarche_globale_388594.pdf. Last accessed 7 Mar 2016
Ministère de l'Éducation nationale (2015b) Bulletin officiel numéro 5 annexe 1: démarche globale de développement durable dans les écoles et les établissements scolaires (E3D) référentiel de mise en œuvre et de labellisation http://cache.media.education.gouv.fr/file/6/59/4/ensel1684_annexe1_E3D_demarche_globale_388594.pdf. Last accessed 13 Apr 2016
Groene Generatie (2016) http://www.groenegeneratie.nl/. Last accessed 22 Oct 2017
Huckle J (2008) An analysis of new labour's policy on education for sustainable development with particular reference to socially critical approaches. EER 14(1):65–75
Intergovernmental Panel on Climate Change (IPCC) (2014) Fifth assessment report: sustainable development and equity climate change. Mitigation of climate change 2014 (AR5) IPCC, Geneva
Kopnina H (2014a) Education for sustainable development (ESD): exploring anthropocentric values in children through vignettes. Stud Educ Eval 41:124–132
Kopnina H (2014b) Education for sustainable development (ESD) as if environment really mattered. Environ Dev 12:37–46
Laessøe J, Mochizuki Y (2015) Recent trends in national policy on education for sustainable development and climate change education. JESD 9(1): 27–43
Mochizuki Y, Bryan A (2015) Climate change education in the context of education for sustainable development: rationale and principles. JESD 9(1):4–26
Mower T (2012) Climate change in the curriculum: are all young people informed and inspired? University of Leeds. http://www.see.leeds.ac.uk/misc/ejournal/Issue%208%20articles/8,%201-37.pdf. Last accessed 11 Mar 2016
Réseau I (2011) L'ErE-DD à l'école http://assises-ere.be/pdf/Presentation-resultats-finaux.pdf. Last accessed 20 Apr 2016
Sauvé L (1996) Environmental education and sustainable development: a further appraisal. CJEE 1:7–34
Sauvé L (1997) Une critique des propositions du dévéloppement durable et de l'avenir viable pour une éducation relative à l'environnement, Montréal: Guérin, 2e édition. http://www.institut-eco-pedagogie.be/spip/IMG/pdf_critiqueSauve_.pdf Last accessed 12 Mar 2016
Stapp WB (1969) The concept of environmental education. J Environ Educ 1(1):30–31
Stern NH (2007) The economics of climate change: the stern review. Cambridge University Press, Cambridge, UK (Print)
Stevenson RB (2007) Schooling and environmental education: contradictions in purpose and practice. EER 13(2):139–153
Stichting Leerplanontwikkeling Nederland (2015a) Curriculumspiegel 2015: generieke trendanalyse. http://downloads.slo.nl/Repository/curriculumspiegel-2015-deel-a.pdf
Tbilisi Declaration (1977) http://unesdoc.unesco.org/images/0003/000327/032763eo.pdf. Last Accessed 22 Oct 2017
UNESCO (2015a) Not just hot air. Putting climate change education into practice http://unesdoc.unesco.org/images/0023/002330/233083e.pdf. Last accessed 11 Mar 2016
UNESCO (2015b) Road map for the implementation of the global action program on ESDhttp://unesdoc.unesco.org/images/0023/002305/230514e.pdf. Last accessed 4 Mar 2016
UNFCCC (1992) United Nations Framework Convention on Climate Change https://unfccc.int/resource/docs/convkp/conveng.pdf. Last accessed 22 Oct 2017
United Nations Climate Change Learning Partnership (2013) Integrating climate change in education at primary and secondary level http://www.uncclearn.org/sites/default/files/inventory/resource_guide_on_integrating_cc_in_education_primary_and_secondary_level.pdf. Last accessed 10 Mar 2016
Van Poeck K, Lysgaard J (2015) The roots and routes of environmental and sustainability education policy research. EER 22(3):305–318

Wals A, Geerling-Eijff F, Hubeek F, van der Kroon S, Vader J (2008) All mixed up? Instrumental and emancipatory learning toward a more sustainable world: considerations for EE policymakers. Appl Environ Educ Commun 7(3):55–65
Whitmarsh L, Lorenzoni I, O'Neill S (2012) Engaging the public with climate change: behaviour change and communication. Routledge, London
Wibeck V (2014) Enhancing learning communication and public engagement about climate change – some lessons from recent literature. EER 20(3):387–411

Author Biographies

Gina Lovett is an Amsterdam-based writer and communications professional currently working in the knowledge innovation community sector. Her work includes publications by Bloomsbury London and Guardian. Her research interests are climate governance and capacity building for sustainable development. She holds a Master of Science Human Geography (cum laude) from the University of Amsterdam.

Claire Lambert holds a Master of Science Human Geography from the University of Amsterdam. She is currently studying Masters in Sustainable Development and GIS at La Sorbonne, Paris.

Eric Chu is lecturer in Planning and Human Geography, University of Birmingham. His research focuses on the politics of governing climate change adaptation, resilience, and development in cities.

Joyeeta Gupta is Professor of Environment and Development in the Global South at the Amsterdam Institute for Social Science Research of the University of Amsterdam and UNESCO-IHE Institute for Water Education in Delft, Netherlands. Her research is on North-South geopolitics and the governance patterns of environment and development.

Climate Change and Renewable Energy: Opinions and Emotions of Elementary School Pupils in the Prefecture of Evros

Sideri Lefkeli, Georgios Tsantopoulos and Evangelos Manolas

1 Introduction

As a result of human activities after the industrial revolution our environment has become very fragile. The entire planet has been converted to a factory for the production of consumer goods for making profit. The result was the removal of man from the natural environment and the adoption by humans of competitive behavior which led to environmental degradation and climate change.

Climate change is one of the most serious contemporary problems of our planet. Efforts to reduce the impact of climate change are crucial. The consequences of rising global temperatures will be very serious for humans and the environment unless urgent action is taken everywhere to reduce emissions. Renewable energy is very important in mitigating global greenhouse gas emissions by radically lowering the emissions profile of the planet's energy system. In addition, beyond the use of renewable energy sources, the materialization of a sustainable energy future also requires citizen participation in decision making processes. The deepening of the environmental crisis strengthened the interest of governments, businesses and researchers for sustainable development. Sustainable development means giving man a prominent position, sets limits to market forces, ensures the democratic planning of production and demands revision of educational policy at national level as well as the redefinition of formal educational systems.

Today's schools must gradually change, with the ultimate aim being the opening of schools to society. It is necessary that today's schools must create pupils who will adopt environmentally responsible behavior, something which schools try to achieve through exploratory and experiential learning. In this framework of

S. Lefkeli · G. Tsantopoulos · E. Manolas (✉)
Department of Forestry and Management of the Environment and Natural Resources,
School of Agricultural and Forestry Sciences, Democritus University of Thrace,
193 Pantazidou Street, 68200 Orestiada, Greece
e-mail: emanolas@fmenr.duth.gr

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_15

exploratory and experiential learning, the pupils as direct participants, can engage with programs related to energy, take part in training trips and play an active role in organizing speeches, exhibitions and daily conferences. The above can be strengthened through cooperation of the school with Environmental Education Centers and local authorities.

Education for sustainability equips pupils with the necessary tools so that they can recognize that the roots of environmental problems are to be found in our way of life. This will be achieved with environmental education programs through which pupils can acquire the required for the protection of the environment knowledge, attitudes and values. Pupils can also acquire skills and formulate a new code of behavior based on an improved management of energy sources.

This chapter investigates opinions and emotions of 5th and 6th grade pupils in elementary education with regard to climate change and renewable forms of energy. 5th and 6th grade pupils have acquired the necessary knowledge and skills in order to respond effectively to the requirements of this research. The results of this research can constitute a valuable tool for educators, communicators and environmental policy makers.

1.1 Theoretical Background

When human interventions in the natural environment intensified and became irreversible the result was the degradation of the quality of life. The excessive consumerism which characterizes modern man created more serious environmental problems which, if they are to be solved, require communication between citizens and specialized scientists. It is important that citizens change the way they think so that they can both evaluate environmental issues and, if necessary, exercise pressure for the adoption and application of appropriate measures.

The means of mass communication are an inseparable part of the everyday life of both children and adults. The means of mass communication can reach large segments of the population while they simultaneously constitute the main source of information on environmental issues and as such they can influence the attitudes and views of citizens. A direct consequence is that they influence the view of citizens through the broadcasting of educational programs, through transmitting environmental information and through promoting discussions on environmental matters. Therefore, the role of the means of mass communication as far as informal environmental education is concerned is decisive because they contribute to the formation of environmental consciousness. This is especially true when information is transmitted in an appropriate manner so that the real dimensions of an issue are presented. In addition, there is the view that the means of mass communication contribute to the development of environmental education, form appropriate consumer behaviors and fill in the gaps of the formal educational system (Skanavis 2004a).

Education can contribute to the formulation of human behavior towards rational use of natural resources as well as alleviate existing environmental problems. According to Agenda 21 citizens and particularly pupils must be exposed to concepts and methods of sustainable development so that they can formulate environmental consciousness. It is important that pupils, tomorrow's citizens, understand the complexity of global problems and be taught the relevant knowledge and values (Lopez-Gorosave and Giron 2013).

It is important that environmental education starts at the level of elementary education since the necessary pre-requisites for strengthening the environmental consciousness of today's generation must be instilled at early age. It is important that schools promote the adoption of behavior towards an environmentally sustainable direction, seek to make pupils environmentally aware and contribute to pupils acquiring the necessary knowledge so that each pupil can build friendly attitudes towards the environment (Zsoka et al. 2013). Schools also constitute one of the most important components of contemporary social and political planning because global environmental problems can be combated only through the participation of people who have understood the causes of these matters and can engage in evaluation of possible solutions (Skanavis 2004b). Creighton (1983) views the public participation process as an adaptive process by which a broad range of values and world views may be reconciled. Based on the premise that "the purpose of public participation is to ensure consideration of the total range of values held by the public", he argues that public values constitute the most important information that a planner may receive.

The opening of the school to society promotes changes in the way of living and the formulation of active and responsible citizens (Kousoulas and Papazisi 2009). Environmental education practices promote the safeguarding of the right to life, human dignity and respect for the natural environment (Teixeira 2013). One of the goals of environmental education programs is the promotion of harmony in the relationship between man and nature. It is through this that the pupil/future citizen will review his views, attitudes and behavior (Frantz and Mayer 2014). Environmental programs usually use the project method through which the pupil has the chance to more effectively study the science of ecology, biology, physics and chemistry as well as get acquainted with environmental legislation and engage with the psychology of responsibility regarding the state of the environment (Derevenskaia 2014). Environmental education is closely linked to exploratory learning; it is close to the interests of pupils and makes them ambassadors of their family and wider social environment, conveying the message of sustainable development.

The school provides knowledge to pupils with regard to management of energy sources and climate change. With regard to the issue of energy, the pupils have formed mental representations through their experience in their physics course, the school program and everyday interaction. Also, the pupils learn about the phenomenon of climate change, have thoughts about the consequences of ecosystem degradation and worry whether or not their thoughts will come true. In addition, the school teaches pupils how to manage energy sources. The school may also function constructively as a means of communication and create responsible pupils—responsible consumers for tomorrow. Energy education can help pupils formulate objective views regarding the use of energy in his everyday life (DeWaters et al. 2013). Through activities on energy education pupils can re-evaluate their personal values, understand the good called energy and learn to use it the right way (Dias et al. 2006). It is important for schools to apply strategies which concern the provision of information to pupils on the seriousness of the issue as well as encourage the participation of pupils in activities on how to deal with the matter (Zerva and Tsantopoulos 2013).

It is also important that pupils receive information on the energy challenges of mankind, know the basic principles of conversion and use of energy and prepare themselves with regard to the application of strategies which emphasize the exploitation of renewable sources of energy (Kandpal and Broman 2014). It is necessary that the pupil/consumer of energy becomes aware of and adopt behavior compatible with the proper management of the natural environment (Ntona et al. 2015).

Although it is important that this generation of pupils is equipped with the necessary knowledge nevertheless, it must be noted that the transmission of knowledge is not sufficient for changing the behavior of pupils. In order for pupils to develop positive attitudes towards adopting such behavior they need to believe that the adoption of environmentally friendly behavior produces positive results. Participation in activities related to environmental protection is very important (de Leeuw et al. 2014). It is not accidental that pupils in Finland who participate in sustainability activities at school learn through such activities about energy saving and natural resource management (Uitto and Seppo 2010). For securing a healthy environment it is important to adopt a way of life which will be based on the reduction of energy consumption at home, energy saving with regard to transportation, the development of environmental programs at school, the provision of information on local and global environmental problems through newspapers, magazines and books. In particular, creating new products characterized by energy efficiency, the recycling of goods, lesser use of electricity and automobiles would certainly contribute to environmental protection (Manolas 2015).

2 Methodology

The research area of this project was defined to be the geographic limits of the Prefecture of Evros which belongs to the administrative region of Eastern Macedonia and Thrace. The Directorate of Elementary Education of the Prefecture of Evros supervises and co-operates with 162 school units (kindergartens and elementary schools). The Prefecture of Evros is made up of five municipalities, i.e. the Municipality of Alexandroupolis, the Municipality of Orestiada, the Municipality of Didymoteicho, the Municipality of Soufli and the Municipality of Samothrace. Every year, teachers, in co-operation with their pupils, design and realize various programs of pupil engagement. These programs, according to their topic are classified in three categories: cultural, health and environmental. The teacher of each class and the responsible official in the Directorate of Elementary Education are the persons responsible for the implementation of the above programs.

For the collection of data regarding the opinions and emotions of pupils a structured questionnaire was used because, for the purposes of this research, it was the most appropriate tool. The questionnaire used in the research was adjusted for children aged 11–12. It included questions related to renewable sources of energy, climate change, energy saving as well as the individual characteristics of pupils and their parents. In particular, the words used and type of questions used were selected and designed in such a way as to reduce the possibility of misinterpretation by the pupils. In addition, the questionnaire had closed type questions because this type of questions makes the codification of the questionnaire and the classification of answers. Questions were presented in sentences in affirmative form where the pupil was asked to declare if he agrees or disagrees with the content of the sentence, if what he read was right or wrong, and, generally, he was asked to judge the credibility of the content of the sentence by selecting one of the suggested alternative answers. The aim was to make it easier for the pupils to answer the questions, in a short time. Also, it must be noted that the completion of the questionnaire was done in such a way so that to secure the anonymity of the pupils-respondents. In addition, the researchers secured the written consent of the parents. The time required for the completion of the questionnaire was calculated to be 15–20 min for each school class.

In order to decide the number of schools and for purposes of sample data collection cluster sampling was used. The sample was comprised of seventeen (17) elementary schools of the Prefecture of Evros. Next, the total of pupils in each class was recorded and 632 questionnaires were completed by 5th and 6th grade pupils. For purposes of approval of this research the procedure followed was the one required by the Pedagogical Institute and the Greek Ministry of Education, Research and Religious Affairs. The collection of data was done the period May–June 2016. Regarding data processing we used descriptive statistics, Friedman's non-parametric test and factor analysis from the SPSS statistical programme (Siardos 1999; Freund and Wilson 2003; Ho 2006). Cronbach's α coefficient was used to identify the internal consistency of the questionnaire, i.e. whether the data have the tendency to measure the same fact. It expresses the squared correlation between the score (observed) that a person is assigned on the given scale and the score that they would have obtained (true) if they had been asked about all issues (Siardos 1999). Friedman's test was used to compare the values of three or more correlated groups of variables. The distribution of Friedman's test is a X^2 distribution with (df) df = k − 1 degrees of freedom, where k is the number of groups or samples. This test classifies the values of the variables for each subject separately and calculates the mean rank of the classification values for each variable. Factor analysis is a statistical method that aims to examine the existence of common factors within a group of variables. More specifically, principal component analysis was used here, which is based on the spectral analysis of the variance (correlation) matrix. The criterion used for the significance of the principal components was the one recommended by Guttman and Kaiser (Cattell 1978; Frangos 2004), according to which, the limit for obtaining the required number of principal components is defined by the eigenvalues which are equal to or greater than one. We concluded with a matrix rotation of the principal components using Kaiser's varimax rotation method (Harman 1976) for better results.

3 Results—Discussion

Regarding the contribution of renewable forms of energy to combating environmental problems (Table 1) almost nine in ten pupils think that it is important, with answers ranging from fairly to very much. In particular, 32.4% of the pupils think that the renewable forms of energy contribute fairly to combating environmental problems while the answers of 56.5% of the pupils range from much to very much. Pupils can promote energy saving by becoming "multipliers" for the wider society (Zografakis et al. 2008). In addition, proper management of the energy sources of a country contributes to the success of its energy policy (Gajibo 2016). However, a pre-requisite for the realization of such a goal is proper use of its renewable energy sources (Karatayev and Clarke 2016).

Next the Pearson's Chi-square Test for Independence was conducted with regard to whether or not renewable forms of energy contribute to combating environmental problems and whether or not this is differentiated in relation to school grade and gender. According to Table 2 the Pearson's Chi-square Test for Independence

Table 1 Contribution of renewable forms of energy to combating environmental problems (percentage %)

Not at all	A little	Fairly	Much	Very much
1.9	9.2	32.4	28.3	28.2

Table 2 Relations between school grade and the opinions of pupils regarding the contribution of renewable forms of energy to combating environmental problems

	School grade			
	5th grade		6th grade	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Not at all	9	2.6	3	1.0
A little	20	5.8	38	13.3
Fairly	99	28.6	106	37.1
Much	120	34.7	59	20.6
Very much	98	28.3	80	28.0
Total	346	100.00	286	100.00

Chi-Square = 25.971, df = 4, p = 0.000 (p < 0.005)

Table 3 Relations between gender and opinions of pupils with regard to the contribution of renewable forms of energy to combating environmental problems

	Gender			
	Male		Female	
	Frequency	Percentage (%)	Frequency	Percentage (%)
Not at all	10	2.8	2	0.7
A little	27	7.7	31	11.1
Fairly	108	30.7	97	34.6
Much	92	26.1	87	31.1
Very much	115	32.7	63	22.5
Total	352	100.00	280	100.00

Chi-Square = 16.503, df = 4, $p = 0.003$ ($p < 0.005$)

Table 4 Emotions about climate change (Percentage %)

	Not at all	Rarely	Sometimes	Usually	Always
Fear	23.3	27.2	27.2	15.0	7.3
Concern	14.7	25.0	29.3	17.7	13.3
Optimism	33.7	17.1	19.6	17.1	12.5
Anxiety	25.3	24.4	24.8	14.4	11.1
Anger	38.0	22.6	17.2	12.2	10.0
Indifference	47.0	20.3	13.3	11.1	8.4

showed that there is dependence between school grade and the answers of pupils on the variable "Contribution of renewable forms of energy to combating environmental problems".

In particular, 5th grade pupils have a more positive opinion with regard to the above question than 6th grade pupils who appear cautious. Also, according to Table 3 the Pearson's Chi-square Test for Independence showed that there is dependence between gender and the answers given by pupils with regard to the variable "Contribution of renewable forms of energy to combating environmental problems". In particular, boys as opposed to girls, think that renewable forms of energy contribute more to combating environmental problems. The teaching of physical sciences in elementary schools is done in a spiraling manner while the development of the material taught is moving from the particular to the general, from simple to complex and from easy to difficult. In the 5th grade the teaching of concepts in Physics is based on the previous knowledge of students, knowledge which they have obtained from the course Study of the Environment. 5th grade pupils have formed their view on the significance of renewable sources of energy with regard to solving environmental problems, something which is especially true for boys. Studies have shown that boys excel in scientific subjects while girls do so in theoretical subjects (Dimaki et al. 2008).

Table 4 shows the emotions of pupils with regard to the issue of climate change. In particular 47% of the pupils do not at all feel indifference and 20% rarely feels indifference for this matter. Almost one in three pupils (31%) usually or always expresses his concern for the effects of climate change. In parallel, 33.7% of the pupils do not at all feel optimism for climate change, while, at the same time, 25.5% of the pupils usually or always express their anxiety on the various dimensions of climate change. Almost one in two pupils, at least sometimes, feels fear or anger with regard to the effects of climate change. The program of studies regarding physical sciences and the content of environmental education programs are oriented on the management of the natural environment and on how to address environmental problems. Elementary school pupils know about the phenomenon of climate change and its consequences from their experiences in the school program and everyday interaction. Children, in this age are very sensitive on issues related to the management of the natural environment (Karatepe et al. 2012).

In order to investigate if there is a statistical difference between the opinions of pupils with regard climate change, Friedman's statistical test was applied (Table 5). According to the results of the above mentioned test, pupils are interested on the effects of climate change with mean rank 4.78. Next the emotions expressed are concern with mean rank 3.68 and anxiety with mean rank 3.28. In the fourth position of the sequence is optimism with mean rank 3.25, in the fifth position fear with mean rank 3.15 and in the sixth position anger with mean rank 2.87.

In the above multidisciplinary variable, the a-Cronbach co-efficient was 0.647 and all necessary checks were conducted before the application of factor analysis. In particular, the value of the Keiser-Meyer-Olkin indicator is 0.846. Although it is suggested that the Keiser-Meyer-Olkin must be greater than 0.80, nevertheless, values greater than 0.60 are acceptable (Sharma 1996). Also, Bartlett's test of sphericity rejects the null hypothesis (Chi-Square = 408,683 df = 15 $p < 0.001$).

In Table 6, the burdens given are partial correlation co-efficients of the six variables with each of the two factors which were extracted from the analysis before and after rotation. The bigger the burden of a variable in a factor, the more this factor is responsible for the total variance of degrees in the variable we consider. The variables which "belong" to each factor are those for which the burden (columns 1 and 2) is near or/and greater than 0.5. From the application of factor analysis on the case of emotions with regard to climate change two factors were extracted (Table 6). In the first factor belong the "positive emotions" with the variables comprising this factor being concern, fear, interest. In the second factor belong the

Table 5 An application Friedman's test regarding the emotions of pupils about climate change

	Mean rank
Fear	3.15
Concern	3.68
Optimism	3.25
Anxiety	3.28
Anger	2.87
Interest	4.78

N = 632, Chi-Square = 186.957, df = 5, Asymp. Sig < 0.000

Table 6 Factor burdens, after rotation, with regard to emotions about climate change

Emotions	After rotation	
	PC1	PC2
Concern	0.824	−0.013
Fear	0.760	0.224
Interest	0.515	0.103
Optimism	0.451	−0.679
Anger	0.270	0.630
Anxiety	0.407	0.582

Table 7 Significance of developing technologies for the production of electric energy in the future (percentage %)

	Not at all	A little	Fairly	Much	Very much
Wind energy	8.1	14.6	25.2	19.5	32.8
Solar energy	3.8	9.5	18.7	27.1	41.0
Geothermal energy	6.2	14.9	20.4	24.5	34.0
Hydroelectric energy	6.8	13.8	21.2	28.3	29.9
Biomass energy	15.3	21.5	27.1	17.9	18.2
Nuclear energy	33.2	23.9	19.3	14.6	9.0
Burning lignite	32.9	26.3	22.5	10.3	8.1
Burning coal	31.3	29.6	20.4	10.4	8.2
Burning oil	26.7	31.8	21.5	9.2	10.8
Burning natural gas	20.3	30.2	20.7	13.6	15.2

"negative emotions" with the variables comprising this factor being pessimism, anger and anxiety. If one takes into account that climate change has serious consequences on peoples' health, then, the reaction of the majority of pupils is expected (Vardoulakis et al. 2015). According to Mandler's (1984) conflict theory, emotions stem from discrepancies between desired and actual values. This is consistent with Lazarus' (1991) idea that emotion derives from goal achievement and goal frustration. The pupils through their studies and everyday interaction have acquired the necessary knowledge on the consequences of climate change. Decisive role for the formation of this attitude play the stimuli pupils receive from their immediate and wider environment. In particular, the above view is strengthened by pupil participation in environmental programs, the teaching of the relevant material and attendance of educational programs by the means of mass communication.

Table 7 shows the significance of developing technologies for the production of electric energy from sources of energy which are not harmful to the natural environment.

In particular, 68.1% of the pupils think that solar energy is either much or very much an important form of energy. 58.5% think the same way for geothermal energy. Almost six in ten pupils (58.2%) support the idea that hydroelectric energy is the most suitable form of energy. Also, according to almost five in ten pupils (52.3%), the most suitable form of energy is wind energy. Also, 36.1% of the pupils think that biomass energy is either much or very much an important form of energy, while 57.1% think that nuclear energy is either a little or not at all important for the development of electric energy in the future. Almost two out of ten pupils think the forms of energy which can help considerably in the production of electric energy are lignite (22.5%), coal (20.4%), oil (21.5%) and natural gas (20.7%).

In order to investigate if there is a statistical difference between the opinions of pupils regarding the significance of developing technologies for the production of electric energy, Friedman's test was applied (Table 8). According to the results of the above test, it was found that solar energy is of primary importance for the production of electric energy with mean rank 7.43. Next, in the second position, comes geothermal energy with mean rank 6.85, and in the third place, hydroelectric energy with mean rank 6.73. In the fourth position is wind energy with mean rank 6.61, in the fifth place biomass energy with mean rank 5.56 and in the sixth place natural gas with mean rank 4.87. Next come oil with mean rank 4.41, coal with mean rank 4.14 and lignite with mean rank 4.12. The program of studies regarding physical sciences is focused on the teaching of solar, hydroelectric and wind energy with the exception of 6th grade physics where reference is made for the first time on oil, coal and natural gas. Because of the above it is expected that the pupils have understood the significance of solar, hydroelectric and wind energy.

In the multidisciplinary variable, "Significance of developing technologies for the production of electric energy", the a-Cronbach co-efficient was 0.802 and before the application of factor analysis all the necessary tests were carried out. In particular, the value of the Keiser-Meyer-Olkin indicator is 0.807. Although it is suggested that the Keiser-Meyer-Olkin indicator must be greater than 0.80, nevertheless, values greater than 0.60 are acceptable (Sharma 1996). Also, Bartlett's test of sphericity rejects the null hypothesis (Chi-Square = 2.703,637, df = 45 $p < 0.001$). In Table 9, the burdens given are partial correlation co-efficients of the ten variables with each of the two factors extracted from the analysis before and after rotation.

Table 8 Application of Friedman's test regarding the significance of developing technologies for the production of electric energy

	Mean rank
Wind energy	6.61
Solar energy	7.43
Geothermal energy	6.85
Hydroelectric energy	6.73
Biomass energy	5.56
Nuclear energy	4.28
Burning lignite	4.12
Burning coal	4.14
Burning oil	4.41
Burning natural gas	4.87

N = 632, Chi-Square = 1.354,916, df = 9, Asymp. Sig < 0.000

Table 9 Factor burdens, after rotation, with regard to the significance of developing technologies for the production of electric energy

Technologies for the production of electric energy	After rotation	
	PC1	PC2
Burning coal	0.893	−0.024
Burning lignite	0.862	0.046
Burning oil	0.852	−0.062
Nuclear energy	0.737	0.233
Burning natural gas	0.580	0.181
Geothermal energy	0.085	0.810
Solar energy	−0.045	0.804
Wind energy	0.015	0.759
Hydroelectric energy	0.147	0.714
Biomass energy	0.413	0.562

From the application of factor analysis regarding the significance of developing technologies for the production of electric energy two factors were extracted (Table 9). In the first factor belong the variables burning coal, burning lignite, burning oil, nuclear energy, burning natural gas. In the second factor belong the variables geothermal energy, solar energy, wind energy, hydroelectric energy, and biomass energy. The research shows that, pupils as a result of courses taught in the elementary school, have understood the differences between renewable and non-renewable forms of energy (Kalkanis 1997). What needs to be pointed out is the misunderstanding or rejection by pupils of nuclear energy as a result of its classification as a non-renewable form of energy, something which may be due to danger for a nuclear accident.

4 Conclusions

This chapter studied the opinions and emotions of 5th and 6th grade pupils of 17 elementary schools in the Prefecture of Evros with regard to climate change and renewable forms of energy. For the completion of this research we used a semi structured questionnaire with closed questions. The number of school units was selected according to cluster sampling and this was to constitute the sample of the population under investigation.

The evaluation of the data of this research led to conclusions which if used could contribute to supporting environmental education efforts. In particular, with regard to the contribution of renewable forms of energy to combating environmental problems, the pupils think that these are very important for the protection of the natural environment. This positive attitude of the pupils makes the work of both teachers and administrators easier. However, in order to produce results during the planning stage both gender and age should be taken into account. In particular, boys, as opposed to girls, think that renewable forms of energy play a key role in combating environmental problems. Also, 5th grade pupils, as opposed to 6th grade pupils, think that renewable forms of energy are very important for the protection of the natural environment.

With regard to the significance of developing technologies for the production of a country's electric energy, the majority of pupils think that the most suitable forms of renewable energy are solar, geothermal, hydroelectric, and wind energy. The variables nuclear energy, biomass, lignite, coal, natural gas and oil occupy the second position. In the first factor belong the variables burning coal, burning lignite, burning oil, nuclear energy and burning natural gas. In the second factor belong the variables geothermal, solar, wind, hydroelectric and biomass energy.

The investigation with regard to emotions about climate change showed that pupils do not at all or rarely feel indifference about this matter. Almost one in three pupils usually or always expresses his/her concern about the impacts of climate change, does not feel optimism about the issue, but usually or always expresses his anxiety about the various dimensions of the phenomenon. In addition, almost one in two pupils feels fear or anger for the consequences of the situation. Also, from the research both "positive" and "negative" emotions were extracted.

During the research every effort was made in order for the results to be credible and justified. Despite the existence of various, mainly exogenous, factors, we think that the above goals were achieved to a satisfactory degree. A problem that comes to mind may be that primary data are affected by the subjectivity of the answers given by pupils. However, it should be mentioned that the large number of the sample limits the subjectivity which might be hidden in the results and conclusions of the research. However, taking into account the time provided to us by the school headmasters, we think that the conclusions we reached are adequately objective but they represent the geographical area this research was carried out in.

References

Cattell RB (1978) The scientific use of factor analysis in behavioral and life sciences. Plenum, New York

Creighton JL (1983) The use of values: public participation in the planning process. In: Daneke GA, Garcia MW, Delli Priscolli J (eds) Public involvement and social impact assessment. Westview Press, Boulder, pp 143–160

de Leeuw A, Valois P, Seixas R (2014) Understanding high school students attitude, social norm, perceived control and beliefs to develop educational interventions on sustainable development. Procedia Soc Behav Sci 143:1200–1209

Derevenskaia O (2014) Active learning methods in environmental education of students. Procedia Soc Behav Sci 131:101–104

DeWaters J, Qaqish B, Graham M, Powers S (2013) Designing an energy literacy questionnaire for middle and high school youth. J Environ Educ 44(1):56–78

Dias AR, Mattos CR, Balestieri JAP (2006) The limits of human development and the use of energy and natural resources. Energ Policy 34(9):1026–1031

Dimaki A, Chaitopoulou I, Papapanou I, Ravanis K (2008) Gender and the teaching of physical sciences: a qualitative analysis of the perceptions of future kindergarten teachers. In: Koumaras P, Seroglou F (eds) Proceedings of the 4th national conference of the Union for the teaching of physical sciences. Christodoulidis Publications, Thessaloniki, pp 514–523

Frangos CK (2004) Methodology of market research and data analysis with the use of the statistical package SPSS for windows. Interbooks Publications, Athens

Frantz CM, Mayer CM (2014) The importance of connection to nature in assessing environmental education programs. Stud Educ Eval 41:85–89

Freund R, Wilson W (2003) Statistical methods. Elsevier, New York

Gajibo IA (2016) Developing a framework for generation of energy from waste through anaerobic digestion in Nigeria: case study—Abuja. University of Abertay Dundee

Harman HH (1976) Modern factor analysis. The University of Chicago Press, Chicago

Ho R (2006) Handbook of univariate and multivariate data analysis and interpretation with SPSS. Chapman & Hall, Florida

Kalkanis G (1997) Energy and its sources, vol II. Centre for Renewable Sources of Energy, Department of Development, General Secretariat for Research and Technology "Open Doors", Athens

Kandpal TC, Broman L (2014) Renewable energy education: a global status review. Renew Sust Energ Rev 34:300–324

Karatayev M, Clarke ML (2016) A review of current energy systems and green energy potential in Kazakhstan. Renew Sust Energ Rev 55:491–504

Karatepe Y, Nese SV, Kecebas A, Yumurtaci M (2012) The levels of awareness about the renewable energy sources of university students in Turkey. Renew Energ 44

Kousoulas G, Papazisi C (2009) The journey goes on … From environmental education for the environment and sustainability. Directorate of Secondary Education of Athens B region. Thita Publications, Athens

Lazarus RS (1991) Emotion and adaptation. Oxford University Press, New York, pp 174–179

Lopez-Gorosave G, Giron MH (2013) Leading environmental education in elementary schools: the case of "La Esperanza" School. In: Slater CL, Nelson SW (ed) Understanding the principalship: an international guide to principal preparation chapter 12 (Advances in educational administration, volume 19). Emerald Group Publishing Limited, pp 269–289

Mandler G (1984) Mind and body: psychology of emotion and stress. Norton, New York

Manolas E (2015) Climate change: challenges for the 210 century. Vol 7: climate change: interdisciplinary approaches. Themes in Forestry and Management of the Environment and Natural Resources, pp 161–168

Ntona E, Arabatzis G, Kyriakopoulos G (2015) Energy saving: views and attitudes of students in secondary education. Renew Sustain Energy Rev 46:1–15

Sharma S (1996) Applied multivariate techniques. Wiley, New York

Siardos G (1999) Multivariate statistical analysis methods. Part I: exploring the relations among variables. Zitis Publications, Thessaloniki

Skanavis C (2004a) Environment and society: a relationship in continuous progress. Kalidoskopio, Athens

Skanavis C (2004b) Environment and communication: having the right to choose. Kalidoskopio, Athens

Teixeira SR (2013) The environmental education as a path for global sustainability. Procedia Soc Behav Sci 106: 2769–2774

Uitto A, Seppo S (2010) The relationship between secondary school students environmental and human values, attitudes, interests and motivations. Procedia Soc Behav Sci 9:1866–1872

Vardoulakis S, Dimitropoulou C, Thornes J, Ka-Man L, Taylor J, Isabella M, Heaviside C, Mavrogianni A, Shrubsole C, Chalabi Z, Davies M, Wilkinson P (2015) Impact of climate change on the domestic indoor environment and associated health risks in the UK. Environ Int 85:299–313

Zerva A, Tsantopoulos G (2013) Public opinion on climate change in international and local scale. In: Manolas EI, Protopapadakis ED, Tsantopoulos GE (eds) Vol 5: international environmental politics: encounters with the future. Themes in Forestry and Management of the Environment and Natural Resources, pp 75–89

Zografakis N, Menegaki A, Tsagarakis K (2008) Effective education for energy efficiency. Energ Policy 36(8):3226–3232

Zsoka A, Szerenyi Z, Szechy A, Kocsis T (2013) Greening due to environmental education? Environmental knowledge, attitudes, consumer behavior and everyday pro-environmental activities of Hungarian high school and university students. J Clean Prod 48:126–138

Author Biographies

Sideri Lefkeli is a graduate of the Department of Primary Level Education of Democritus University of Thrace. Since 2002 she works as a teacher in primary schools. She has recently received a Master of Science degree in Sustainable Management of Environment and Natural Resources from the Department of Forestry and Management of the Environment and Natural Resources of Democritus University of Thrace.

Georgios Tsantopoulos has received an undergraduate degree in Forestry and Natural Environment from the Aristotle University of Thessaloniki (1995) and a Philosophy Doctorate also from the Aristotle University of Thessaloniki (2000). He is Associate Professor in the Department of Forestry and Management of the Environment and Natural Resources at the Democritus University of Thrace.

Evangelos Manolas was born in Naxos, Greece, in 1961. He has received a Bachelor of Arts in Sociology from the University of Essex (1983), a Master of Arts in International Relations from the University of Kent at Canterbury (1985) and a Philosophy Doctorate from the University of Aberdeen (1989). He is Associate Professor in the Department of Forestry and Management of the Environment and Natural Resources at the Democritus University of Thrace.

Incorporation of Local Ecological Knowledge (LEK) into Biodiversity Management and Climate Change Variability Scenarios for Threatened Fish Species and Fishing Communities—Communication Patterns Among BioResources Users as a Prerequisite for Co-management: A Case Study of Berlenga MNR, Portugal and Resex-Mar of Arraial do Cabo, RJ, Brazil

Heitor de Oliveira Braga, Miguel Ângelo Pardal and Ulisses M. Azeiteiro

1 Introduction

With the current increasing exploitation of the world's oceans (Gaines et al. 2010), marine reserves have emerged as an essential tool for the management of the marine ecosystem (Worm et al. 2006). Most marine protected areas (MPAs) are located in high biodiversity sites, and fishing appears to be the main threat in most of these

H. O. Braga (✉) · M. Â. Pardal
Centre for Functional Ecology—CFE, Department of Life Sciences, University of Coimbra, Calçada Martins de Freitas, 3000-456 Coimbra, Portugal
e-mail: heitorob@gmail.com

M. Â. Pardal
e-mail: mpardal@uc.pt

H. O. Braga
CAPES Foundation, Ministry of Education of Brazil, Caixa Postal 250, DF 70040-020 Brasília, Brazil

U. M. Azeiteiro
Department of Biology and CESAM—Centre for Environmental and Marine Studies, University of Aveiro, 3810-193 Aveiro, Portugal
e-mail: ulisses@ua.pt

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_16

marine protected areas (Gaines et al. 2010). Thus, development of MPAs is closely related to artisanal fisheries, cultural factors, survival and livelihood of coastal communities (Diegues 2008). As there is no sufficient knowledge on the capacity of marine organisms to adapt to the current changes in the marine environment (Munday et al. 2013), it is increasingly important to recognize humans as one component of the ecosystem to better understand ecological change (Yáñez-Arancibia et al. 2013).

The incorporation of both the ecological and human dimensions into conservation plans can be beneficial for management models focused on conservation of biodiversity (Novacek and Cleland 2001) and facing climate change variability. Biocultural approaches in conservation studies, management and governance (also climate governance) are an alternative and fully effective approach to addressing the accelerated loss of biological and cultural diversity (Gavin et al. 2015).

In this context, local ecological knowledge (LEK) appears as a conservation tool that can generate data to test new hypotheses and thus contribute to a more sensitive, culturally relevant research approach (Drew 2005) and communication interface. The detection of environmental changes, the development of strategies to adapt to these changes, and the implementation of sustainable management principles are all important climate action items that can be informed by LEK (Viegas et al. 2016). LEK can contribute valuable ecological information when properly acquired and may be useful for evaluating most vulnerable ecosystems and long-term environmental change (Beaudreau and Levin 2014).

Portuguese artisanal fisheries face difficulties due to European Union legislation despite the social importance, wide-spread locations and source of livelihood for coastal communities of these fisheries (Santos et al. 2012; Viegas et al. 2016). Their low economic profitability and the lack of manpower puts the permanence of artisanal fishing activities at risk in many places (Santos et al. 2012; Viegas et al. 2016). In Brazil, solutions to conservation issues are often confused by rapid economic growth and political decisions; the resulting management decisions may threaten global tropical biodiversity (Pelicice et al. 2014).

Due to commonly observed abrupt nonlinear changes in the marine ecosystem (Rocha et al. 2015), studies on artisanal fisheries in Portugal and Brazil using LEK data can be extremely important for more sustainable management of fisheries resources and the maintenance of traditional fishing practices in both areas. Thus, the general objective of this study is to briefly characterize the biology and ecology of the main species of threatened small fish fauna in two marine protected areas located in different hemispheres (The Berlenga Marine Natural Reserve (MNR), Peniche, Portugal and the Marine Extractive Reserve (Resex-Mar) of Arraial do Cabo—Rio de Janeiro, Brazil). To address this goal, this work emphasizes the positive aspects of the use of ethnobiology tools in fisheries and biodiversity management scenarios using fishers' local ecological knowledge, and propose that this line of research can be used to assist in the perception of climate change (Viegas et al. 2016) through of ethnoecological studies. Climate change perceptions in the Peniche fishing community started with Santos et al. (2012) and Viegas et al. (2016). This follow up study about LEK and Climate Change Communication continues the already started Building resilience for adaptation to climate change in the fisheries. Climate researchers must improve their ability to explain uncertainties and risks (Ward 2010) in this changing climate where knowledge is continuously evolving and particularly within the most vulnerable when it comes to preparing for adapting to change in resource-dependent communities (Cinner et al. 2015) (e.g. marine bioresources and fisheries coastal communities) that are particularly at risk from the impacts of a changing climate (Islam et al. 2014).

2 Methodology

2.1 Study Area

2.1.1 Study Area the Resex-Mar of Arraial do Cabo and Berlenga MNR

The Resex-Mar of Arraial do Cabo was created on January 3, 1997 by Presidential Decree. According to the National System of Conservation created by Law No. 9.985/2000, this marine reserve is one of the Brazilian Conservation Unit modalities (ICMBio 2015). Resex-MAR is included in Category IV (i.e., protected area with sustainable use of natural resources) according to the IUCN Protected Areas Categories System.

Resex-MAR is located in the municipality of Arraial do Cabo (Fig. 1), Cabo Frio region, Rio de Janeiro, Brazil (23°00′ S, 42°00′ W) and lies within the Marine Biome in the South Atlantic system three nautical miles from shore, with an area of 56.769 ha (ICMBio 2015).

According to Koppen’s classification, the region of Cabo Frio and Arraial do Cabo has a dry climate BSh (low latitude steppe). The average annual temperature is 25 °C, with precipitation that can reach 800 mm/year. Due to upwelling of cold water along the coastline, the climate is semi-arid, with reduced local precipitation (Scheel-Ybert 2000). This marine reserve is located in one of the most attractive regions of the Brazilian coast and supports tourism and local recreational activities (Pereira et al. 2008).

The Berlenga MNR (39°24′ N, 9°, 30 W) is located in the Northern Atlantic system in Portugal (Fig. 2) to the east of Cabo Carvoeiro on the Iberian Peninsula. This Marine Nature Reserve (MNR) was designated as a Nature Reserve in 1981 and is considered Category Ia: Strict Nature Reserve, according to the IUCN Protected Areas Categories System.

The MNR consists of a large island (Berlenga Grande) and adjacent reefs (Estela, Farilhões and some rocks) located 10 km west from mainland Portugal of the Peniche coast (Pardal and Azeiteiro 2001; Radhouani et al. 2010). Berlenga Grande is a granite boulder with a field of seventy-eight hectares, reaching a height of eighty-eight meters and a maximum length of fifteen hundred meters (Santos

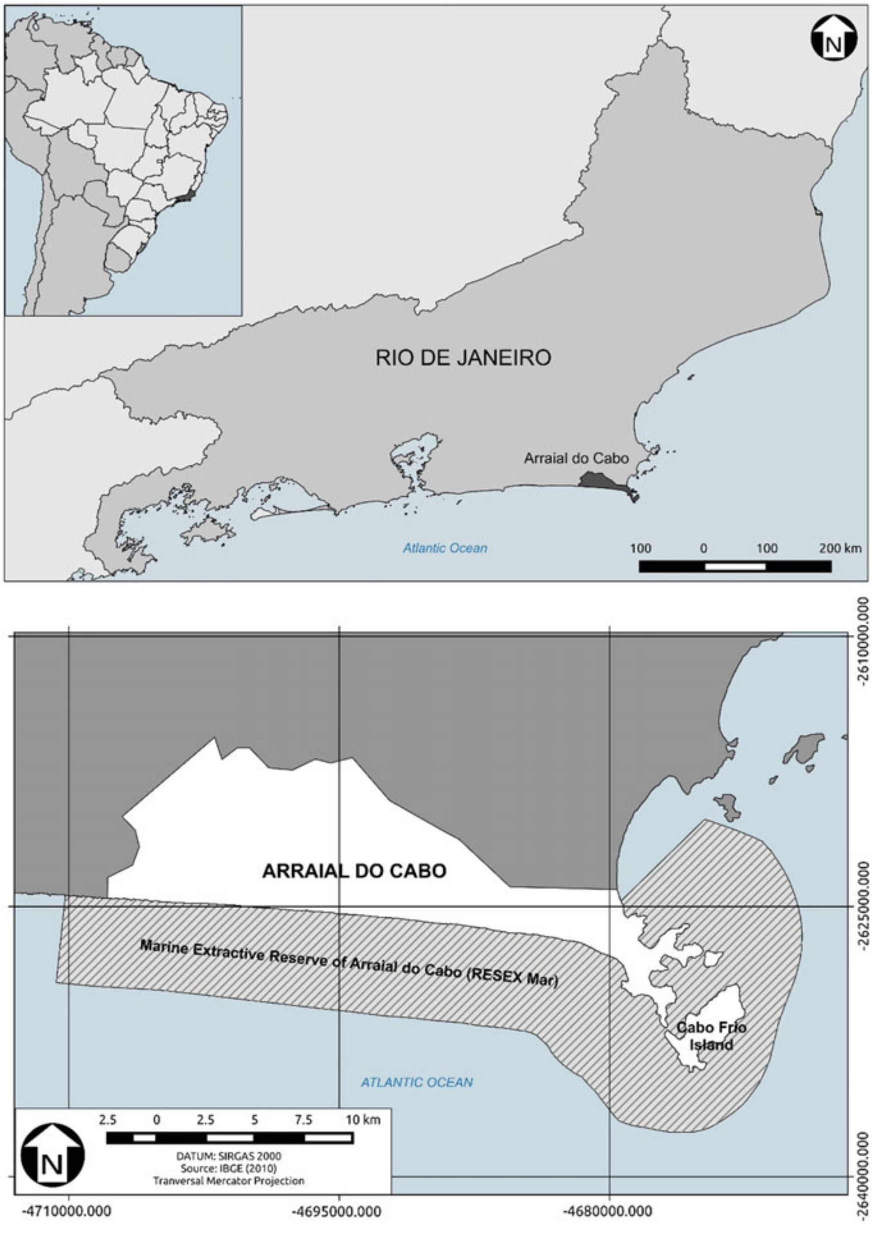


Fig. 1 Location of the city of Arraial do Cabo and the Marine Extractive Reserve of Arraial do Cabo, State of Rio de Janeiro, Brazil

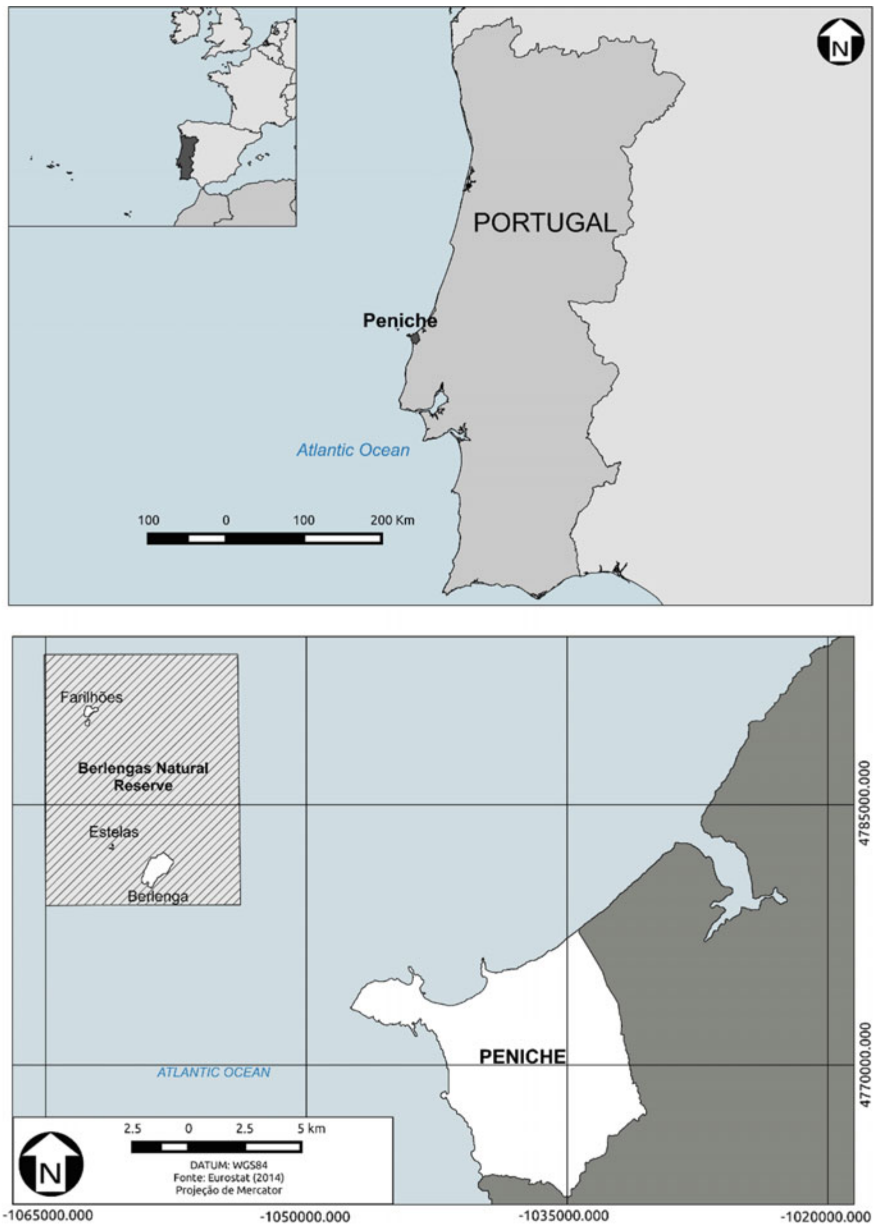


Fig. 2 Location of the city of Peniche and the Marine Nature Reserve of Berlengas, Peniche, Portugal

et al. 2011). The distinct climatic conditions present make the zone an important area for biological studies (Pardal and Azeiteiro 2001).

The self-preservation and sustainable use of renewable natural resources traditionally used by the fishing communities in the region (i.e., Arraial do Cabo, Brazil and Peniche, Portugal) are the main goals of both marine reserves.

2.1.2 Upwelling Events and Biodiversity in Both Marine Protected Areas (MPAs)

Upwelling events are extremely important for maintaining the high biodiversity and productivity of marine areas. In an upwelling event, deep water enriched by nutrients moves upwards with the help of the winds. These nutrients on the sea surface contribute to the expansion of fish populations in conjunction with the development of plankton communities (Godoy et al. 2013).

The Brazilian Southwest Atlantic is notable for its remarkable tropical and subtropical features, with a considerable amount of endemism (Mckenna and Allen 2002). An upwelling system located in the Brazilian Exclusive Economic Zone (EEZ), influences the external conditions (climatic and oceanographic) of the region, with important implications for local biodiversity (Amaral and Jablonski 2005). Upwelling events are most intense in the Cabo Frio region (State of Rio de Janeiro), primarily due to the northeasterly (NE) winds that are more frequent in austral spring and summer (Godoy et al. 2013). The annual variation in upwelling observed in Cabo Frio has been associated with the El Niño/La Niña system, and the magnitude of the upwelling is influenced by coastline geomorphology and ocean bottom topography (Rodrigues and Lorenzzetti 2001). The occasional occurrence of upwelling in this region contributes to increased local productivity (Amaral and Jablonski 2005). Indeed, the State of Rio de Janeiro stands out for its diversity of flora and fauna within the Brazilian subtropical waters (Monteiro-Neto et al. 2013), and the Resex-Mar of Arraial do Cabo is an area of great faunal abundance, primarily due to the occurrence of the intense marine upwelling along this coast (Da Silva 2004).

The Berlenga MNR is located in the upper portion of the southern slope of the Nazaré Submarine Canyon. Submarine canyons are considered key structures for ecosystem functioning (Würtz 2012) and are associated with enriched productivity (Vetter and Dayton 1998; Vetter et al. 2010). It is assumed that physical processes present around submarine canyons have the potential to influence the permanence of marine organisms in this habitat (Bosley et al. 2004).

Nazaré Canyon is recognized as one of the largest and deepest submarine canyons in the world (Curdia et al. 2004). Upwelling occurs there primarily between April and September (Haynes et al. 1993) and has contributed to the maintenance of fish stocks on the west coast of the Iberian Peninsula (Loureiro et al. 2005). Along the west coast of Portugal, upwelling is governed by equatorward winds, which influence oceanographic conditions in the summer (Oliveira et al. 2009). Upwelling conditions off the Portuguese coast are more persistent and active during the summer, which contributes to the high productivity of phytoplankton and zooplankton.

2.2 Literature Review

An exhaustive search of articles in the B-on database (http://www.b-on.pt/) was performed to gather information on the target species for most artisanal fisheries in the Resex-Mar of Arraial do Cabo and the Berlenga MNR, and threatened species by the consequences of climate change in the Atlantic Ocean. We focused on a subset of papers discussing the importance of fisher's local ecological knowledge (LEK) for resources fisheries and LEK used for management of marine protected areas in Brazil and Portugal; we also used a brief review of ethnobiology studies of artisanal fisheries in Portugal.

3 Results and Discussion

3.1 Artisanal Fisheries in Both Marine Protected Areas (MPAs)

According to Azevedo (2004), in the Resex-Mar of Arraial do Cabo, there are 82 species of pelagic organisms, including 65 species of Actinopterygii, 12 species of Condrichthyes and 5 species of invertebrates (crustaceans and mollusks). The most representative fish species are as follows: bluefish (*Pomatomus saltatrix*), largehead hairtail (*Trichiurus lepturus*), little tunny (*Euthynnus alletteratus*), chub mackerel (*Scomber japonicus*), horse-eye jack (*Caranx latus*), common dolphinfish (*Coryphaena hippurus*) and Brazilian sardine (*Sardinella brasiliensis*). These fish comprise a considerable portion of the fishery production in the Cabo Frio region (Azevedo 2004; Coelho-Souza et al. 2012). *S. brasiliensis* is historically the most landed teleost in Arraial do Cabo, accounting for approximately 14% of all marine fish fisheries extractions in Brazil (ICMBio 2010). In addition, *Mycteroperca acutirostris* (comb grouper) is one of the groupers most commonly fished in Arraial do Cabo (Floeter et al. 2006). Bender et al. (2014) identified a sharp decline in abundance of *Pomatomus saltatri*x, the groupers *Epinephelus marginatus*, *Mycteroperca acutiros*tris, *M. bonaci* and *M. microlepis*, and large parrotfishes (mainly S*carus trispinosus*) over the last six decades.

The following paragraphs describe the fish species considered to exhibit the greatest decline in abundance in local artisanal fisheries (Bender et al. 2014) and other species that are important for local fisheries in the study area (Azevedo 2004; ICMBio 2010; Coelho-Souza et al. 2012).

The comb grouper, (*Mycteroperca acutirostris* Valenciennes, 1828), from the Serranidae family, has a distribution within the Western Atlantic from Bermuda and the Gulf of Mexico to southern Brazil in shallower waters (Heemstra et al. 2003). This species is called Badejo mira or Miracelo locally (Bertoncini et al. 2008a; IUCN 2016). *M. acutirostris* is not in significant decline and is listed as Least Concern (LC) in the IUCN Red List Category and Criteria (Bertoncini et al. 2008a; IUCN 2016). However, the species suffers from heavy fishing pressures in some areas (Floeter et al. 2006).

The Brazilian sardine, (*Sardinella brasiliensis* Steindachner, 1879) is a marine species belonging to the Clupeidae family and is of great importance to the Brazilian fishing fleet (Baloi et al. 2014). This species is typical of the western Atlantic (Gulf of Mexico, Caribbean, West Indies southward, north of Uruguay and Brazil) (Whitehead et al. 1985). Paiva and Falcão (2002) note that this species is endemic to the Brazilian coast and is geographically isolated from other species of this genus in the Atlantic Ocean. In Brazil, *S. brasiliensis* is found mainly in the south and southeast of the country, specifically between Cabo de São Tomé - Rio de Janeiro State (22° S) and Cabo de Santa Marta—Santa Catarina State (29° S) (Jablonski 2007). Large variations were observed in catches of *S. brasiliensis* in recent decades (Cergole and Dias-Neto 2011; Dias et al. 2014). Landings in Rio de Janeiro, Santos (São Paulo State) and Itajaí (Santa Catarina State) showed a downward trend in 2000, which was possibly linked to overfishing, fluctuations in reproduction and spawning habitat changes (Soares et al. 2011). The sharp decline in production in 2010 may be a warning to managers and co-management fisheries of the possibility of a new downward cycle in production in Brazil (Dias-Neto et al. 2011). This taxon has not yet been assessed for the IUCN Red List (IUCN 2016).

The marine bluefish, (*Pomatomus saltatrix* Linnaeus, 1766) is a cosmopolitan coastal pelagic fish of the family Pomatomidae that is widely distributed along the continental shelf in temperate and warm Atlantic waters (Juanes et al. 1996). Estuaries are extremely important for this species. These fish are targeted for both commercial and recreational purposes, including in a artisanal fisheries (Ceyhan et al. 2007), and populations have fluctuated in abundance (Candelmo et al. 2010). The marine bluefish is listed as Least Concern (LC) in the IUCN Red List Category and Criteria (Bizsel et al. 2011; IUCN 2016).

The dusky grouper (*Epinephelus marginatus* Lowe, 1834) is a well-known teleost fish of the family Serranidae that is widely distributed in tropical and temperate seas (Heemstra and Randall 1993; Marino et al. 2001). It is found along the southeast coast of Brazil in tropical and subtropical waters, with the Cabo Frio upwelling presenting a zoogeographical divisor (Paiva and Andrade-Tubino 1998). Overexploitation is considered the main threat to populations of this reef-associated species (Echwikhi et al. 2015). Bender et al. (2014) described the downward trend in abundance of this species in the subtropical reefs of Arraial do Cabo, Rio de Janeiro. Along the southern and southeastern coast of Brazil, there are restrictions on the minimum landing size of *E. marginatus* (MMA 2005), and in the

Berlenga MNR, this species has been strictly protected (Inglês 2010). This taxon is in danger, facing a very high risk of extinction in the wild and is listed as Endangered (EN) in the IUCN Red List Category and Criteria (Cornish and Harmelin-Vivien 2004; IUCN 2016).

The black grouper (*Mycteroperca bonaci* Poey 1860) is a typically solitary reef species (Claro 1994; Fishbase 2014) of the family Serranidae and is found in the Western Atlantic, from the United States to southern Brazil, including around Cuba, the Bahamas, the Florida Keys and in the southern Gulf of Mexico (Heemstra and Randall 1993). Groupers are targets of various types of fisheries (Craig et al. 2011). Members of the genera *Mycteroperca* are at particular risk due to their large body size, long life-span and late age at reproduction (Morris et al. 2000). Bender et al. (2013) identifies *M. bonaci* as one of the species that is overexploited in artisanal fisheries in the Recife de Fora Marine Park in Bahia state, northeast Brazil. In northeastern Brazil, specifically between the States of Ceará and Alagoas, this species is the target of some artisanal and compressor-assisted spear fishing (Teixeira et al. 2004). *M. bonaci* is listed as Near Threatened (NT) in the IUCN Red List Category and Criteria (Ferreira et al. 2008; IUCN 2016).

Gag (*Mycteroperca microlepis* Goode and Bean, 1879) is a shallow-water serranid species that ranges from the Western Atlantic (North Carolina, USA) to Bermuda, Cuba, the Yucatán Peninsula (Mexico) and Brazil (southeast to Santa Catarina State) (Heemstra and Randall 1993). This grouper has a strong relationship with coral reef ecosystems and may be vulnerable to overexploitation due to their life history characteristics (Brulé et al. 2011). In the United States, this species is exploited in recreational and commercial fisheries (McGovern et al. 1998). It is listed under Least Concern (LC) in the IUCN Red List Category and Criteria because of the considerable distribution and abundance of individuals (Bertoncini et al. 2008b; IUCN 2016). However, *M. microlepis* is targeted by commercial fishermen and sport fisheries, and sharp declines in abundance have been observed in southwestern Brazil (Bender et al. 2014).

The green back parrotfish (*Scarus trispinosus* Valenciennes, 1840) is a member of the family Scaridae that is endemic to Brazil. It is called “bico-verde” and “budião-azul” by local artisanal fishermen (Moura et al. 2001; Floeter et al. 2007). *S. trispinosus* occurs strictly in the southwestern Atlantic, from the northern to the southeastern coast of Brazil (Moura et al. 2001). Parrotfish populations are a constant target of fisheries (Comeros-Raynal et al. 2012; Bender et al. 2014), with spearfishing being a major cause of the decline of green back populations on Brazilian reefs (Ferreira et al. 2005). Floeter et al. (2007) described the extinction of the species in Arraial do Cabo, primarily due to spearfishing. This species is listed as endangered in the IUCN Red List Category and Criteria (Padovani-Ferreira et al. 2012; IUCN 2016).

The marine fish fauna in Berlenga MNR is renowned for its biological richness and diversity (Inglês 2010). Approximately seventy-six species of fish occur around the MNR islands (Rodrigues et al. 2008). Some species are of particular commercial fishing importance, especially small pelagic fish such as sardines (*Sardina pilchardus*), Atlantic mackerel (*Scomber scombrus*), chub mackerel (*Scomber* *japonicus*) and horse mackerel (*Trachurus trachurus*). Eleven species from the family Sparidae are present in this area. The occurrence of pelagic species is common in Berlenga and the communities of reefs are dominated by macrocarnivores, omnivorous and invertivores species (Vasco-Rodrigues et al. 2011). The *Epinephelus marginatus* is commonly hunted by divers in this area (Queiroga et al. 2008); this species appears on the Red List of the International Union for Conservation of Nature (IUCN) as endangered (Cornish and Harmelin-Vivien 2004; IUCN 2016). According to Inglês (2010), the species most exploited in artisanal fisheries within the Berlenga MNR are chub mackerel, sardine, horse mackerel, gilthead seabream (*Sparus aurata*), seabass (*Dicentrarchus labrax*) and white seabream (*Diplodus sargus*).

The chub mackerel, (*Scomber japonicus*) is a coastal, cosmopolitan species inhabiting oceanic tropical and temperate waters (Atlantic, Indian, Pacific) and adjacent seas (Scoles et al. 1998). *S. japonicus* is still recognized as an important fishery resource many parts of the world (Vasconcelos et al. 2012); in the Berlenga MNR, this pelagic species is considered a major target for local artisanal fisheries (Inglês 2010). This species is caught primarily with purse seines, hook and line and nets, and it can still be caught in both sport and recreational fisheries. It is listed under Least Concern (LC) in the IUCN Red List Category and Criteria (Collette et al. 2012; IUCN 2016).

The sardine (*Sardina pilchardus*) is a small pelagic fish from the family Clupeidae and is primarily distributed in the eastern North Atlantic, North Sea, Mediterranean, Sea of Marmara and Black Sea (Parrish et al. 1989). Sardine has an important ecological role in the ecosystem and is also commercially important (ICES 2013; Correia et al. 2014). *S. pilchardus* is heavily fished in Portugal (Tacon and Metian 2009) and Spain (ICES 2013). This taxon has not yet been assessed for the IUCN Red List (IUCN 2016).

The Atlantic horse mackerel (*Trachurus trachurus*) is a very important species in the Atlantic-Iberian region (Murta 2000). This species has a high nutritional value, primarily because it is rich in minerals (Özden 2010). This species is distributed in the Mediterranean Sea and the northeast Atlantic from Norway to the Cape Verde Islands (Abaunza et al. 2008). *T. trachurus* is the second mostly commonly targeted species on the Portuguese coast, with more than 15,000 tons landed per annum and is well appreciated in smaller sizes by the Portuguese population (Bandarra et al. 2001). The IUCN Red List status of this species has not been evaluated (IUCN 2016).

The gilthead seabream (*Sparus aurata*) is a subtropical Sparidae that is quite important in the Mediterranean region (Boulton et al. 2011). *S. aurata* can also be found on the east coast of the Atlantic (from Great Britain to Senegal) and in the Black Sea (FAO 2015a). In Portugal, this species has a high market value and is very important for Portuguese marine aquaculture, primarily in the Algarve (Andrade et al. 1996). This species is targeted using traditional fishing gear such as trawl nets, bottom set longlines and hand lines (Crosetti et al. 2014). The IUCN Red List status of this species has not been assessed (IUCN 2016).

The European seabass (*Dicentrarchus labrax*) is a member of the Moronidae family and is quite widespread along the European coast, primarily in the Eastern Atlantic, Mediterranean Sea and Black Sea (Kottelat and Freyhof 2007). Vasco-Rodrigues et al. (2011) observed a decrease of 14.8% in the occurrence of this species in the Berlenga MNR. The lack of effective control over spearfishing in the Berlengas Archipelago caused a decline in abundance of this target species in the Berlenga MNR (Inglês 2010). European seabass is listed under Least Concern (LC) in the IUCN Red List Category and Criteria (Freyhof and Kottelat 2008; IUCN 2016).

The white seabream (*Diplodus sargus*) is a teleost from the family Sparidae and is very abundant in the coastal waters of the Persian Gulf and Mediterranean Sea and in the Indian and Atlantic Oceans (González-Wangüemert and Pérez-Ruzafa 2012). *D. sargus* is considered a species of great importance in artisanal fisheries that use fixed gear, such as trammels and gillnets (Benchalel and Kara 2013). In Portugal, white seabream have potential for cultivation due to its high economic value (Rigos and Katharios 2010). This species has not been evaluated by the IUCN Red List for conservation status (IUCN 2016).

3.2 Important Aspects of Local Ecological Knowledge (LEK) for the Management of Fisheries in Marine Protected Areas (MPAs)

3.2.1 LEK and Its Role Within Marine Protected Areas (MPAs)

Environmental quality is affected by several types of human exploitation and organizations. (Lubchenco et al. 2003). Amid the recognition of the enormous influence of humans on marine environments, marine reserves arise as a strategy to protect these critical areas from overfishing and other destructive and extractive activities (Lubchenco et al. 2003).

Overfishing and side effects from fishing directly influence the population structure of different species of fish in marine protected areas, often by mismanagement that was not effective in their sustainability objectives (Botsford et al. 1997). In this perspective, new conservation tools that respond to environmental changes, particularly the effects from climate change, are suggested to assist biodiversity conservation strategies (Hannah et al. 2002). In addition to biological points, other additional factors, such as local participation and political viability, are key features to the success of a marine reserve (Allison et al. 1998). The link between ecosystems and humans is crucial for the recovery strategy of biota on a planet that has been changed by various anthropogenic activities (Novacek and Cleland 2001).

Berkes et al. (2007) showed that the aggregation of participatory management, where all stakeholders are involved, can facilitate better assessments and understanding of the marine environment. In a biodiversity hotspot in Papua New Guinea, for example, the local community was involved in a successful planning process for the management of a marine protected area (Green et al. 2009).

For more effective conservation in a system in which a few resources are limited, it is advisable to use management regimes where the interests of the communities are also taken into consideration (McClanahan et al. 2006). Imposing restrictions on limited fishery resources in a protected area could trigger instability of social and economic factors within coastal communities and generate future conflict over resources. All parties should be supported for effective management (Agardy et al. 2003; Dietz et al. 2003).

"Traditional ecological knowledge" (TEK) has emerged as a means to assist in the management of complex systems by using local information to help understand local dynamics and ensure greater chances of survival of a particular traditional dependent community (Berkes et al. 2000). TEK reflects the experience of humans with the environment, which has been acquired for thousands of years (Berkes 1993), and is presently a useful tool in modern conservation programs (Drew 2005). TEK can be defined as, "a cumulative body of knowledge, practice and belief evolving by adaptive processes and handed down through generations by cultural transmission, about the relationship of living beings (including humans) with one another and with their environment" (Berkes 2012).

Similarly to TEK, local ecological knowledge (LEK) is the cumulative knowledge derived from the interaction of individuals in a population with the environment acquired by living with the biological resources they use (Yli-Pelkonen and Kohl 2005). It is important to clarify that TEK can be observed in most cases as a synonym for ethno-ecological knowledge, indigenous knowledge or local ecological knowledge (Berkes 2012). We have chosen to use the term LEK in this work as it is more commonly used in fisheries management (Wilson et al. 2003).

There is growing interest in the use of LEK as a complementary tool that can be used in adaptive management of protected areas (Berkes et al. 2007; Gómez-Baggethun et al. 2010; Bender et al. 2013; Mmassy and Røskaft 2014). Studies of local ecological knowledge may provide some biological information regarding a feature of the fish fauna that fishermen have explored at some point. However, for this knowledge to be used in biodiversity management and to be validated and shared appropriately within the scientific literature, its confidentiality must be maintained (Hamilton et al. 2012).

The information generated by a community, such as observations of fish behavior in the local habitat and the knowledge of fisherman regarding the ecology and biology of a species (ethnoecology, ethnobiology and ethnotaxonomy of fish species), are highly relevant to fisheries management (Begossi 2008). Another goal of the LEK approach is to analyze and understand the description of local physical and biological characteristics within a social context and with regard to other productive activities of these communities (Ruddle 2000).

The use of LEK can complement scientific studies and replace some types of scientific research; LEK may even be recognized as a new source of scientific information with proven quality (Le Fur et al. 2011). LEK contributes to better discussions among stakeholders, thereby facilitating the management of funds by fishermen, exposing existing conflicts and highlighting the necessary measures to be considered in decision making (Mellado et al. 2014).

In areas where biological data are scarce, LEK can be useful for formulating testable hypotheses and providing auxiliary information to guide further investigation (Silvano and Valbo-Jørgensen 2008). Specialized artisanal fishermen can be a valid source of information in situations where there is no available long-term data for an ecosystem. Focusing on LEK of fisheries and the biology of key species becomes the most effective and functional way of gathering local information (Begossi and Silvano 2008).

Understanding the attitudes towards conservation from LEK studies and sharing the socio-economic information of communities is extremely important for improving the management and biophysical health of coastal marine systems (Malleret-King et al. 2006). Thus, comprehensive studies involving continuous interactions between fishermen, scientists and other stakeholders are key to the effective contribution of LEK to resource management (Wilson et al. 2006). The inclusion of LEK is presented as an alternative to traditional management aimed at preserving biodiversity, especially for fisheries management systems in MPAs (Ruddle and Hickey 2008; Silvano and Begossi 2012).

3.2.2 Fisher's Local Ecological Knowledge in Brazil

There is great interest in scientific research based on fishers' local ecological knowledge (LEK) of the Brazilian coast (Begossi and Silvano 2008; Caló et al. 2009; Gerhardinger et al. 2009a, b; Silvano and Begossi 2012; Bender et al. 2013, 2014; Ferreira et al. 2014; Herbst and Hanazaki 2014; Martins et al. 2014; Giglio and Bornatowski 2016; Barbosa-Filho et al. 2016; Pinto et al. 2016; Begossi et al. 2016).

Fisher's LEK in Brazil includes detailed knowledge of the conservation status of reef fish (Bender et al. 2013, 2014), on the relative abundance and aggregation of fish (Gerhardinger et al. 2009a, b), on reproduction, diet and areas of risks (Begossi and Silvano 2008), on temporal and spatial distribution of both prey and predators (Caló et al. 2009), on various aspects of fisheries, such as temporal changes in catches and biology (Giglio and Bornatowski 2016), on fish diets and habitat use (Begossi et al. 2016), on species interactions (Barbosa-Filho et al. 2016), on ethnotaxonomic classification systems (Pinto et al. 2016), and about the life cycles of these species, which is generally consistent with the ichthyological scientific literature (Lima and Batista 2012).

Through the collection of data in standardized interviews, with calculated precision and reliability, LEK was found to exhibit a considerable amount of alternative information for nine coastal fishes in Búzios Island in the State of Rio de Janeiro, Brazil (Silvano and Begossi 2012). These data were considered to be the only available source of information on some species and thus could contribute positively to local fisheries management initiatives (Silvano and Begossi 2012). In a fishing community near the Arvoredo Biological Reserve in southern Brazil, studies showed that the accurate LEK of fishermen pertaining to different species around the reserve could support an MPA evaluation. Fishermen report that the MPA was only effective for reef species but was not efficient for the recovery of target species; this type of ethnobiological research suggests that LEK can contribute to the monitoring of marine protected areas (Martins et al. 2014).

The results of the work involving the LEK of artisanal fishermen regarding the goliath grouper (*Epinephelus itajara* Lichtenstein, 1822) along the Bahia coast, which generated refined data on ecological and biological characteristics of a critically endangered species. The initial study of the species based on LEK of expert fishermen along the Ilhéus coast suggests an important starting point encouraging new studies on the behavior, reproduction and ecology of *E. itajara* in the region (Ferreira et al. 2014).

Similarly, Herbst and Hanazaki (2014) highlighted the detailed LEK regarding the life cycle of mullets (*Mugil liza* Valenciennes, 1836) along the coast of Santa Catarina State. Furthermore, the authors noted the importance of conservation measures taken based on the information provided by the fishermen of the variations in migration routes as an attribute to the species natural life cycle.

Interactions with whale sharks (*Rhincodon types*) reported by fishermen along the Brazilian coast provided important data to support the government plans to regulate fishing activities (Barbosa-Filho et al. 2016). In a small-scale fishery on the northeast coast of Brazil, use of local ecological knowledge was suggested as a complement to scientific data and may improve modeling efforts for research and management of fishery resources (Bevilacqua et al. 2016).

Diegues (2003) recognized that the artisanal fishermen of Arraial do Cabo, Rio de Janeiro, Brazil have a vast local knowledge on the ecology, behavior and distribution of fish species. In the same region, the combination of local ecological knowledge with scientific data indicates a decline of different fish species, suggesting the importance of LEK as an auxiliary tool in marine biodiversity maintenance strategies (Bender et al. 2014). Moreover, other studies investigating the beliefs, customs, food taboos, and attitudes towards the conservation of local biological resources can aid the conservation of marine ecosystems.

However, in Brazil MPA management is guided mainly by traditional science, which cannot provide all the information necessary for making management decisions. Thus, the population must be a partner in all phases of research and management. However, local knowledge should be subjected to a filtering process to remove sensitive information that might otherwise benefit competing interests (Gerhardinger et al. 2009a, b).

3.2.3 Fishers' Local Ecological Knowledge in Portugal

There is still a huge gap in the scientific literature pertaining to ethnobiology in Portugal, with most LEK papers targeting ethnobotany. There is one study that addresses LEK of fishermen in three zones along the Portuguese coast. This study focuses on LEK pertaining to climate change, coastal issues and the factors that influence these two topic areas (Delicado et al. 2012). A study of Peniche, a community on the central-western coast of Portugal, also focused on exploring the relationship between fisherman and climate change (Viegas et al. 2016). However, no studies to date have focused on LEK regarding the ecology, behavior, spatial distribution, feed, population, reproduction or conservation of target species for artisanal fisheries along the Portuguese coast. In this perspective, this knowledge may be an alternative to study emerging changes in fish diversity due to the unexpected effects of global change (Azurro et al. 2011).

Understanding LEK and attitudes towards conservation of critical artisanal fisheries species in the Peniche region could provide important information and collaboration in the management of the ichthyofauna of the Berlenga MNR. It is possible that food taboos and beliefs about some species may improve resource conservation (Begossi et al. 2002; Braga and Schiavetti 2013). Also, it is still necessary to conduct a detailed investigation into the real participation of local people in decision making within the Berlenga MNR and its current impact on the preservation of the ecosystem.

Even with all the potential of artisanal fisheries in Portugal, the current situation indicates the likely influence of tourism and other various pressures on fisheries resources (Santos et al. 2012). Although it is known that the oceanographic conditions within the Berlenga MNR and its submarine archaeological heritage permit the presence of a large biodiversity of fish fauna (Queiroga et al. 2008; Inglês 2010), the possibility of the extinction of beliefs, customs, taboos and fishing gear used by artisanal fishermen of Peniche is imminent.

4 Global Change Communication

Fishing Communities (close ties with and reliance on ecosystem goods and services) have benefitted from the application of LEK in natural and cultural resource management and there is increasing recognition of the value of LEK as it applies to climate change assessment and adaptation efforts (Setti et al. 2016a, b). Traditional ecological knowledge can help build an understanding of climate impacts on ecological processes and climate phenomena (2016a, b; Alexander et al. 2011; Ford et al. 2010; Nabhan 2010; Berkes 2009; Salick and Ross 2009; Riedlinger and Berkes 2001). The applicability of LEK, associated with socioeconomic and adaptive human responses to environmental change and climate change strategies can make an important contribution to understanding the impacts from climate change adaptation. Similarly, despite community-based approaches to climate change adaptation and disaster risk reduction increasing there is very limited guidance on how to effectively communicate climate change in a way that enhances people's resilience (Dumaru 2010; Berkes and Jolly 2001; Berkes et al. 1995). This document shows the experiences of LEK in Brazil and proposes LEK scenarios in the AMP of Peniche and Arraial do Cabo in coastal zones and in fishing communities, as well as scenarios for LEK studies to analyze the perceptions of fishermen of climate change in the fauna of fish in both areas. Three key climate change communication challenges are being prepared for the future studies: interviews, focus group discussions and online discussion site with the purpose of drawing recommendations for good practice guidance in climate change communication that is empowering and culturally relevant. Effectively communicate this Climate Change Challenge is critical (Moser 2010), Climate researchers must improve their ability to explain uncertainties and risks (Ward 2010) and raising awareness about climate change remains crucial, importantly and essential for communities to make local sense of climate change, particularly in an ever-changing world where knowledge is continuously expanding and changing (McNamara 2013).

5 Conclusions

This work attempts to demonstrate the importance of fisher's local ecological knowledge (LEK) and communication strategies as a source of additional information for use in the conservation and management of fishery resources and climate change adaptation of fishing communities. The geographic regions discussed are representative of different socio-environmental and jurisdictional contexts; ongoing research will provide new insights to this scientific and environmental field. The inclusion of fishers' LEK can contribute greatly to the construction and improvement of management plans for the sustainable use of a particular resource within these areas. However, the use of local ecological knowledge is not a guarantee that a fishery will be sustainable, but rather offers an alternative knowledge source as fishermen manage resources, especially when scientific biological data are scarce.

The Berlenga MNR offers a spatial context, with relevant conservation concerns, for the development of the use of fishers' local ecological knowledge in Portugal (and Europe). LEK has been identified as a potential contributor to conservation practices in Europe within communities where the local livelihood depends on ecosystem resources and services (Hernández-Morcillo et al. 2014). On the Iberian Peninsula, especially in Portugal, studies could utilize ethnobiology methodologies for developing the National Network of Protected Areas (RNAP) with a focus on local ecological knowledge of biological resources, especially ichthyofauna for which no assessment of conservation status has been made.

Despite neglect in European research (Svanberg et al. 2011), ethnobiology exhibits evident growth as a science in Latin America (Albuquerque et al. 2013). With this approach, new data will help elucidate emerging changes in marine ecosystems as a result of inherent current overexploitation and climate change. Like many studies highlighted here, the use of LEK can be an important tool in fisheries management, and thus could be more used in climate change management and mitigation along with the affected resources. Therefore, ethnobiological studies in Portugal can promote a better understanding of climate change (Byg and Salick

2009), as well as provide and predict new local information for fisheries management along the European Atlantic coast. In this context climate researchers must improve their ability to explain uncertainties and risks (Ward 2010) particularly in an ever-changing world where knowledge is continuously expanding and changing (McNamara 2013) and particularly to most vulnerable when it comes to preparing for and adapting to change in resource-dependent communities (Cinner et al. 2015) like the Coastal communities that are particularly at risk from the impacts of a changing climate (Islam et al. 2014).

Acknowledgements We are grateful to Bruno Zucherato for his collaboration. We thank the CAPES Foundation—Ministry of Education of Brazil for financial support (BEX: 8926/13-1).

References

Abaunza P, Murta AG, Campbell N, Cimmaruta R, Comesaña AS, Dahle G, Santamaría MG, Gordo LS, Iversen SA, MacKenzie K, others (2008) Stock identity of horse mackerel (Trachurus trachurus) in the Northeast Atlantic and Mediterranean Sea: integrating the results from different stock identification approaches. Fish Res 89:196–209

Agardy T, Bridgewater P, Crosby MP, Day J, Dayton PK, Kenchington R, Laffoley D, McConney P, Murray PA, Parks JE, Peau L (2003) Dangerous targets? Unresolved issues and ideological clashes around marine protected areas. Aquat Conserv Mar Freshw Ecosyst 13:353–367

Albuquerque UP, Silva JS, Campos JLA, Sousa RS, Silva TC, Alves RRN (2013) The current status of ethnobiological research in Latin America: gaps and perspectives. J Ethnobiol Ethnomed 9:72

Alexander C, Bynum N, Johnson E, King U, Mustonen T, Neofotis P, Oettlé N, Rosenzweig C, Sakakibara C, Shadrin V, Vicarelli M, Waterhouse J, Weeks B (2011) Linking indigenous and scientific knowledge of climate change. BioScience 61(6):477–484

Allison GW, Lubchenco J, Carr MH (1998) Marine reserves are necessary but not sufficient for marine conservation. Ecol Appl 8:S79–S92

Amaral ACZ, Jablonski S (2005) Conservation of marine and coastal biodiversity in Brazil. Conserv Biol 19:625–631

Andrade JP, Erzini K, Palma J (1996) Gastric evacuation and feeding in the gilthead sea bream reared under semi-intensive conditions. Aquac Int 4:129–141

Azevedo PJS (2004) Onze Anos de Produção Pesqueira na Região de Arraial do Cabo-RJ. Brasil. MSc thesis, Universidade Federal Fluminense. Niterói, Rio de Janeiro, Brasil

Azzurro E, Moschella P, Maynou F (2011) Tracking signals of change in Mediterranean fish diversity based on local ecological knowledge. PLoS ONE 6:9

Baloi M, Carvalho CV, Sterzelecki FC, Passini G, Cerqueira VR (2014) Effects of feeding frequency on growth, feed efficiency and body composition of juveniles Brazilian sardine, *Sardinella brasiliensis* (Steindacher 1879). Aqua Resear 47:554–560

Bandarra NM, Batista I, Nunes ML, Empis JM (2001) Seasonal variation in the chemical composition of horse-mackerel (*Trachurus trachurus*). Eur Food Res Technol 212:535–539

Barbosa-Filho MLV, Tavares DC, Siciliano S, Moura JF de, Costa-Neto EM, Motta F dos S, Del Vechio Koike C (2016) Interactions between whale sharks, *Rhincodon typus* Smith, 1928 (Orectolobiformes, Rhincodontidae), and Brazilian fisheries: The need for effective conservation measures. Mar Policy 73:210–215

Beaudreau AH, Levin PS (2014) Advancing the use of local ecological knowledge for assessing data-poor species in coastal ecosystems. Ecol Appl 24:244–256

Begossi A (2008) Local knowledge and training towards management. Environ Dev Sustain 10:591–603

Begossi A, Silvano RA (2008) Ecology and ethnoecology of dusky grouper [garoupa, *Epinephelus marginatus* (Lowe, 1834)] along the coast of Brazil. J Ethnobiol Ethnomedicine 4:20

Begossi A, Hanazaki N, Silvano RAM (2002) Ecologia humana, etnoecologia e conservação. In: Amorozo MCM, Ming LC, Silva SP (eds) Métodos de coleta e análise de dados em etnobiologia, etnoecologia e disciplinas correlatas. UNESP/CNPq, Rio Claro, pp 92–128

Begossi A, Salivonchyk S, Lopes PFM, Silvano RAM (2016) Fishers' knowledge on the coast of Brazil. J Ethnobiol Ethnomedicine 12:20

Benchalel W, Kara MH (2013) Age, growth and reproduction of the white seabream *Diplodus sargus* sargus (Linneaus, 1758) off the eastern coast of Algeria. J Appl Ichthyol 29:64–70

Bender MG, Floeter SR, Hanazaki N (2013) Do traditional fishers recognise reef fish species declines? Shifting environmental baselines in Eastern Brazil. Fish Manag Ecol 20:58–67

Bender MG, Machado GR, de Azevedo Silva PJ, Floeter SR, Monteiro-Netto C, Luiz OJ, Ferreira CE (2014) Local ecological knowledge and scientific data reveal overexploitation by multigear artisanal fisheries in the Southwestern Atlantic. PLoS ONE 9:e110332

Berkes F (1993) Traditional ecological knowledge in perspective. In: Inglis JT (ed) Traditional ecological knowledge: concepts and cases. Canadian Museum of Nature, Ottawa, pp 1–9

Berkes F (2009) Indigenous ways of knowing and the study of environmental change. J Royal Soc N Z 39(4):151–156

Berkes F (2012) Sacred ecology. Routledge: traditional ecological knowledge and resource management. Taylor & Francis, London

Berkes F, Jolly D (2001) Adapting to climate change: social-ecological resilience in a Canadian western Arctic community. Conserv Ecol 5(2):18. [online] URL: http://www.consecol.org/vol5/iss2/art18/

Berkes F, Folke C, Gadgil M (1995) Traditional ecological knowledge, biodiversity, resilience and sustainability. In: Perrings C, Mäler K-G, Folke C, Holling CS, Jansson B-O (eds) Biodiversity conservation. Kluwer Academic Publishers, Dordrecht, pp 281–299

Berkes F, Colding J, Folke C (2000) Rediscovery of traditional ecological knowledge as adaptive management. Ecol Appl 10:1251–1262

Berkes F, Berkes MK, Fast H (2007) Collaborative integrated management in Canada's north: the role of local and traditional knowledge and community-based monitoring. Coast Manag 35:143–162

Bertoncini A, Gerhardinger L, Sadovy Y, Rocha L, Choat J, Ferreira B, Craig M (2008a) *Mycteroperca acutirostris*. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/132830/0. Accessed 4 Jun 2015

Bertoncini A, Choat J, Craig M, Ferreira B, Rocha L (2008b) Mycteroperca microlepis. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/14050/0. Accessed 13 Apr 2015

Bevilacqua AHV, Carvalho AR, Angelini R, Christensen V (2016) More than anecdotes: fishers' ecological knowledge can fill gaps for ecosystem modeling. PLOS ONE 11:e0155655

Bizsel C, Yokes B, Pollard D, Kara MH, Bariche M, Quignard JP (2011) *Pomatomus saltatrix*. The IUCN Red List of Threatened Species. Version 2014.3. www.iucnredlist.org. Accessed 4 Jul 2015

Bosley KL, Lavelle JW, Brodeur RD, Wakefield WW, Emmett RL, Baker ET, Rehmke KM (2004) Biological and physical processes in and around Astoria submarine Canyon, Oregon, USA. J Mar Syst 50:21–37

Botsford LW, Castilla JC, Peterson CH (1997) The management of fisheries and marine ecosystems. Science 277:509–515

Boulton K, Massault C, Houston RD, de Koning DJ, Haley CS, Bovenhuis H, Batargias C, Canario AV, Kotoulas G, Tsigenopoulos CS (2011) QTL affecting morphometric traits and stress response in the gilthead seabream (*Sparus aurata*). Aquaculture 319:58–66

Braga HO, Schiavetti A (2013) Attitudes and local ecological knowledge of experts fishermen in relation to conservation and bycatch of sea turtles (reptilia: testudines), Southern Bahia, Brazil. J Ethnobiol Ethnomed 9:15

Brulé T, Mena-Loría A, Pérez-Díaz E, Renán X (2011) Diet of juvenile gag *Mycteroperca microlepis* from a non-estuarine seagrass bed habitat in the southern Gulf of Mexico. Bull Mar Sci 87:31–43

Byg A, Salick J (2009) Local perspectives on a global phenomenon—climate change in Eastern Tibetan villages. Gl Environ Change 19(2):156–166

Caló CFF, Schiavetti A, Cetra M (2009) Local ecological and taxonomic knowledge of snapper fish (Teleostei: Actinopterygii) held by fishermen in Ilhéus, Bahia, Brazil. Neotropical Ichthyol 7:403–414

Candelmo AC, Deshpande A, Dockum B, Weis P, Weis JS (2010) The effect of contaminated prey on feeding, activity, and growth of young-of-the-year bluefish, *Pomatomus saltatrix*, in the laboratory. Estuaries Coasts 33:1025–1038

Cergole MC, Dias-Neto J (2011) Plano de Gestão para o Uso Sustentável da Sardinha-verdadeira do Brasil. Brasilia: IBAMA, 5:180 pp. (Série Plano de Gestão dos Recursos Pesqueiros)

Ceyhan T, Akyol O, Ayaz A, Juanes F (2007) Age, growth, and reproductive season of bluefish (*Pomatomus saltatrix*) in the Marmara region, Turkey. ICES J Mar Sci J Cons 64:531–536

Cinner JE, Huchery C, Hicks CC, Daw TM, Marshall N, Wamukota A, Allison EH (2015) Changes in adaptive capacity of Kenyan fishing communities. Nat Clim Change 5:872–876. doi:10.1038/nclimate2690

Claro R (1994) Características generales de la ictiofauna. In Claro R (ed) Ecología de los peces marinos de Cuba. Instituto de Oceanología Academia de Ciencias de Cuba and Centro de Investigaciones de Quintana Roo, pp 55–70

Coelho-Souza SA, López MS, Guimarães JRD, Coutinho R, Candella RN (2012) Biophysical interactions in the Cabo Frio upwelling system, Southeastern Brazil. Braz J Oceanogr 60:353–365

Collette B, Acero A, Canales Ramirez C, Cardenas G, Carpenter K, Chang S-K, Di Natale A, Fox W, Guzman-Mora A, Juan Jorda M, Miyabe N, Montano Cruz R, Nelson R, Salas E, Schaefer K, Serra R, Sun C, Uozumi Y, Wang S, Wu J, Yeh (2012) *Scomber japonicus*. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/170306/0. Accessed 13 Apr 2015

Comeros-Raynal MT, Choat JH, Polidoro BA, Clements KD, Abesamis R, Craig MT, Lazuardi ME, McIlwain J, Muljadi A, Myers RF, others (2012) The likelihood of extinction of iconic and dominant herbivores and detritivores of coral reefs: the parrotfishes and surgeonfishes. PLoS One 7:e39825

Cornish A, Harmelin-Vivien M (2004) (Grouper & Wrasse Specialist Group). *Epinephelus marginatus*. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/7859/0. Accessed 4 Sep 2015

Correia AT, Hamer P, Carocinho B, Silva A (2014) Evidence for meta-population structure of *Sardina pilchardus* in the Atlantic Iberian waters from otolith elemental signatures of a strong cohort. Fish Res 149:76–85

Craig MT, Sadovy Y, Heemstra PC, International Union for Conservation of Nature, IUCN Species Survival Commission, IUCN/SSC Groupers & Wrasses Specialist Group (2011) Groupers of the world: a field and market guide. NISC ; [Distributed by] CRC Press/Taylor & Francis Group, Grahamstown, South Africa; Boca Raton, FL

Crosetti D, Rossi AR, De Innocentis S (2014) AquaTrace species leaflet: gilthead sea bream (*Sparus aurata*)—© ISPRA Istituto Superiore per la Protezione e la Ricerca Ambientale. Università di Roma—La Sapienza, Italy. https://aquatrace.eu/documents/80305/142567/gilthead+sea+bream+leaflet.pdf. Accessed 16 Apr 2015

Curdia J, Carvalho S, Ravara A, Gage JD, Rodrigues AM, Quintino V (2004) Deep macrobenthic communities from Nazaré submarine canyon (NW Portugal). Sci Mar 68:71–180

Da Silva PP (2004) From common property to co-management: lessons from Brazil's first maritime extractive reserve. Mar Policy 28:419–428

Delicado A, Schmidt L, Guerreiro S, Gomes C (2012) Pescadores, conhecimento local e mudanças costeiras no litoral Português. Rev Gest Costeira Integrada 12:437–451
Dias DF, Pezzi LP, Gherardi DFM, Camargo R (2014) Modeling the spawning strategies and larval survival of the Brazilian sardine (*Sardinella brasiliensis*). Prog Oceanogr 123:38–53
Dias-Neto JD, dos Santos GCB, others (2011) Comportamento da produção total e por estado, frota permissionada e balança comercial de sardinha-verdadeira. Rev CEPSUL-Biodiversidade E Conserv Mar 2:34–49
Diegues AC (2003) Conhecimento e manejo tradicionais em áreas protegidas de uso sustentável: o caso da resex marinha do Arraial do Cabo-Rio de Janeiro. http://nupaub.fflch.usp.br/sites/nupaub.fflch.usp.br/files/color/resexarraial.pdf. Accessed 7 Jun 2016
Diegues AC (2008) Marine protected areas and artisanal fisheries in Brazil. Chennai, India, International Collective in Support of Fishworkers, (SAMUDRA Monograph). http://aquaticcommons.org/1565/1/Samudra_mon2.pdf. Accessed 5 Jul 2016
Dietz T, Ostrom E, Stern PC (2003) The struggle to govern the commons. Science 302:1907–1912
Drew JA (2005) Use of traditional ecological knowledge in marine conservation. Conserv Biol 19:1286–1293
Dumaru P (2010) Community-based adaptation: enhancing community adaptive capacity in Druadrua Island, Fiji. Wiley Interdiscip Rev Clim Change 1:751–763
Echwikhi K, Jribi I, Saidi B, Bradai MN (2015) The influence of the type of hook on the capture of groupers and bycatch with bottom longline in the Gulf of Gabès, Tunisia. J Mar Biol Assoc UK 95:207–214
FAO (2015a) Fisheries and Aquaculture Department. Rome: Food and Agriculture Organization of the United Nation. Cultured Aquatic Species Information Programme *Sparus aurata* (Linnaeus, 1758). http://www.fao.org/fishery/culturedspecies/Sparus_aurata/en. Accessed 24 Sep 2016
Ferreira CEL, Gasparini JL, Carvalho-Filho A, Floeter SR (2005) A recently extinct parrotfish species from Brazil. Coral Reefs 24:128–128
Ferreira B, Gaspar A, Sadovy Y, Craig M (2008) *Mycteroperca bonaci*. The IUCN Red List of Threatened Species. Version 2014.3. www.iucnredlist.org. Accessed 4 Sep 2015
Ferreira HM, Reuss-Strenzel GM, Alves JA, Schiavetti A (2014) Local ecological knowledge of the artisanal fishers on *Epinephelus itajara* (Lichtesntein, 1822) (Teleostei: epinephelidae) in Ilhéus coast—Bahia State, Brazil. J Ethnobiol Ethnomed 10:1
Fishbase (2014) Froese, R. e D. Pauly. Editors. 2014. FishBase. World Wide Web electronic publication. www.fishbase.org. Accessed 4 Sep 2015
Floeter SR, Halpern BS, Ferreira CEL (2006) Effects of fishing and protection on Brazilian reef fishes. Biol Conserv 128:391–402
Floeter SR, Ferreira CE, Gasparini JL (2007) Os efeitos da pesca e da proteção através de UC's marinhas: três estudos de caso e implicações para os grupos funcionais de peixes recifais no Brasil. Áreas Aquáticas Protegidas Como Instrum Gest Pesqueira Bras Ministério Meio Ambiente-MMA Org MMA Brasília 4:183–199. http://www.mma.gov.br/estruturas/sbf2008_dap/_publicacao/149_publicacao16122010104405.pdf. Accessed 25 Jul 2016
Ford JD, Berrang-Ford L, King M, Furgal C (2010) Vulnerability of aboriginal health systems in Canada to climate change. Global Environ Change Hum Policy Dimensions 20(4):668–680
Freyhof J, Kottelat M (2008) *Dicentrarchus labrax*. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/135606/0. Accessed 16 Apr 2015
Gaines SD, White C, Carr MH, Palumbi SR (2010) Designing marine reserve networks for both conservation and fisheries management. Proc Natl Acad Sci 107:18286–18293
Gavin MC, McCarter J, Mead A, Berkes F, Stepp JR, Peterson D, Tang R (2015) Defining biocultural approaches to conservation. Trends Ecol Evol 30:140–145
Gerhardinger LC, Godoy EAS, Jones PJS (2009a) Local ecological knowledge and the management of marine protected areas in Brazil. Ocean Coast Manag 52:154–165
Gerhardinger LC, Hostim-Silva M, Medeiros RP, Matarezi J, Bertoncini ÁA, Freitas MO, Ferreira BP (2009b) Fishers' resource mapping and goliath grouper *Epinephelus itajara* (Serranidae) conservation in Brazil. Neotropical Ichthyol 7:93–102

Giglio VJ, Bornatowski H (2016) Fishers' ecological knowledge of smalleye hammerhead, *Sphyrna tudes*, in a tropical estuary. Neot Ichthyol 14:2

Godoy JM, Souza TA, Godoy MLD, Moreira I, Carvalho ZL, Lacerda LD, Fernandes FC (2013) Groundwater and surface water quality in a coastal bay with negligible fresh groundwater discharge: Arraial do Cabo, Brazil. Mar Chem 156:85–97

Gómez-Baggethun E, Mingorría S, Reyes-García V, Calvet L, Montes C (2010) Traditional ecological knowledge trends in the transition to a market economy: empirical study in the Doñana Natural Areas. Conserv Biol 24:721–729

González-Wangüemert M, Pérez-Ruzafa Á (2012) In two waters: contemporary evolution of lagoonal and marine white seabream (*Diplodus sargus*) populations. Mar Ecol 33:337–349

Green A, Smith SE, Lipsett-Moore G, Groves C, Peterson N, Sheppard S, Lokani P, Hamilton R, Almany J, Aitsi J, Bualia L (2009) Designing a resilient network of marine protected areas for Kimbe Bay, Papua New Guinea. Oryx 43:488–498

Hamilton R, de Mitcheson YS, Aguilar-Perera A (2012) The role of local ecological knowledge in the conservation and management of reef fish spawning aggregations. In: de Mitcheson YS, Colin PL (eds) Reef fish spawning aggregations: biology, research and management. Springer, The Netherlands, pp 331–369

Hannah L, Midgley GF, Lovejoy T, Bond WJ, Bush M, Lovett JC, Scott D, Woodward FI (2002) Conservation of biodiversity in a changing climate. Conserv Biol 16:264–268

Haynes R, Barton ED, Pilling I (1993) Development, persistence, and variability of upwelling filaments off the Atlantic coast of the Iberian Peninsula. J Geophys Res Oceans 1978–2012 (98):22681–22692

Heemstra PC, Randall JE (1993) FAO species catalogue. Groupers of the world (Family Serranidae, Subfamily Epinephelinae). An annotated and illustrated catalogue of the grouper, rockcod, hind, coral grouper and lyretail species known to date. FAO Fisheries Synopsis. Rome, FAO 16, 382 pp

Heemstra PC, Anderson WJ, Lobel PS (2003) Serranidae, 1308–1369 pp. In: Carpenter KE (ed) The living marine resources of the western central Atlantic, vol 2: Bony fishes part 1 (Acipenseridae to Grammatidae). FAO Species Identification Guide for Fishery Purposes and American Society of Ichthyologists and Herpetologists Special Publication No. 5. Food and Agriculture Organization of the United Nations, Rome. 2, i–viii + 601–1374 pp [Dated 2002, but actually published in 2003]

Herbst DF, Hanazaki N (2014) Local ecological knowledge of fishers about the life cycle and temporal patterns in the migration of mullet (Mugil liza) in Southern Brazil. Neotropical Ichthyol 12:879–890

Hernández-Morcillo M, Hoberg J, Oteros-Rozas E, Plieninger T, Gómez-Baggethun E, Reyes-García V (2014) Traditional ecological knowledge in Europe: status quo and insights for the environmental policy agenda. Environ Sci Policy Sustain Dev 56:3–17

ICES (2013) Report of the Working Group on Southern Horse Mackerel, Anchovy, and Sardine (WGHANSA), Bilbao, Spain, 21–26 June 2013, ICES CM 2013/ACOM:16, 544 p

ICMBio (2010) Instituto Chico Mendes de Conservação da Biodiversidade (ICMBio) - Ministério da Pesca e Aquicultura (MPA). Produção pesqueira e aquícola: estatística 2008 e 2009. Brasília (DF). Brasil. http://www.icmbio.gov.br/cepsul/acervo-digital/37-download/estatistica/111-estatistica.htm. Accessed 4 May 2016

ICMBio (2015) Instituto Chico Mendes de Conservação da Biodiversidade. DECRETO DE 3 DE JANEIRO DE 1997. Dispõe sobre a criação da Reserva Extrativista Marinha do Arraial do Cabo, no Município de Arraial do Cabo, Estado do Rio de Janeiro, e dá outras providências. In: RESEX ARRAIAL CABO. http://www.icmbio.gov.br/portal/biodiversidade/unidades-de-conservacao/biomas-brasileiros/marinho/unidades-de-conservacao-marinho/2282-resex-arraial-do-cabo.html. Accessed 4 Feb 2016

Inglês MCG (2010) Avaliação dos impactes das condicionantes nas actividades económicas em áreas marinhas protegidas: caso de estudo na reserva natural da Berlenga. MSc Thesis, Universidade de Lisboa, Portugal. http://repositorio.ul.pt/bitstream/10451/2333/1/ulfc090521_tm_Mafalda_Ingles.pdf. Accessed 19 Oct 2016

Islam MM, Sallu S, Hubacek K, Paavola J (2014) Vulnerability of fishery-based livelihoods to the impacts of climate variability and change: insights from coastal Bangladesh. Reg Environ Change 14:281. doi:10.1007/s10113-013-0487-6

IUCN (2016). The IUCN Red List of Threatened Species. Version 2016-3. http://www.iucnredlist.org. Downloaded on 07 December 2016

Jablonski S (2007) The Brazilian sardine. Is there any room for modelling? Pan Am J Aquat Sci 2:86–93

Juanes F, Hare JA, Miskiewicz AG (1996) Comparing early life history strategies of *Pomatomus saltatrix*: a global approach. Mar Freshw Res 47:365–379

Kottelat M, Freyhof J (2007) Handbook of European freshwater fishes. Publ. Kottelat, Cornol and Freyhof, Berlin. 646 p

Le Fur J, Guilavogui A, Teitelbaum A, Rochet M-J (2011) Contribution of local fishermen to improving knowledge of the marine ecosystem and resources in the Republic of Guinea, West Africa. Can J Fish Aquat Sci 68:1454–1469

Lima LG de, Batista VS da (2012) Ethnoictiology studies on Pirarucu (Arapaima mock-ups) in Central Amazon. Acta Amaz 42:337–344

Loureiro S, Newton A, Icely JD (2005) Microplankton composition, production and upwelling dynamics in Sagres (SW Portugal) during summer of 2001. Sci Mar 69:323–341

Lubchenco J, Palumbi SR, Gaines SD, Andelman S (2003) Plugging a hole in the ocean: the emerging science of marine reserves 1. Ecol Appl 13:3–7

Malleret-King D, Glass A, Wanyonyi I, Bunce L, Pomeroy B (2006) Socio-economic Monitoring guidelines for coastal managers of the Western Indian Ocean, SocMon WIO. CORDIO East Africa publication (Version 1). 108 p. http://www.socmon.org/pdf/SocMon_WIO_English.pdf. Accessed 15 Sept 2016

Marino G, Azzurro E, Massari A, Finoia MG, Mandich A (2001) Reproduction in the dusky grouper from the southern Mediterranean. J Fish Biol 58:909–927

Martins IM, Medeiros RP, Hanazaki N (2014) From fish to ecosystems: the perceptions of fishermen neighboring a southern Brazilian marine protected area. Ocean Coast Manag 91:0e57

McClanahan TR, Marnane MJ, Cinner JE, Kiene WE (2006) A comparison of Marine Protected Areas and alternative approaches to coral-reef management. Curr Biol 16:1408–1413

McGovern JC, Wyanski DM, Pashuk O, Manooch CS II, Sedberry GR (1998) Changes in the sex ratio and size at maturity of gag, *Mycteroperca microlepis*, from the Atlantic coast of the southeastern United States. Fish Bull 96:797–807

Mckenna S, Allen GR (2002) Coral reef biodiversity: assessment and conservation. In: Best BA, Pomeroy RS, Balboa CM (eds) Implications for coral reef management and policy: relevant findings from the 19th International Coral Reef Symposium. US Agency for International Development, World Resources Institute, Conservation International, International Society for Reef Studies. pp 92–94

McNamara KE (2013) Raising awareness about climate change in Pacific communities. Environ Educ Res. doi:10.1080/13504622.2013.769046

Mellado T, Brochier T, Timor J, Vitancurt J (2014) Use of local knowledge in marine protected area management. Mar Policy 44:390–396

MMA (2005) Ministério do Meio Ambiente do Brasil—INSTRUÇÃO NORMATIVA No-53, DE 22 DE NOVEMBRO DE 2005 Estabelece o tamanho mínimo de captura de espécies marinhas e estuarinas do litoral sudeste e sul do Brasil. http://www.icmbio.gov.br/cepsul/images/stories/legislacao/Instrucao_normativa/2005/in_mma_53_2005_tamanhominimoespeciesmarinhaseestuarinas_se_s_altrd_in_mma_03_2006.pdf. Accessed 11 Mar 2016

Mmassy EC, Røskaft E (2014) Factors affecting local ecological knowledge and perceived threat to the kori bustard (Ardeotis kori struthiunculus) in the Serengeti Ecosystem, Northern Tanzania. Int J Biodivers Conserv 6:459–467

Monteiro-Neto C, Bertoncini ÁA, Chaves LC de, Noguchi R, Mendonça-Neto JP, Rangel CA (2013) Checklist of marine fish from coastal islands of Rio de Janeiro, with remarks on marine conservation. Mar Biodivers Rec 6:e139

Morris AV, Roberts CM, Hawkins JP (2000) The threatened status of groupers (Epinephelinae). Biodivers Conserv 9:919–942

Moser S (2010) Communicating climate change: history, challenges, process and future directions. WIREs Clim Change 1:31–53

Moura RL, Figueiredo JL, Sazima I (2001) A new parrotfish (Scaridae) from Brazil, and revalidation of Sparisoma amplum (Ranzani, 1842), Sparisoma frondosum (Agassiz, 1831), Sparisoma axillare (Steindachner, 1878) and Scarus trispinosus Valenciennes, 1840. Bull Mar Sci 68:505–524

Munday PL, Warner RR, Monro K, Pandolfi JM, Marshall DJ (2013) Predicting evolutionary responses to climate change in the sea. Ecol Lett 16:1488–1500

Murta AG (2000) Morphological variation of horse mackerel (*Trachurus trachurus*) in the Iberian and North African Atlantic: implications for stock identification. ICES J Mar Sci J Cons 57:1240–1248

Nabhan GP (2010) Perspectives in ethnobiology: ethnophenology and climate change. J Ethnobiol 30(1):1–4

Novacek MJ, Cleland EE (2001) The current biodiversity extinction event: scenarios for mitigation and recovery. Proc Natl Acad Sci 98:5466–5470

Oliveira PB, Nolasco R, Dubert J, Moita T, Peliz Á (2009) Surface temperature, chlorophyll and advection patterns during a summer upwelling event off central Portugal. Cont Shelf Res 29:759–774

Özden Ö (2010) Micro, macro mineral and proximate composition of Atlantic bonito and horse mackerel: a monthly differentiation. Int J Food Sci Technol 45:578–586

Padovani-Ferreira B, Floeter S, Rocha L, Ferreira C, Francini-Filho R, Moura R, Gaspar A, Feitosa C (2012) *Scarus trispinosus*. The IUCN Red List of Threatened Species. Version 2014.3. http://www.iucnredlist.org/details/190748/0. Accessed 13 Apr 2015

Paiva MP, Andrade-Tubino MF (1998) Distribuição e abundância de peixes bentônicos explotados pelos linheiros ao largo do sudeste do Brasil (1986–1995). Rev Bras Biol 58:619–632

Paiva MP, Falcão A (2002) Estrutura de cardumes da sardinha-verdadeira, Sardinella brasiliensis (Steindachner, 1879), no estado do Rio de Janeiro (Brasil). Revta Bras Zool 19:85–92

Pardal MA, Azeiteiro UM (2001) Zooplankton biomass, abundance and diversity in a shelf area of Portugal (the Berlenga Marine Natural Reserve). Arquipélago. Life and Mar Sci 25:49–62

Parrish RH, Serra R, Grant WS (1989) The monotypic sardines, sardina and sardinops: their taxonomy, distribution, stock structure, and zoogeography. Can J Fish Aquat Sci 46:2019–2036

Pelicice FM, Vitule JRS, Lima Junior DP, Orsi ML, Agostinho AA (2014) A serious new threat to Brazilian freshwater ecosystems: the naturalization of nonnative fish by decree. Conserv Lett 7:55–60

Pereira GC, Coutinho R, Ebecken NFF (2008) Data mining for environmental analysis and diagnostic: a case study of upwelling ecosystem of Arraial do Cabo. Braz J Oceanogr 56:1–12

Pinto MF, Mourão JS, Alves RRN (2016) How do artisanal fishermen name fish? An ethnotaxonomic study in Northeastern Brazil. J Ethnobiol 36:348–381

Queiroga H, Leão F, Coutinho M (2008) Candidatura das Berlengas a Reserva da Biosfera da UNESCO. Versão para consulta pública. IDAD, Aveiro. Portugal. 138 p

Radhouani H, Poeta P, Pinto L, Miranda J, Coelho C, Carvalho C, Rodrigues J, López M, Torres C, Vitorino R, others (2010) Proteomic characterization of vanA-containing Enterococcus recovered from Seagulls at the Berlengas Natural Reserve, W Portugal. Proteome Sci 8:1–12

Riedlinger D, Berkes F (2001) Contributions of traditional knowledge to understanding climate change in the Canadian arctic. Polar Record 37(203):315–328

Rigos G, Katharios P (2010) Pathological obstacles of newly-introduced fish species in Mediterranean mariculture: a review. Rev Fish Biol Fish 20:47–70

Rocha J, Yletyinen J, Biggs R, Blenckner T, Peterson G (2015) Marine regime shifts: drivers and impacts on ecosystems services. Philos Trans R Soc B Biol Sci 370:20130273

Rodrigues RR, Lorenzzetti JA (2001) A numerical study of the effects of bottom topography and coastline geometry on the Southeast Brazilian coastal upwelling. Cont Shelf Res 21:371–394

Rodrigues NV, Maranhão P, Oliveira P, Alberto J (2008) Guia de espécies submarinas: Portugal, Berlengas. Edição Instituto Politécnico de Leiria, Portugal

Ruddle K (2000) Systems of knowledge: dialogue, relationships and process. Environ Dev Sustain 2:277–304

Ruddle K, Hickey FR (2008) Accounting for the mismanagement of tropical nearshore fisheries. Environ Dev Sustain 10:565–589

Salick J, Ross N (2009) Traditional peoples and climate change. Glob Environ Change 19(2):137–139

Santos AJFR (2011) O papel dos conhecimentos e dos modos de vida locais no desenvolvimento sustentável: estudo exploratório sobre o impacto da Reserva Natural das Ilhas Berlengas na Comunidade Piscatória. MSc thesis, Universidade Aberta

Santos MPN, Seixas S, Aggio RBM, Hanazaki N, Costa M, Schiavetti A, Dias JA, Azeiteiro UM (2012) A Pesca enquanto Atividade Humana: Pesca Artesanal e Sustentabilidade. Rev Gest Costeira Integrada 12:405–427

Scheel-Ybert R (2000) Vegetation stability in the Southeastern Brazilian coastal area from 5500 to 1400 14C yr BP deduced from charcoal analysis. Rev Palaeobot Palynol 110:111–138

Scoles DR, Collette BB, Graves JE (1998) Global phylogeography of mackerels of the genus Scomber. Fish Bull 96:823–842

Setti AFF, Ribeiro H, Gallo E, Alves F, Azeiteiro UM, (2016a) Climate change and health: governance mechanisms in traditional communities of Mosaico Bocaina/Brazil. In: Climate change and health. Springer International Publishing, 329–351 pp

Setti AFF, Ribeiro H, Azeiteiro UM, Gallo E (2016b) Governance and the promotion of sustainable and healthy territories in the experience of Bocaina, Brazil. Jour of Integr Coast Zon Manag 16:57–69

Silvano RAM, Begossi A (2012) Fishermen's local ecological knowledge on Southeastern Brazilian coastal fishes: contributions to research, conservation, and management. Neotropical Ichthyol 10:133–147

Silvano RAM, Valbo-Jørgensen J (2008) Beyond fishermen's tales: contributions of fishers' local ecological knowledge to fish ecology and fisheries management. Environ Dev Sustain 10:657–675

Soares HC, Ponzi Pezzi L, Marcolino Gherardi DF, Tavares Paes E (2011) Oceanic and atmospheric patterns during spawning periods prior to extreme catches of the Brazilian sardine (*Sardinella brasiliensis*) in the southwest Atlantic. Sci Mar 75:665–677

Svanber I, Łuczaj Ł, Pardo-de-Santayana M, Pieroni A (2011) History and current trends of ethnobiological research in Europe. Ethnobiol. Wiley-Blackwell, Chichester, pp 191–214

Tacon AGJ, Metian M (2009) Fishing for aquaculture: non-food use of small pelagic forage fish-a global perspective. Rev Fish Sci 17:305–317

Teixeira SF, Ferreira BP, Padovan IP (2004) Aspects of fishing and reproduction of the black grouper *Mycteroperca bonaci* (Poey, 1860) (Serranidae: Epinephelinae) in the Northeastern Brazil. Neotropical Ichthyol 2:19–30

Vasconcelos J, Afonso-Dias M, Faria G (2012) "ARQUIPÉLAGO. Life and Marine Sciences". Atlantic chub mackerel (Scomber colias) spawning season, size and age at first maturity in Madeira waters. Life Mar Sci 43–51

Vasco-Rodrigues N, Mendes S, Franco J, Castanheira M, Castro N, Maranhão P (2011) Fish diversity in the Berlengas Natural Reserve (Portugal), a marine protected area. Rev Ecol 35–43

Vetter EW, Dayton PK (1998) Macrofaunal communities within and adjacent to a detritus-rich submarine canyon system. Deep Sea Res Part II Top Stud Oceanogr 45:25–54

Vetter EW, Smith CR, De Leo FC (2010) Hawaiian hotspots: enhanced megafaunal abundance and diversity in submarine canyons on the oceanic islands of Hawaii. Mar Ecol 31:183–199

Viegas V, Azeiteiro UM, Alves F (2016) Fostering resilience among artisanal fishers in Peniche (Portugal): an exploratory study. In: Filho WL, Musa H, Cavan G, O'Hare P, Seixas J (eds) Climate change adaptation, resilience and hazards. Springer International Publishing, Switerzland, pp 305–327

Ward R (2010) Communicating climate change. Weather 65:309–310

Whitehead PJP, Nelson GJ, Wongratana T (1985) FAO s clupeoid fishes of the world (suborder Clupeoidei). An annotated and illustrated catalogue of the herrings, sardines, pilchards, sprats, anchovies and wolf-herrings. Part 1—chirocentridae, clupeidae, and pristigasteridae. Food & Agriculture Org. Fis Synopsis, 7 (Pt. 1): pp 1–303

Wilson DC, Nielsen JR, Degnbol P (eds) (2003) The fisheries co-management experience. Accomplishments, challenges and prospects. Fish and fisher series, vol 26

Wilson DC, Raakjær J, Degnbol P (2006) Local ecological knowledge and practical fisheries management in the tropics: a policy brief. Mar Policy 30:794–801

Worm B, Barbier EB, Beaumont N, Duffy JE, Folke C, Halpern BS, Jackson JBC, Lotze HK, Micheli F, Palumbi SR, Sala E, Selkoe KA, Stachowicz JJ, Watson R (2006) Impacts of biodiversity loss on ocean ecosystem services. Science 314:787–790

Würtz M (2012) Mediterranean submarine canyons: ecology and governance. IUCN, Gland, Switzerland and Málaga, Spain

Yáñez-Arancibia A, Day JW, Reyes E (2013) Understanding the coastal ecosystem-based management approach in the Gulf of Mexico. J Coast Res 63:244–262

Yli-Pelkonen V, Kohl J (2005) The role of local ecological knowledge in sustainable urban planning: perspectives from Finland. S Sci, Pract Pol 1:1

Author Biographies

Heitor O. Braga Ph.D. student in Marine Ecology at the University of Coimbra, Portugal and Master in Ecology and Biodiversity Conservation in the University of Santa Cruz, Bahia, Brazil. Research Area: Human Ecology, Ethnobiology and Biodiversity Conservation, and Cognitive Systems. Expertise: He has experience in Ecology, with emphasis Ethnoecology, Ethnozoology, and Ethnoictiology in fishing communities in tropical and temperate regions. Through an interdisciplinary approach, the researcher seeks to investigate how human societies understand nature through systems of beliefs, knowledge, cognitive systems and sets of practices. It also aims to examine local ecological knowledge (LEK) whose function is to understand the relationship between a specific group of humans and ecosystems through interactions between organism-organism and organism-environment. Current project: LEK of small pelagic fish in the Berlengas Nature Reserve, Peniche, Portugal and the Marine Extractive Reserve of Arraial do Cabo, Brazil.

Miguel Â. Pardal is an Associate Professor at the Life Sciences Department of the University of Coimbra and the coordinator of the Marine Coastal Processes Research Line of the Centre for Functional Ecology (CFE). In the last twenty years supervised over 20 Ph.D. students and 40 M.Sc. students. So far has already published over 250 ISI papers and 15 book chapters as co-author.

Ulisses M. Azeiteiro is a Senior Professor (Associate Professor with Habilitation and Tenure) and Coordinator of the Climate Change and Biodiversity Assets Unit from the Biology Department and Integrated Member/Senior Researcher of the Centre for Environmental and Marine Studies (CESAM) at University of Aveiro in Portugal. His main interests are the Impacts of Climate Change in the Marine Environment (Biology and Ecology of Global Change) and Adaptation to Climate Change in the Context of Sustainable Development (Social and Environmental

Sustainability and Climate Change). Research Coordinator since 2008 (Research Line Long Term Ecological Response to Global Changes at IMAR-CMA—Marine and Environmental Research from 2008 to 2010 and Research Group Social-Economic Governance and Sustainability from the Centre for Functional Ecology, hosted by the Faculty of Sciences and Technology at University of Coimbra from 2010 to 2016) was member of several evaluation panels from research projects and grants (International, European and National—Portuguese and outside Portugal), member of the organizing and scientific committees of more than 100 international and national congresses, member of more than 150 exam panels for viva voice examinations (for Ph.D. and M.Sc.) and carer assessment and supervised over 50 Postgraduate students (M.Sc. and Ph.D. students). Professor Ulisses M. Azeiteiro has written, co-written, edited or co-edited more than 200 publications, including books (>20), book chapters (>50), Special Issues of Scientific Journals and papers in refereed journals (>75 ISI and >50 peer reviewed).

Delivering Solutions: Engaging Farmers and Land Holders in the Climate Change Debate

Becky Willson and Stephen Roderick

1 Introduction

It is increasingly acknowledged that meeting the sustainability challenge in the agri-food system will require system innovation and transition (Ingram et al. 2015), as well as improving farmer competence by developing skills and knowledge (Hansen 2015). Farming systems worldwide are facing a combination of challenges posed by irregular production levels, price volatility and growing concerns over the impact of agricultural activities on the environment (Le Gal et al. 2011). At the same time there is mounting public pressure and societal expectation on farmers in relation to their environmental performance (Greiner et al. 2009). Responding to these pressures will require innovation both in terms of practices and in how we communicate farming and food production messages (Leitgeb et al. 2011). There is an increasing expectation for agricultural practices to change, yet the factors that drive how farmers manage their land remain poorly understood (Fleming and Vanclay 2010).

1.1 Resource Management, Climate Change and Agriculture

Farmers and growers face a unique challenge in terms of adapting to climate change and the issue is complex. The science and research behind GHG reduction and

B. Willson (✉) · S. Roderick
Rural Business School, Duchy College, Stoke Climsland, Callington, Cornwall PL17 8PB, UK
e-mail: becky.willson@duchy.ac.uk

B. Willson
The Farm Carbon Cutting Toolkit, Colleymore Farm, Coleshill, Highworth, Swindon SN6 7PU, UK

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_17

mitigation in agriculture is not complete, while at the same time with the complexity of biochemical processes in agriculture, it is not always clear what practices will make an effective difference. The UK Government has imposed targets on the agricultural sector to reduce its Greenhouse Gas emissions and mitigate the effects of climate change. Agriculture in the UK is responsible for 84% of total nitrous oxide emissions and 44% of total methane emissions (Defra 2013). Farmers need support and encouragement to use continuous improvements to reduce the carbon footprint of their farms in response to the need to rapidly reduce farm related greenhouse gas emissions.

There is a need to engage farmers in the debate over the extent and impact of climate change and persuade farmers that the messages are relevant to them. Psychological literature on message sources recommend consistent and authoritative content which is difficult to deliver when dealing with the contested and uncertain nature of adaptation and mitigation (Blackstock et al. 2007). Helm (2008) explained that "*we are condemned to live with uncertainty*" and highlighted the difficulty in making precise predictions on future impact of our changing climate. To achieve resilience and enable adaptive management, farmers will need to be knowledgeable, aware, and proactive working with policy makers and scientists rather than passively receiving transferred knowledge. Policies will also need to be developed that are adaptive enough to deal with the heterogeneity of farming systems (Wall and Smit 2005). Factoring in farmer behavioural characteristics has the potential to improve the effectiveness of mitigation and adaptation policy (OECD 2012).

There are mixed messages from science when looking at effectively reducing greenhouse gas emissions from agricultural production systems. Some mitigation measures co-deliver on a range of targets whilst others have conflicting outcomes. Before implementation of management practices we require knowledge of the win-win scenarios that not only score highly for efficient land use specific priorities but also contribute to secondary ecosystem services or mitigate potential pollutant processes (Dawson and Smith 2010). Co-creating practical opportunities to implement these win-wins with farmers, in a manner which inspires participation, allows farmers to value advice (as they have been instrumental in producing it), and provides a baseline which other farmers can replicate. It is these win-wins which can be used to engage farmers in a very practical way with the climate change agenda whilst also making the economic and environmental advantages clearly visible.

Farmers are natural innovators, and have been characterised as "practical experimentalists who understand the idiosyncrasies of their land" (MacMillan and Benton 2014) who pride themselves on their ability to solve problems (Nowak 2013). If we can harness this problem solving ability and present information in a way which engages farmers with the issues surrounding resource management, sustainability and reducing emissions, then we can co-create solutions which will have impact and longevity. Farmers "*value knowledge delivered by persons rather than roles, privilege farming experience, and develop knowledge with empiricist rather than rationalist techniques*" (Wood et al. 2014). Holding practical, farm-based events puts farmers and their management in the spotlight and enables more effective practical knowledge exchange by highlighting demonstrative innovations and their real-life impacts.

1.2 The Farm Carbon Cutting Toolkit

This paper deals with activities undertaken by the Farm Carbon Cutting Toolkit, a farmer led UK based organisation, concerned with providing practical support for farmers interested in climate change. The organisation was started and has been developed and run by farmers, and aims to encourage the awareness of climate change within the UK farming community and support farmers who understand the importance of taking action to reduce GHG emissions from their farming operations. It does this by providing a range of tools to enable farmers to take action on their own farms and demonstrating farm-scale mitigation measures as a mechanism for other farmers to understand practical opportunities.

Farmers and growers can produce quality food, enhance biodiversity and absorb carbon by adapting the way that their businesses work. FCCT provides the mechanisms to assess the current business performance and a toolkit that allows farmers to assess potential mitigation options for the future. All of the resources from FCCT are offered to farmers free of charge and with no affiliation to a political or commercial partner. FCCT operates a system of farmer to farmer support, creating networks, sharing best practice and enabling actions, with the caveat that there are no 'set' solutions. FCCT supports farmers demonstrating a wide range of technologies and farm systems as are appropriate to each individual farm.

1.3 FCCT Resources

The Toolkit and Carbon Calculator which are housed on the FCCT website and freely available, are the backbone of the organisation, which allow farmers and growers to engage with the climate change agenda. The resources that FCCT creates aim to get farmers engaged and excited about the opportunities available to them to optimise production and reduce emissions through disseminating advice in a very practical way.

The Farm Carbon Calculator is a fully comprehensive carbon calculator for farmers and growers in the UK. It incorporates Tier 1, 2 and 3 emissions, as well as carbon sequestration. It is unique in assessing all carbon sequestration in biomass and soils. Free to use, the tool enables users to access and store their carbon reports, which give a full breakdown of all emissions and sequestration associated with their farm business. The calculator and the use of metrics to assess the farm's emissions was analysed for this paper, in terms of its usability, relevance of results to farm and the farmer's ability to interpret the results.

As well as the calculator and the toolkit, FCCT runs technical sessions, farm walks, conferences and other events for farmers to disseminate practical information and new research and to promote sharing of ideas. In 2016 FCCT launched, in partnership with Innovation for Agriculture, a competition aimed at finding the UK's first Soil farmer of the Year. This allowed farmers who were passionate about soil management and were employing practices on-farm that were building soil organic matter, reducing nitrous oxide emissions, improving biological activity and reducing carbon loss to be recognised for the first time. The attendance and response to the events associated with this competition were monitored and the results used as a comparison with more 'conventional' technical events on soil management hosted by FCCT.

2 Aims

This paper aims to investigate how best to engage farmers with the issues around climate change and adoption of best management practices, through testing the use of different communication strategies. These strategies were:

- The use of metrics and farmers' engagement with carbon assessment tools through a comparison of self-assessment with dedicated and personalised support; and
- Knowledge transfer initiatives focussed on one particular technical issue (soil management), to engage farmers and improve farmers understanding of the problem, their role in that problem and what they could do differently on-farm.

The investigation is limited to the analysis of experiences of events run by FCCT during the period 2014–16 and the work undertaken through the demo farm project.

3 Methodology

The research method used in this study is the collection of empirical evidence and feedback from farmers who have taken part in carbon footprinting or attended events that have been hosted by FCCT.

(i) Self-assessed versus supported carbon footprinting

The use of metrics was assessed by looking at usage data and feedback from farmers using the FCCT carbon footprinting tool. The footprinting tool has been freely available for use by farmers for the last 4 years through the link available on the FCCT website (http://www.farmcarbontoolkit.org.uk/carbon-calculator).

During the last 4 years, the assessment has been completed by farmers independently on five occasions. Completing the footprinting tool independently comprised collecting the data, inputting it into the calculator and then being presented with a results sheet. The farmers had no guidance from FCCT staff on the interpretation of the results and were free to use the results as they wished. These farmers were contacted and their feedback on the usability of the tool and their future plans having used the tool were recorded. This feedback was collected by telephone during February and March 2016, which was at least a year post completion of the footprint, and the responses recorded and summarised. The same four questions were posed to all users of the tool, which assessed their views on the usability of the tool, the process of gathering data, the ability to interpret the data and the value of completing the footprint (would they repeat it annually).

Since March 2015, FCCT have been involved in a project looking at demonstrating emissions reductions potential at the farm level (the DEMO farm project). As part of this project, three demo farmers were selected and monitored in depth for two years. The demo farm process involved initial recruitment of farmers, completion of the data collection (by the farmer), the carbon footprint calculation and report (by FCCT staff), farm visits, support and mentoring throughout the two years and then a re-assessment of the carbon footprint at the end of year two.

The process undertaken by the demo farmers was intensively supported by FCCT project staff, and although the data collection for the calculator was completed by the farmer, the calculations and discussion on the focus areas were led and guided by FCCT staff.

Feedback from participating farmers was collected at the end of the process. The demo farmers were also asked about the value of having guidance, interpretation and mentoring. Feedback was gathered during mentoring sessions and also through the use of an email survey to allow the farmers to feedback their thoughts on the process without the FCCT staff being present. A comparison was made of the feedback collected from the demo farmers with those participating in the self-assessment process.

(ii) Comparing farmer engagement with two different types of events focussing on soil management.

A comparison was made between the attendance and feedback from participants attending three conventional technical events with three farm walk events organised as part of the 2016 Soil Farmer of the Year competition. All events were concerned with soil management. The conventional technical events were held on-farm and led by experts. The farm walks were hosted by the top three winners of the soil farmer competition.

The three technical events were as follows:

- Building Soil Carbon Masterclass, which took place on the 19th March 2014 in Cornwall;
- An event focussing on Soil Organic Matter which took place on the 3rd November 2015 in Warwickshire; and
- Building Soil Organic matter farm walk which took place on the 25th February 2016 in Northamptonshire.

All events were promoted and advertised through the FCCT network of farmers as well as circulated to other organisations that are affiliated with agricultural soil management, and social media. All delegates that attended each event completed a feedback form post-event which asked specific questions on their assessment of the event, whether they found it useful and what they felt the key learning outcomes were. As well as individual feedback, the professional background and home address of delegates were recorded.

FCCT hosted and promoted the inaugural Soil Farmer of the Year competition in 2016. Applications were invited from farmers who were passionate about soil management, and were carrying out some form of sustainable soil management. Applications were submitted online via Survey Monkey, and included questions on soil structure, management of compaction and soil damage, soil chemical and fertility building, management of soil biological populations and attitudes to soil health and new ideas. It also included a question on why the applicant felt they should be the Soil Farmer of the Year.

On closure of the competition application window, 19 applications were received from farmers managing a total of 7500 hectares of farmland in the UK. The applications were anonymously scored by a panel of judges that included soil scientists, project staff, farmers and the competition sponsors to provide a shortlist of three who were then assessed by a farm visit. The top three farmers hosted farm walks on the 13th June 2016, 8th July 2016, and the 17th October 2016. These events were advertised through the FCCT network and by the winning farmers.

Feedback from participants at the events was collected post event in the same manner as the technical events and comparisons were made with responses from the conventional technical events.

4 Results

4.1 Carbon Assessments

Results from the feedback from farmers that were self-assessing and those that were assisted were collated and summarised. The key themes are presented below.

4.1.1 Time to Complete

All farmers completing the carbon footprint expressed concern over the amount of time the assessment took. Guidelines suggest that the calculator takes on average one hour to complete if all the data is to hand whilst collating the data (from farm records and utility bills) takes extra time. All farmers took extra time to collect records needed to complete the footprint, (no farmer had all the data to hand).

4.1.2 Level of Detail Required and Data Availability

The calculator being tested is one of the most comprehensive calculators available to farmers and all farmers commented on this requirement for such detail. One farmer commented "*There is no way that I will be recommending this to other farmers to complete, no-one has the time to sit down and fill in forms for hours on end. What is the need to put in how long my hedge is—does it matter*?"

4.1.3 So What?

Having completed the form and received the analysis report, all famers enquired as to what the relevance of the footprinting was. The farm carbon footprint, expressed as the kilograms of carbon dioxide per year, appeared to be meaningless to all farmers taking part. The relevance only became obvious when the results for different enterprises were made clear and areas of particularly high or low emissions were identified. All farmers required interpretation and signposting as to what actions may be required after the footprinting.

4.1.4 Results Accuracy

A number of farmers engaged in foot-printing (6 out of 8) raised issues regarding the accuracy of the results, particularly where proxy values had been used in the absence of actual data (e.g. the number of fence posts used or amount of steel used in a building, or the results of soil analysis). The validity of emissions factors for different commodities was also questioned, particular where calculations were based on national rather than regional data).

4.1.5 Lack of Comparison with Other Tools

Two of the farmers that took part were involved in supply chains that had mandatory carbon footprinting requirements and as a result had additional carbon assessments completed annually. These were seen by the participating farmers as a "paperwork, tick box exercise" rather than a useful farm management tool. These two farmers expressed frustration that the results generated through the FCCT calculator could not be compared with footprints created as part of supermarket contracts.

4.1.6 Would You Do It Again?

All respondents on having completed the assessment replied that they could not see the value of repeating the footprinting due to the time requirements and the lack of relevance to day to day farm management. There appeared to be more value placed on the discussion with FCCT project staff on the result of the assessment. Comments included that "*it was a pain to complete, but at least it puts some numbers on things and provides a baseline*," and "*if we do change our management, we should now be able to see the impact on our footprint of doing it*."

There was a split between those farmers who had been through the demo farm process (and as such had support and mentoring) versus the self-assessment farmers. The demo farmers, who were completing the footprinting as part of a longer process, were more interested in the future results as they had changed their management and were eager to see the results (in March 2017).

4.2 Soil Management Events

Results of the attendance at the soil events are shown in Table 1 as well as the breakdown of the type of attendant. A total of 61 feedback responses were received.

Feedback from farmers attending the events indicated that they were generally more than satisfied with the quality of the events and speakers. Some of the positive comments referred to the events as providing a valuable opportunity to talk to people in the industry, as an aid to understanding future research needs (n = 10/61). The opportunity for open discussions and the practical grounding of a farm walk were also appreciated (n = 30), as was the opportunity to hear first-hand experience of farmers implementing these measures (n = 28).

Other valued aspects included the use of practical examples (rather than theoretical models), meeting other farmers and sharing knowledge, developing a more profound awareness of carbon sequestration within soils, and the understanding of "who's doing what" around different management practices.

Table 1 Number of delegates at soil technical events

Event date	Total number	Farmer	Industry	Researcher
March 15	19	8	6	5
November 15	28	12	8	8
February 16	14	6	2	6

Table 2 Number of delegates at soil farmer events

Event date	Total number	Farmer	Industry	Researcher
13 June 16	43	36	5	2
8th July 16	15	10	4	1
17th Oct 16	28	21	6	1

Forty three percent (43%) of the event attendants at the three events were farmers, twenty six percent (26%) were from the wider industry (which including agronomists and advisors) and thirty one percent (31%) were involved in research.

Results of the attendance at the Soil Farmer competition events are shown in Table 2. A total of 86 delegates attended the events and provided feedback.

The Soil Farmer events also received positive feedback, with ninety five percent (95%) of responses rating the events as excellent. Aspects of value highlighted from these events included the relevance to practical farming, the right balance of practical and theory, the timing of the events and the subject matter (e.g. no-till cultivation). One farmer commented (event 13th June) "*In spite of coming a long way the evening was 100% fascinating and informative and thoroughly worthwhile in attending. I am inspired now to work out how to start no-till at home.*" Another delegate from the same event commented, "*I have taken away a number of points that I will incorporate into my system, it is difficult to obtain knowledge in relation to no-till as it is not in the agribusiness interest to promote as there is little commercial return.*"

The other farm walks focussed on horticulture (8th July) and grazing livestock production (17th October) and feedback was overwhelmingly positive. Farmers commented that they were able to see the techniques working in a commercial system, and 85% of delegates reported that they would do something different as a result of coming to the event.

Seventy eight percent (78%) of the event attendants at the three events were farmers, seventeen percent (17%) were industry, and five percent (5%) were working on research.

5 Discussion

5.1 Assessment Tools

The results from this study indicate that there is growing interest in practical management opportunities for farmers to improve their soil health and resilience, and to improve sustainability.

Metrics provide a useful baseline in terms of documenting the farmer's journey, but the process is onerous and time consuming and the farmers in our study were not confident in the value of completing such an exercise on a regular basis, although it is acknowledged that the study is limited by the small sample size. Simplicity of data entry, the use of real time sensors and integration with current management software would ease this process in the future. The ability to compare footprinting results from one accounting package with another was highlighted. Currently there is no common methodology that is used by any footprinting calculator in the UK, as such comparison is not possible. As progress is measured by the difference between at least two annual calculations, this is a barrier to widespread adoption. In order to understand whether emissions were high or low, there is a need to develop a level of benchmarking that farmers can assess how well they are doing compared to their peers. One farmer explained "*a number is all very well, but am I doing well or less well? Is that a good number, or do I need to do something different?*"

Tools are required to provide the answer to the question "so what?", and this would probably best be achieved using systems of benchmarking. Metrics can help in the diagnosis of areas of weakness in a business, but also in identifying solutions and driving technological changes. Including benchmarking in a format that allows the farmer the insight and information needed to weigh up the impacts of changing management was identified as a priority.

To demonstrate the contribution of agriculture to the national inventory of GHG emissions there is a need for metrics that demonstrate the impact on the ground. Comparing the experience of farmers undertaking self-assessment with the more in-depth monitoring of the demo farms provided some stark differences.

The self-assessed farmers were not in favour of repeating the assessment for a range of reasons including time to complete, lack of trust in figures and being too in depth. However, those farmers who were involved in the demo farm project had a higher level of understanding as the process of assessment was completed with a member of FCCT staff who was able to interpret results and answer questions throughout the process.

The demo farmers were also invested in a longer term process (the demo farm project) which they had 'signed up to' for two years. As such there was an understanding that there was going to be a time commitment. This resulted from multiple interactions with the FCCT project, including answering of questions, talking through the methodology, justification of the need for capture of certain data sets and explaining the relevance. This is not possible when farmers self-assess, and there is potential for misunderstanding and frustration by the user with such bad experience resulting in abandoning of the process before real value can be seen.

Although the study was conducted with a small sample of farmers who may not have been representative of the wider farming population, similar experiences with benchmarking have been observed for other aspects of farming. Benchmarking is viewed by policy makers as a useful tool to help create a more competitive agricultural industry through the provision of quality information to farmers and growers from which they can make business decisions. However, in practice, the combination of metrics and discussion is where the value lies. Experiences from other projects within the UK confirms this. AHDB Cereals and Oilseeds run a monitor farm project that balances benchmarking (which documents the impact) with the peer to peer discussions and farmer input. This has been shown to result in raising of relevant issues and solutions delivered in a format that are understood and actionable (AHDB Cereals and Oilseeds 2016).

Comparing the level of farmer engagement with other carbon management software tools with the FCCT model reveals a similar low level of voluntary uptake. Discussions with other footprinting providers reveal a need to 'package' the metric tool with an advisor to add value. This partnership allows for farmer engagement through making the metrics (and report) relevant to the farmer's situation at home and their areas of interest. This is made easier when the advisor has a practical understanding of agriculture and local issues and is further enhanced if there is an existing trusted relationship between advisor and farmer.

5.2 Knowledge Events

The Soil farmer of the Year competition was a new project by FCCT with the aim to engage with a wider network of farmers and growers by demonstrating farmer innovation and commercial solutions at a field scale.

The campaign was a success in bringing together a new cohort of people who had not previously engaged with FCCT. The top prize winner of the competition was a farmer who was active on social media and well respected in the arable farming world. As a consequence, this broadened the reach to other farmers who were generally interested in his views and opinions and were able to benefit from hearing of his successful approach to soil management. The event at this farm attracted the largest number of farmers from any FCCT event since its inception. The other two events also had higher than average farmer numbers, with farmers apparently enjoying the practical elements of the farm walk and the opportunity for peer to peer learning.

Often the issue with engaging farmers in discussions about climate change is challenging because of prior perceptions and a lack of understanding of the direct relevance to day to day business operations. Through targeting one particular issue (soil management) that impacts on farm greenhouse gas emissions, the campaign was able to realign the climate change messages with practical on-farm management. During the soil competition events, the project facilitators were able to relate farmers' actions with the likely impacts on their carbon footprint and the potential for increased carbon sequestration but without making this issue the main focus of the knowledge exchange event.

The main focus was soil, which the farmers related to as it is a resource that they work with every day. The more traditional technical events had similar messages, were all hosted on-farm and included a farm walk to look at in-field techniques and practices. However, although they contained a lot of the same information, they were less well attended and were attended by a larger proportion of advisors, researchers and industry. Of course there are benefits to delivering knowledge via advisors and informing an advisor is an accepted method of indirect knowledge exchange to farmers. However, for emotive and poorly understood topics such as carbon management, the fact that the knowledge may then be delivered to farmers in a diluted and adapted format may reduce its effectiveness.

By running the campaign as a competition, it was apparent that farmers appreciated the resulting recognition of their farming practise. There has been a shift (especially among arable farmers) towards a sharper focus on soil management, and the timing of the competition allowed farmers who had been instrumental in championing practices such as minimum or zero tillage to share their experiences and be recognised for this paradigm shift away from ploughing.

Farming tends to have a negative press with regard to its impact on climate change. Allowing farmers to apply for recognition for something that they are proud of (their farm, management system and the impact on quality) allows for a positive slant on a subject that traditionally attracts negative attention. Creating an atmosphere where farmers can showcase the positive steps that they are taking to be more sustainable, safeguard their farms and soils for future generations and protect natural resources changes the conversation from one of defence to celebration.

6 Conclusions

This paper has examined the potential opportunities to engage farmers in the climate change debate by assessing the efficacy of different communication strategies. The two specific strategies that were assessed focused on the use of metrics (both guided and self-assessed), and the use of 'framing' climate change around a particular technical issue (and comparing advisor led versus farmer led method of dissemination).

The results suggest that while metrics are a good method of documenting impact and highlighting change they are not a good introduction to issues as they are complex and require time, patience and understanding. However, by including metrics as part of a package with discussion from an advisor who has an understanding of the footprinting process, it allows for the creation of meaningful results both at the farm level (through the advisor making it relevant to the farmer) and at the industry level (where it is possible to document mitigation efforts from agriculture).

The focus on the technical issue of soil management rather than hosting events around agricultural and climate change attracted more farmer interest. What helped to increase the farmer network even further was the use of a competition and the opportunity for other farmers to share in the positive experience of seeing award winning farmers explain their management strategies. There is renewed interest in soils currently, and so allowing farmers who were safeguarding their soils an outlet to be rewarded was timely.

Although scientific research showing the effects of farming on climate change is important, it is the response of those involved in farming that is most critical. Farmers need to feel engaged and to have a clear understanding of the impact of their actions, including the positive contribution they can make. The impacts on their farm operations and businesses need to be made obvious and the potential solutions realistic and achievable.

This can be best achieved via a suite of appropriate dissemination approaches that responds to the diversity within the farming population as well as the complexity of the problem and its solutions. It is key that positive stories are included in this process, as these serve to encourage as well as engage. Successful solutions rely on the interaction between the scientist, farmer and policy maker to develop practical and innovative actions. Farmer participation not only enhances the opportunity for sustainability, but also acts as a conduit for wider community engagement, as was the case with the soil farmer competition.

Acknowledgements Thank you to all the farmers who attended the technical and soil farmer events and responded to positively to requests for feedback. Thank you to the demo farmers, and the self-assessment farmers for engaging with the project and providing your opinions so readily as well as the FCCT team.

References

AHDB Cereals and Oilseeds (2016) The Monitor Farm Programme. Retrieved from https://cereals.ahdb.org.uk/get-involved/monitor-farms.aspx. Last accessed 12 Dec 2016
Blackstock KL, Dwyer J, Ingram J (2007) Negotiating change: the importance of knowledge networks in mitigating diffuse pollution. Paper given at the CAIWA conference, Basel, 11–15 Nov 2007
Dawson J, Smith P (2010) Integrative management to mitigate diffuse pollution in multi-functional landscapes. Curr Opin Environ Sustain 2:375–382
Defra (2013) Agricultural statistics and climate change (4th ed). Retrieved from https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/225181/agriclimate-4edition-30jul13.pdf. Last accessed 12 Dec 2016
Fleming A, Vanclay F (2010) Farmer responses to climate change and sustainable agriculture. A review. Agron Sustain Dev 30(1):12–17
Greiner R, Patterson L, Miller O (2009) Motivations, risk perceptions and adoption of conservation practices by farmers. Agric Syst 99:86–104
Hansen BG (2015) Financial extension that challenges farmers' thinking in discussion clubs helps farmers improve their problem solving abilities. Agric Syst 132:85–92
Helm D (2008) Climate change policy: why has so little been achieved? Oxf Rev Econ Policy 24 (2):211–238
Ingram J, Maye D, Kirwan J, Curry N, Kubinakova K (2015) Interactions between niche and regime: an analysis of learning and innovation networks for sustainable agriculture across Europe. J Agric Educ Ext 21(1):55–71
Le Gal P, Dugue P, Faure G, Novak S (2011) How does research address the design of innovative agricultural production systems at the farm level? A review. Agric Syst 104:714–72
Leitgeb F, Funes-Monzote FR, Kummer S, Vogl CR (2011) Contribution of farmers' experiments and innovations to Cuba's agricultural innovation system. Renew Agric Food Syst 26(4):354–367
MacMillan T, Benton T (2014) Engage farmers in research. Nature 509:25–27
Nowak P (2013) Thinking about a future conservation agenda. J Soil Water Conserv 68:50A–52A
OECD (2012) Introduction to farmer management practices. In: Farmer behaviour, agricultural management and climate change. OECD Publishing, Paris
Wall E, Smit B (2005) Climate change adaptation in light of sustainable agriculture. J Sustain Agric 27(1):113–123
Wood BA, Blair HT, Gray DI, Kemp PD, Kenyon PR, Morris ST, Sewell AM (2014) Agricultural science in the wild: a social network analysis of farmer knowledge exchange. PLoS ONE 9(8): e105203

The Role of Risk Perceptions in Climate Change Communication: A Media Analysis on the UK Winter Floods 2015/2016

Viktoria Cologna, Rosalind H. Bark and Jouni Paavola

1 Introduction

In the winter 2015/2016 a series of storms caused widespread flooding in Cumbria, Lancashire and Yorkshire in the northwest and northeast England. Flood damage was severe and two years on many residents and businesses are still in the recovery phase. Floods are the most serious natural hazard in the United Kingdom and their intensity and frequency are expected to increase in the changing future climate, leaving a growing number of people at risk from flooding (Committee on Climate Change 2016; Evans 2004; HM Government 2016; Thorne 2014).

The UK faces many risks exacerbated by climate change, which means that they are now incalculable and unpredictable to such an extent that Beck's (1992) assertion that we live in a risk society rings true. Most experts refer to risk as the probability of an adverse event times its consequences (Wilson and Crouch 1982). Contemporary usage of the term 'risk' implies precision of calculation, objectivity and control (Joffe 1999). However, such positivist definitions fail to acknowledge the complexity and subjectivity of risks. As the concept of 'risk' is a human construct, we cannot speak of 'real' or 'objective' risk as the concept of risk itself is of subjective nature (Rausand 2011). On the other hand, the validity of conceptualising risk perception solely in terms of individual cognition has been questioned (Joffe and O'Connor 2013). It is accepted that responses to risk develop in, and through, interaction with others and result from a culturally formed interplay between institutional and individual subjectivities (Gabe 2004; Joffe 2003; Kahan et al. 2010). This makes scientists, the media and the political and institutional

V. Cologna · R. H. Bark (✉) · J. Paavola
School of Earth and Environment, Maths/Earth and Environment Building,
University of Leeds, Leeds LS2 9JT, UK
e-mail: R.H.Bark@leeds.ac.uk

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_18

entities in charge of assessing, communicating and managing risks, key actors in influencing the way the public perceives risks (Beck 1992).

It can therefore be argued that scientists, the media and political and institutional entities have heuristic potential to influence our risk perceptions and the way we respond to risk, as the media shapes our sociocultural constellation. Mental models that individuals use to judge risks are internalised through social and cultural learning and constantly reinforced, modified, amplified, or attenuated by media reports, peer influences, and other communication processes (Morgan et al. 2001). This potential of the media to shape risk perception and to drive agendas and policy development has been acknowledged in the literature (Escobar and Demeritt 2014; Kasperson et al. 1988; McCombs 2005).

The main communication channels for informing the public on risks are scientists, the media and political entities. However, their incongruous opinions on future risks can confuse public risk perception, which in turn can result in serious consequences, such as inaction and unpreparedness. The proliferation of counterintuitive ideas originates to poor understanding and reporting by the media and government on climate change and related risks, and poor communication between scientists, journalists and policy-makers; together they affect public understanding of risk (Stoutenborough and Vedlitz 2012; Stoutenborough et al. 2014). There is also growing evidence that the way risk and uncertainty-related information is presented to the public needs to be tailored to expert and non-expert audiences in order to increase understanding (Taylor et al. 2014).

Understanding flood risk perception and the factors influencing it, such as climate change, has important social and political implications as the level of awareness of flood risk directly influences people's actions before and during a flood (Grothmann and Reusswig 2006). Key factors influencing risk perception include: (1) information provided by communication channels and; (2) trust in authorities and flood defence measures (Wachinger et al. 2013). The interplay between these two factors is crucial as policy-makers and institutional entities both need to communicate risk in ways that enable the public, as well as, delivering effective flood defences and describing the level of defence provided in a simple way. There is an opportunity to create a two-way dialogue between the public and government on the main issues and risks at stake with the objective of increasing public and community preparedness.

For now, the media mediates this dialogue and therefore it is important to understand how it does this. In this chapter, we analyse the reporting of the winter floods 2015/2016 in order to understand the role of the media as a social moderator of flood risk. We find woeful reporting of climate change and an unhelpful focus on assigning blame that is counterproductive to achieve safe level of preparedness. We end with some recommendations on how communication can be improved to increase preparedness to flooding events.

2 Methods and Data Analysis

The research for this chapter contributes to the CuPESS project funded by the European Commission to investigate the role of landscape scale nature-based flood risk reduction and adaptation policy in England, as well as to the work programme of the Centre for Climate Change Economics and Policy (CCCEP) on climate change adaptation. The devastating 2015–16 floods raised questions about the UK's current approach to flood risk management, its effectiveness and delivery particularly given the wider context of climate change and the potential for large-scale floods to create reputational risks to government ministries and specific government agencies through perceived or actual inaction, or action that is poorly delivered. We had a particular interest in how the floods were portrayed in the media, specifically the narratives used by the media, for instance, were they around assigning blame, the unprecedented nature of storms, the failure of infrastructure, around community resilience, or the need for new solutions? Systematically coding content provided opportunity to test emergent themes around flood policy and delivery and to perhaps offer useful insights for the development and delivery of future flood risk management solutions.

We adapted Wachinger et al.'s (2013) framework to conceptualise factors that influenced risk perceptions regarding the 2015/2016 winder floods (Fig. 1). The media is visualised as a filter in Fig. 1. We added *political and institutional responses* to the framework as they are considered highly influential factors for risk perception (Butler et al. 2016). Using this framework, we analysed to what extent the media reported on these factors and whether and how the media might amplify, reinforce, modify or attenuate risk perception by selectively conveying and shaping information.

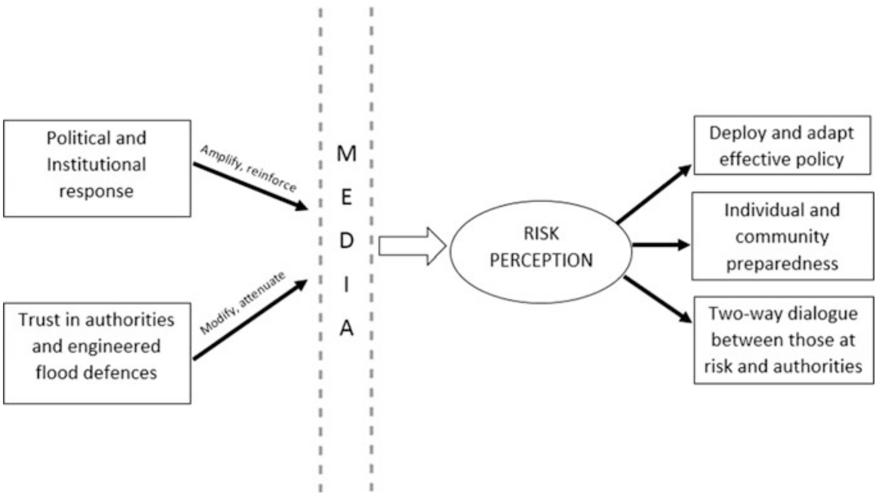


Fig. 1 Framework for media influence on risk perception, adapted from Wachinger et al. (2013)

We collected UK National tabloid and broadsheet newspaper articles on the 2015/2016 winter floods; tabloids for their large circulation and broadsheet newspapers for their influence on agenda setting (Escobar and Demeritt 2014). The articles were collected from Nexis® using News Search for the period from December 4, 2015 through to February 2, 2016. Search terms used were “flood” and “flooding”. We restricted our search to newspaper articles of over 500 words in length, to obtain more in-depth articles and acquired a final sample of 44.

We conducted content analysis of the media articles using NVivo 10 and used axial coding to capture strong recurring themes (Glaser and Strauss 1967). We included themes such as legitimacy, credibility and salience (Cash et al. 2003), emotions, including blame, which has been identified as reoccurring feature in disaster coverage in British newspapers (Hall 2011; Pantti and Wahl-Jorgensen 2011), and other themes found to play a role in influencing risk perception in UK newspaper disaster coverage, such as “community resilience” and importantly “climate change” (Escobar and Demeritt 2014; Gavin et al. 2011). We also coded for “Political and Institutional entities”, “Affected Population” and “Media” to identify the key actors involved. Articles were coded for disaster phase, i.e. preparedness (before the flood event), response (immediately after the event) and recovery (following the response phase).

The coding was revisited as the project developed to ensure a rounded perspective. While the rate of occurrence of different codes provided first insights into salient topics, qualitative analysis was conducted using a constructivist grounded theory approach to explore their meaning and framing (Fairclough 1992). Analysing the coding’s frequency in temporal specificity, allowed us to better understand the temporal dynamics of risk perceptions from the preparedness through the recovery phase. To contextualise and illustrate key findings we provide quotes.

3 Results

We find that the political response to the floods was significantly different from the public response; communities blamed political and institutional entities and these entities blamed climate change. Furthermore, the language used by political and institutional entities in the response phase decreased people’s trust and obstructed active two-way dialogue on flood risk management. In what follows we will explain and substantiate these findings in more detail.

3.1 Political and Institutional Response

Members of the public perceive the causes and implications of natural hazards such as floods differently than political and institutional entities (Butler et al. 2016). We found that political and institutional entities actively sought to create a sense of security by discounting scientists' findings concerning increased flood risk due to climate change (Evans et al. 2004) and in so doing diminished risk perception in the preparedness phase, by presenting newly constructed or reinforced engineered flood defences as panaceas, and by referring to past floods as "once in a lifetime" events. After the floods had occurred, residents were left with a feeling of mistrust in political and institutional entities and their empty promises. Emotions of despair and disappointment were replaced by anger towards political and institutional entities, who were quick to change their language in the recovery phase to emphasise the "unprecedented" nature of these events.

In the media coverage, politicians initially highlighted the unprecedented nature of the floods, implying that predicting and calculating the extent of the floods ex ante was beyond their power. For example, Rory Steward MP said:

> "We have had more rain than has ever happened in this month. Rivers here which haven't flooded in this way for 75 years are 15 feet up. I'm afraid that is the fundamental problem here. We are spending an enormous amount of money on flood defences. In the end what is beating us is this relentless rain." Mail Online, December 29, 2015.

Politicians explained the unprecedented nature of the floods by climate change. This was perceived in the media as an excuse for inaction:

> "Locally too, the words "climate change" can be politically expedient. Indeed, as Cumbria is left considering the aftermath of the floods […] politicians and officials have been quick to blame climate change. It is, frankly, a cheap way to abdicate any responsibility for the devastating effect of flooding." The Daily Telegraph, December 17, 2015.

The media criticised politicians for using terms such as unprecedented and "once in a lifetime" as excuses for failed engineered flood defences:

> "They (residents of Cumbria) might also feel less inclined to believe the "once in a lifetime" mantra that usually accompanies weather of the sort witnessed last weekend: unless the lifetime in question is that of a goldfish." The Independent, December 9, 2015.

Furthermore, assurances on engineered flood defences came back to haunt the Environment Agency (EA). In January 2015 for example, a spokesman of the EA had stated that:

> "You can never say never to flooding happening, but what we can say is Carlisle is a well-protected city". The Times, December 7, 2015.

3.2 Trust in Authorities and Engineered Flood Defences

Political and institutional entities were blamed for flooding, e.g. because of reduced investment or decisions taken. The prominent blaming of political and institutional entities and the very limited blaming of existing engineered flood defences can be explained as follows. First, although the City of York had a flood barrier in place, the EA decided to lift the barrier to avoid the possible shutdown of electrical works. This decision caused widespread disdain and mistrust towards political decisions and flood response effectiveness.

> "We have never had to worry about flooding because the barrier was there to protect these homes. They made the decision to raise the barrier and that's why all this has happened." York resident. Express Online, December 28, 2015.

Second, residents in Cumbria and Yorkshire did not blame the existing flood barriers, as they reduced flood damage. Instead, they blamed politicians because although new investments had enhanced engineered flood defences, these were inadequate for scale of threat.

> "I dread to think what it would have been like without the flood defences, but it's still not adequate is it?" Carlisle resident. The Times, December 7, 2015.

Third, we find that affected populations did not blame climate change as a cause of flooding events but rather the inadequacy of flood risk management policy. For instance, a Carlisle resident commented "Something is wrong somewhere—*they* have spent £38 million and it has not worked." (The Times, December 7, 2015, our emphasis). We find that residents already blamed political and institutional entities in the preparedness phase before the flooding event, and that the level of blame remained high in the recovery phase. This suggests that political and institutional entities did not meet public expectations in relation to flood risk management before the floods occurred, and their effort and support in the recovery was deemed unsatisfactory.

4 Discussion

In this chapter we developed a methodological framework for conceptualising factors that have been shown to influence individual risk perception and modified it to explicitly incorporate the role of the media. We applied this conceptualisation to news articles on the UK winter floods of 2015/2016. We found that whilst political and institutional entities made an explicit link between the unprecedented nature of floods and climate change the public did not. This confirms other research that has shown that: flooding intensity in the UK is expected to increase (Evans et al. 2004); winter precipitation has already increased in northern England over the last decades (Jenkins et al. 2008); and this increase in flood risk hazard has been perceived by the UK public (Taylor et al. 2014), nevertheless UK flood victims do not link flood events to climate change (Kazmierczak and Bichard 2010; Whitmarsh 2008). An outcome is that climate change risks are not viewed as personally relevant (Lorenzoni et al. 2006).

Several explanations can be given to explain why residents do not seem to link floods to climate change. One reason could be related to what Giddens (1991) refers to as ontological security or "the feeling of existential safety and meaningfulness that results from a belief in the continuity of one's identity and existence" (Harries 2013, p. 55). In social representation theory, people's representation of the world consists of peripheral elements that cluster around a central core (Abric 1984). Any peril to the core elements causes anxiety and threatens ontological security (Wilkinson 2001). Therefore, the response to new information about flood risks, such as a possible increasing intensity due to climate change, is assimilated to prevent impacts on the core (Harries 2013). Negative intense emotions like fear and anxiety have been found to have a counterproductive effect on risk protection behaviour, leading to avoidant behaviours (Witte and Allen 2000). Second, there is evidence that the media fail to present climate change in an understandable manner for the public (Boykoff 2011; Feldman et al. 2014). Third, political entities emphasised the "once in a lifetime" nature of the 2015–16 floods and made claims about the capability of engineered flood defences to prevent future flooding events without regard to the effects of climate change.

The media reporting kept returning to the fact that investment in flood barriers and flood walls had directly reduced perception of risks and furthermore that most places affected by the winter floods had recently reinforced engineered flood defences. Engineered flood defences are very visible in the landscape, bolstering trust and decreasing risk perception (Grothmann and Reusswig 2006; Kazmierczak and Bichard 2010; NAO 2001; Siegrist et al. 2005; Terpstra 2009) and often reducing household prevention and preparedness (Armas et al. 2015). Political entities also emphasised their effectiveness to withstand future floods by discounting the effects of climate change and by doing so decreased public risk perception. Therefore, people may not have seen the need to take protective measures themselves (NAO 2001; Paton 2008). This should be worrisome for the government as in many cases engineered flood defences may in fact be providing downstream and not in situ flood risk reduction. Trust in engineered flood defences can lead to potentially serious adverse consequences because of underestimation of risk (Kasperson et al. 1988).

Understanding risk perception, we argue is a pillar to: formulate better policy; enable preparedness; and shape effective two-way dialogue, i.e. the right hand side of Fig. 1. There is a central role for communication to facilitate both better policy and preparedness (Kreibich et al. 2011). A first step is to raise awareness of flood risk. The winter floods may act as a "focusing event" (Kingdon 1995) drawing National government attention to flood risk vulnerability and to changes in flood risk management policy. This has already been evidenced by the latest review of flood risk policy (HM Government 2016). Familiarising the public with climate change projections and hydrological modelling which suggests increasing frequency and intensity of flood events is an essential first step.

In order for this to happen it is important that information is provided for both experts and non-experts. The media plays an essential role in creating an informed public by diffusing knowledge from expert sources to a non-expert public in a comprehensible way. Stoutenborough et al. (2014) found that this could be achieved by *increasing* communication between expert sources such as scientists and non-experts, such as the media and policy makers, to increase validity and public understanding. Scientists also need to *improve* their science communication as there is evidence that the majority of commissioned scientific reports are never actually read by the politicians and their staff (Boswell et al. 2011). This may involve improving the presentation of climate information (Taylor et al. 2015) including finding more meaningful language and tailoring information according to the public level of understanding, e.g. 1 in 100 years flood risk messages are confusing to the public (HM Government 2016).

Another avenue where better communication is needed is on the subject of risk. There is a general disagreement between experts and lay people on what constitutes future risk and the public is unable to differentiate long-term risk from familiar risks (Slovic et al. 1979). The permanency of climate change as a long-term risk requires a paradigm shift to accept and adapt to a risk society (Beck 1992). However, a glaring oversight is the scarcity of information provided to readers on the long-term nature of flood risk under climate change. This is a crucial oversight because climate change awareness and stated willingness to adopt domestic flood protection measures are correlated in England and Wales (Bichard and Kazmierczak 2012). Better communication and education have a potentially significant role (Renn and Levine 1988). It is important that scientists communicate with journalists and educate them on climate change and related risks, so that the media can filter and present information to the public in a way that increases rather than reduces ontological security so that the messages are assimilated in a way that promotes adaption to risk. However, this can only happen if political entities themselves communicate with scientists and the public, accept the reality of future risks before natural hazards occur, rather than blaming them ex ante, and provide flood management solutions that are based on scientific evidence.

So the question arises, what type of communication is needed? Looking at the 141 page National Flood Resilience Review (HM Government 2016), it seems clear that there is a need to make information more comprehensible for lay people. Namely, key messages from such reviews need to be distilled for TV, radio, print, social media and peer networks in ways that acknowledge risk perception patterns (Renn 2004). Other communication outlets have been shown to be effective when communicating with the public. General awareness of flood risk can be raised by public information campaigns (Lamond and Proverbs 2009) though the type of information may need to be tailored depending on tenure, prior experience of floods, demographics of the affected population (Kellens et al. 2011).

To avoid challenging ontological security, it is important to find ways to communicate with the public that do not increase fear but rather perceptions of safety. Changing individual and community behaviour through calls for action to raise risk awareness need also empower personal risk reduction and local community preparedness (Lamond and Proverbs 2009; Thieken et al. 2007). Authorities could adopt holistic transdisciplinary approaches that include both scientific and cognitive-psychological knowledge (Beck 1992; Renn 2004; Rose 1998) to ensure that risk policy is neither purely science-based nor purely value-based (Renn 2004). Another key step is to facilitate effective communication between affected communities and those involved in flood relief efforts and political and institutional entities. These efforts may take advantage of local governance innovations, such as community flood wardens, catchment partnerships and networks of pop-up volunteers. Communication is a two-way process, and politicians and institutional entities need to learn how to integrate public views and societal values into the process of risk analysis (Frewer 2004).

We recognise the potential of the media to act as a filter that can amplify, reinforce, modify or attenuate risk perception and therefore, there is growing recognition of the potential role of the media to initiate and sustain a two-way dialogue on flood risk resilience. Natural hazards create a "window of opportunity" (Kingdon 1995) where the media has the potential contribute to risk education. In fact, after a flood event, risk perception and risk awareness can reach high levels, before dropping back to average levels (Wachinger et al. 2013). These "windows of opportunities" provide a fertile ground for the media to educate the population on future climate change and influence their risk perception. This post-event period is important, as the way communication channels frame these events at that time can have different institutional effects (Kaufmann et al. 2016). This requires flood coverage (Gavin et al. 2011) even when flood damage is minor, because the media has the potential to normalise flood risk including a dialogue on the dynamics of a flood from displacing people from their homes and businesses, disruption to transportation links, and raising insurance premiums, which have been shown to increase household uptake of prevention measures (Thieken et al. 2007).

This research has limitations that could be addressed in future research. For example, what are the roles of the media in moderating risk perception prior to, during and after flooding? A limitation of the paper is the focus on traditional media outlets. Extending the analysis to social media (Twitter, Facebook) 'reporting' of the flooding would add to our understanding of the role of media, however, this would require new methodology to take into account the short nature and large number of such 'reports' (Tweets, Updates and Comments). Another possible extension to this research would be to explicitly compare media reporting of different floods and different flood types (riverine, surface water, coastal) in the UK over time and space. Future work should also look at how risk perception and response after a flood event differs for cities and villages where different approaches to sustainable flood management are in place, compared to those solely reliant on engineered flood defences.

5 Conclusion

In this chapter we developed and extended a framework for analysing different factors that influence risk perception and the media's role in filtering information and in turn influencing adaptation policy, preparedness and communication. We found that opinions and knowledge regarding climate change and related future risks differ between experts and lay people and that this influences risk perception, possibly leading to unpreparedness amongst the at-risk public. Our recommendations are that there is a need for improved climate change information and risk communication between experts and the media and for more media coverage of climate change and flood risk. In this way and by providing coverage of communities that are preparing for flood risks the media can play a role in empowering communities to understand the risks they face and to prepare. As risk perception is an important psychological factor that determines preparedness and response, it is essential that both the media and political entities learn lessons from research on risk perception in order to communicate climate change risk with the public in a way that is meaningful and enables preparedness actions. If media coverage does not evolve in a way that constructively contributes to climate change adaptation then political entities will have to find other ways of communicating with the public to foster household and community resilience.

Acknowledgements This project was funded from the European Union's Horizon 2020 research and innovation programme under the Marie Skłodowska-Curie grant agreement No 659449 and from the School of Earth and Environment, University of Leeds's Research Experience Placement scheme. Jouni Paavola also acknowledges the support of the UK Economic and Social Research Council (ESRC) to the Centre for Climate Change Economics and Policy (CCCEP).

References

Abric JC (1984) A theoretical and experimental approach to the study of social representations in a situation of interaction. In: Farr R, Moscovici S (eds) Social representations. Cambridge University Press, Cambridge, pp 169–183

Armas I, Ionescu R, Nenciu Posner C (2015) Flood risk perception along the Lower Danube River, Romania. Nat Hazards 79:1913–1931

Beck U (1992) Risk society: towards a new modernity. Sage, London

Bichard E, Kazmierczak A (2012) Are homeowners willing to adapt to and mitigate the effects of climate change? Clim Change 112:633–654

Boykoff MT (2011) Who speaks for the climate? Making sense of media reporting on climate change. Cambridge University Press, New York

Boswell C, Geddes A, Scholten P (2011) The role of narratives in migration policy-making: a research framework. Br J Polit Int Relat 13(1):1–11

Butler C, Walker-Springett K, Adger WN, Evans L, O'Neill S (2016) Social and political dynamics of flood risks, recovery and response. The University of Exeter, Exeter. Available online at http://geography.exeter.ac.uk/media/universityofexeter/schoolofgeography/winterfloods/documents/Butler_et_al_2016_Socia_Political_DynamicsFloods.pdf. Accessed 18 Aug 2016

Cash DW et al (2003) Knowledge systems for sustainable development. Proceed Natl Acad Sci U S 100:8086–8091

Committee on Climate Change (2016) UK climate change risk assessment 2017. Synthesis report: priorities for the next five years. Available online at https://www.theccc.org.uk/wp-content/uploads/2016/07/UK-CCRA-2017-Synthesis-Report-Committee-on-Climate-Change.pdf. Accessed 18 Aug 2016

Escobar M, Demeritt D (2014) Flooding and the framing of risk in british broadsheets, 1985–2010. Public Underst Sci 23(4):454–471

Evans ER (2004) Foresight future flooding, scientific summary, vol 1. Dept. of Trade and Industry, London. Available online at https://www.gov.uk/government/publications/future-flooding. Accessed 18 Aug 2016

Evans EP, Ashley R, Hall JW, Penning-Rowsell EP, Saul A, Sayers PB, Thorne CR, Watkinson A (2004) Foresight future flooding, scientific summary, vol 1. Future risks and their Drivers (London: Office of Science and Technology)
Fairclough N (1992) Discourse and text: linguistic and intertextual analysis within discourse analysis. Discourse Soc 3:193–217
Feldman L, Myers TA, Hmielowski JD, Leiserowitz A (2014) The mutual reinforcement of media selectivity and effects: testing the reinforcing spirals framework in the context of global warming. J Commun 64(4):590–611
Frewer L (2004) The public and effective risk communication. Toxicol Lett 149:391–397
Gabe M (2004) A critical introduction to the risk society. Routledge, London
Gavin NT, Leonard-Milsom L, Montgomery J (2011) Climate change, flooding and the media in Britain. Public Underst Sci 20:422–438
Giddens A (1991) Modernity and self-identity. Polity Press, Cambridge
Glaser B, Strauss A (1967) The discovery of grounded theory: strategies for qualitative research. Aldine de Gruyter, New York
Grothmann T, Reusswig F (2006) People at risk of flooding: why some residents take precautionary action while others do not. Nat Hazards 38:101–120
Hall A (2011) The rise of blame and recreancy in the United Kingdom: a cultural, political and scientific autopsy of the North Sea flood of 1953. Environ Hist 17:379–408
Harries T (2013) Responding to flood risk in the UK. In: H Joffe, Rossetto T, Adams J (eds) Cities at risk: living with perils in the 21st Century. Advances in natural and technological hazards research, vol. 33, pp 45–72
HM Government (2016) National flood resilience review. Available online at https://www.gov.uk/government/uploads/system/uploads/attachment_data/file/551137/national-flood-resilience-review.pdf. Accessed 3 Dec 2016
Jenkins GJ, Perry MC, Prior MJ (2008) The climate of the united kingdom and recent trends. Met Office Hadley Centre, Exeter. Available online at http://www.ukcip.org.uk/wp-content/PDFs/UKCP09_Trends.pdf. Accessed 18 August 2016
Joffe H (2003) Risk: From perception to social representation. Br J Soc Psychol 42:55–73
Joffe H (1999) Risk and 'The Other'. Cambridge University Press, Cambridge
Joffe H, O'Connor C (2013) Risk societies and representation of risk: earthquakes and beyond. In: Joffe H, Rossetto T, Adams J (eds) Cities at risk: living with perils in the 21st century. Advances in natural and technological hazards research, vol. 33. pp 9–23
Kahan DM, Jenkins-Smith H, Braman D (2010) Cultural cognition of scientific consensus. J Risk Res 14(12):147–174
Kaufmann M et al (2016) Shock events and flood risk management: a media analysis of the institutional long-term effects of flood events in the Netherlands and Poland. Ecol Soc 21(4):51
Kasperson RE, Renn O, Slovic P et al (1988) The social amplification of risk: a conceptual framework. Risk Anal 8(2):177–187
Kazmierczak A, Bichard E (2010) Investigating homeowners' interest in property-level flood protection. Int J Disaster Resil Built Environ 1(2):157–172
Kellens W, Zaalberg R, Neutens T et al (2011) An analysis of the public perception of flood risk on the Belgian Coast. Risk Anal 31(7):1055–1068
Kingdon JW (1995) Agendas, alternatives, and public policies, 2nd edn. Longman, New York
Kreibich H, Seifert I, Thieken AH, Lindquist E, Wagner K, Merz B (2011) Recent changes in flood preparedness of private households and business in Germany. Reg Environ Change 11:59–71
Lamond JE, Proverbs DG (2009) Resilience to flooding: lessons from international comparison. Urban Des Plan 162(2):63–70
Lorenzoni I, Leiserowitz A, Doria M, Poortinga W, Pidgeon N (2006) Cross-national comparisons of image associations with "global warming" and "climate change" among laypeople in the United States of America and Great Britain. J Risk Res 9:265–281
McCombs ME (2005) A look at agenda-setting: past, present and future. Journal Stud 6:543–547

Morgan MG, Fischhoff B, Bostrom A, Atman CJ (2001) Risk communication: a mental models approach. Cambridge University Press, Cambridge, MA

NAO (2001) Inland flood defence: report by the controller and auditor general HC 299, Session 2000–2001. National Audit Office. Available online at https://www.nao.org.uk/wp-content/uploads/2001/03/0001299.pdf. Accessed 16 Aug 2016

Pantti MK, Wahl-Jorgensen K (2011) ‘Not an act of God’: anger and citizenship in press coverage of British man-made disasters. Media Cult Soc 33(1):105–122

Paton D (2008) Risk communication and natural hazard mitigation: how trust influences its effectiveness. Int J Glob Environ Issues 8(1/2):2–15

Rausand M (2011) Risk assessment theory, methods, and applications. John Wiley & Sons, New Jersey

Renn O, Levine D (1988) Trust and credibility in risk communication. In: Jungermann H, Kasperson RE, Wiedemann PM (eds) Risk communication. Proceedings of the International Workshop on Risk Communication October 17–21, 1988. Jülich. Jülich, FRG: Kernforschungsanlage Jülich, pp 51–81

Renn O (2004) Perception of risks. The geneva papers on risk and insurance 29:102–114

Rose EA (1998) Metatheoretical foundations for post-normal risk. J Risk Res 1:15–44

Siegrist M, Gutscher H, Earle TC (2005) Perception of risk: the influence of general trust, and general confidence. J Risk Res 8(2):145–156

Slovic P, Fischhoff B, Lichtenstein S (1979) Rating the risks. Environment 21(3):14

Stoutenborough JW, Vedlitz A (2012) Public opinion and climate-related policy solutions: a comparison of the policy preferences of the public, stakeholders, and climate scientists. Paper presented at the annual meeting of the Midwest Political Science Association Chicago

Stoutenborough JW et al (2014) Understanding the communication of climate change risk: climate scientists’ perspectives of media sources and policy makers. Risk Hazards Cris Public Policy 5(4):365–384

Taylor AL, Bruine de Bruin W, Dessai S (2014) Climate change beliefs and perceptions of weather-related changes in the United Kingdom. Risk Anal 34(11):1995–2004

Taylor AL, Dessai S, Bruine de Bruin W (2015) Communicating uncertainty in seasonal and interannual climate forecasts in Europe. Philos Trans Royal Soc A 373:1–16

Terpstra T (2009) Flood preparedness: thoughts, feelings and intentions of the Dutch Public. Ph.D. Thesis, University of Twente. Available online at https://www.researchgate.net/publication/239851761_Flood_Preparedness_Thoughts_Feelings_and_Intentions_of_the_Dutch_Public. Accessed on 16 Aug 2016

Thieken AH, Kreibich H, Müller, Merz B (2007) Coping with floods: preparedness, response and recovery of flood-affected residents in Germany in 2002. Hydrol Sci J 52(5):1016–1037

Thorne C (2014) Geographies of UK flooding in 2013/4. The Geogr J 180(4):297–309

Wachinger G, Renn O, Begg C, Kuhlicke C (2013) The risk perception paradox—Implications for governance and communication of natural hazards. Risk Anal 33(6):1049–1065

Whitmarsh L (2008) Are flood victims more concerned about climate change than other people? The role of direct experience in risk perception and behavioural response. J Risk Res 11(3): 351–374

Wilkinson I (2001) Anxiety in a risk society. Routledge, London, England

Wilson R, Crouch E (1982) Risk/Benefit analysis. Ballinger Publishing Co, Cambridge, MA

Witte K, Allen M (2000) A meta-analysis of fear appeals: Implications for effective public health campaigns. Health Educ Behav 27(5):591–615

The Feeling of Red and Blue—A Constructive Critique of Color Mapping in Visual Climate Change Communication

Birgit Schneider and Thomas Nocke

1 Introduction

In this article the authors will present some new research gained by different methodologies on color symbolism in climate change visualizations. For this purpose, the authors took questions and insights derived by visual studies methods and transferred them into the test setting of a qualitative survey on impacts of color schemes in climate change maps. The core question is what impact colors have on the interpretation of global climate change visualizations. With their combined setting the authors sought to interpret maps depicting global temperature rises not from a cartographic perspective in the first place but from an *iconic* perspective: what does a certain color scheme applied to global data maps tell different viewers? Does color play a role in the assessments of scientific appearance, risk and danger?

With the outcome of the research the authors hope to offer a contribution to estimate the complex and sometimes conflicting impacts of color in visual climate change communication, by taking into account the following difficulties: the difference of culturally influenced types of risk perception, the gravity of the issue and the dynamic interplay between science, media and the public, that trigger different narratives and speak different languages of catastrophe (Hulme 2009, Chap. 6). Therefore, if an IPCC-map is analyzed in the following this approach is not about criticizing the message of climate science or the work of the IPCC, but to estimate the role IPCC visualizations produced for policy makers play in climate change communication and to value their productive function as communicative instru-

B. Schneider (✉)
Professorship for Media Ecology, University of Potsdam, European Media Studies, Am Neuen Palais 10, D-14469 Potsdam, Germany
e-mail: birgit.schneider@uni-potsdam.de.de

T. Nocke
Potsdam Institute for Climate Impact Research, Telegraphenberg, 14412 Potsdam, Germany
e-mail: nocke@pik-potsdam.de

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_19

ments for the "honest brokers" of climate change. Nonetheless the authors know that analyzing the complexity of climate change communication today is in itself problematic, because on a level of the post-factual many powerful actors still undermine the findings by a profound and deliberate misunderstanding of skepticism (Washington and Cook 2011). At the same time, the authors should like to emphasize right at the beginning the limits of their survey: because of the small size of the group interviewed the argument cannot be universalized to any extent; still it is possible to recognize tendencies which would then need further research.

The question was derived from humanity's interpretation of color in the first place. It grounds on the fundamental assumption that no message is neutral, instead facts are always filtered, amplified and rhetoricised in many ways (Hulme 2009, 225). This holds also true for images also: History of art and visual studies base on the assumption that meaning in imagery can never be completely controlled—this polyphony of pictorial meaning has been studied extensively in the field of semiotics, philosophy and art history (Hatt and Klonk 2006). Art history has proved that there always is a surplus of uncontrollable meaning. The analysis of pictorial media is able to access layers of "disguised symbolism" (Panofsky 1953) beyond the factual form, which materialize in any pictorial medium (Bredekamp et al. 2015). In particular, artists and creatives in advertising, who target broader audiences, are very aware of the fact that the meaning of images cannot be restricted completely. This is especially true for color. Colors address human perception immediately, they influence the meaning of a picture. They are able to highlight, to superimpose symbolic layers, to aestheticize, to attract attention, to clarify, to alarm or to balance out what they display.

Because of the polyphony of meaning of colors, very different and powerful symbolic meanings are inevitably assigned to the subject that go beyond the natural coding of red and blue to depict temperatures but which likewise belong to the established semantics of these colors. The appliance of color in map design often is arbitrary and in most cases got ruled only by conventions. A cultural history of color here offers many conflicting paths of interpretation (Gage 1993, 2000). On a physical level the color red is less energetic than blue, opposing the temperature scheme found in map design, because from a color-psychological perspective, red is perceived to be more warm than blue, which is perceived as a cold color (Meadows 2014, 131). At the same time red has an exceptional position because it occurs only rarely in nature. Therefore, it not only became the color of honor, love and energy, but also got conventionalized as the color of highlighting and of marking danger and action at the same time, because red also stands for the destructive power of fire and blood. The highlighting dimension of the color red applies to information design, where red triggers symbolic layers such as danger, warning signal, intensity and the deviation of a norm—especially in the case of visualizing global risks. Map historian Gilles Palsky even put forward the thesis (Palsky 1996) that colors turn maps into political maps, because colors always imply meanings and interpretations in the case of scientific climate maps becomes strangely valid also. At the same time, it was stated from a history of science' perspective that black-and-white images in science tend to give a more neutral and objective impression (Daston and

Galison 2007), although it is not clear if this argument applies to map and information design in general, because color plays a crucial role for enriching the image with information.

From an information graphic perspective, data visualization in a scientific sense must fulfill specific quality criteria. In informational design colors denote data, they represent numbers, measurements. At the same time, they denote frontiers within the data because somebody has to decide where to cut the data into zones. With maps one also can highlight certain findings and readings of the data. Informational designers learn certain rules to apply color to maps: A key finding should be recognizable by color spaces. By applying color to a map it is assumed that it gets possible to display more data layers and to make visible more details in the data in a clearer and more direct way (Bertin 1967). If certain color schemes are used it is possible to display the data in a very exact way. The image becomes readable. Since the early twentieth century, guidelines exist at a level of practical knowledge about the use of colors in a "good" and "effective" way and how to apply this to data graphics and maps (Bertin 1967; Tufte 1990; Palsky 1996; Stauffer et al. 2015). As data visualizers know, graphics are capable of containing only a limited amount of information.

Summing up, the case with red and blue is tricky. Colors can trigger symbolic and iconic levels at the same time: In the case of climate science graphs, this lead to the interpretation that the pure informative level of the intensive colors red and purple in contrast to blue in order to code warming can very strongly direct attention to all possible notions of red in connection to the motive: alarm, devastating heat, fire and destruction, meaning that the hot color schemes not only work on a rational level but at the same time heat up the feelings of their beholders and depict future as catastrophe (Schneider 2016; Horn 2014).

The interpretation of the IPCC map (Fig. 1) by Schneider (2016) using methods of image analysis from a humanity's perspective, came to the following results: It contains alerting effects by the chosen fiery red color spectrum; this impression is increased by the extra color of a bright purple added to the end of the color scheme, where one would expect a darker red. The color purple marks the highest temperature increase on the map. It adds alertness in particular because it carries connotations of unnatural danger, alarm, and abnormal exceeding of extreme values ("the new normal of abnormalities"). If this color scheme is used to present already occurred global warming, the map suggests a burning future of extreme disasters that does not call for action but evokes feelings like powerlessness.

With the survey undertaken here the authors want to change this analysis into a constructive critique, because it is not about interpreting a certain map as "good" or "bad", but to gain a better understanding in the role of color in relation to climate change maps. Therefore, the authors are interested to ask in a more general way if color plays a crucial role for the impact of global warming imagery, how would a politically constructive and empowering map look like? Or is it just not possible to change the imagination of climate change by modifying color?

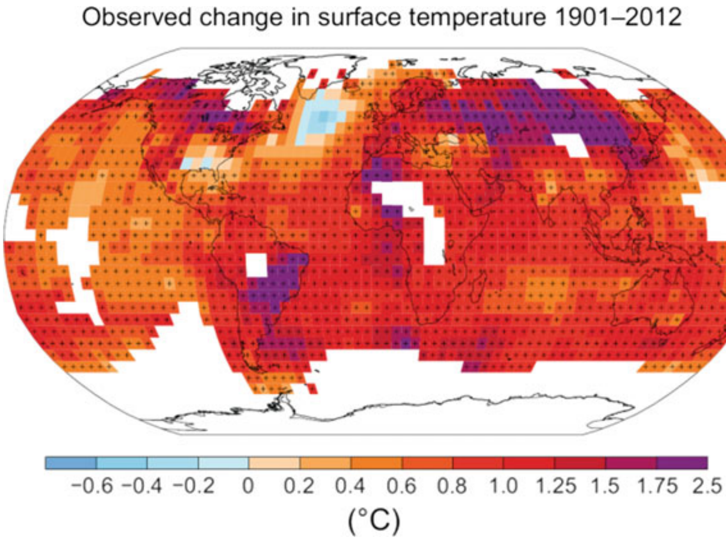


Fig. 1 IPCC AR5 WG1-SPM map representing the observed change in surface temperature in a blue–red–magenta color scheme

Those interpretations, derived from a cultural reading, the authors wanted to study more deeply by changing the methodology from visual studies to a qualitative survey and by at the same time altering the color scheme of an IPCC global temperature map. If color changes perception on an emotional and interpretative level, different colors would have to lead to different interpretations. So what does it change for the understanding and impact of the map to apply colors different to the conventional color scheme of blue (cold) and red (hot)? Therefore, for test purposes, the authors chose a prominent global map from the IPCC AR5 report. In the process of recoloring this map it gets possible to analyze its color scheme and to provide alternatives.

2 Starting Point: Discussion of the Original IPCC Map

For their study the authors decided to change a single global temperature map from the Summary for Policy Makers-Report of the Intergovernmental Panel on Climate Change, Working Group I (see Fig. 1). The map represents global temperature changes between the years 1901 and 2012 based on measurement data. It visualizes data of global temperature observations from the last 100 years by using a color scheme that diverges from blue to orange to different shades of red, the highest temperature rise is given in a bright purple. The map played an important role in the recent report, because it proves that global warming is already happening in the present, it is not a distant future anymore. Its importance was confirmed during the press conference of the IPCC on the occasion of the publication date of the last report in September 2013. It was one of the few visualizations that got highlighted during the press conference to emphasize the urgency and the need to act politically because of global warming. At the same time global red maps in general might be called *iconic* for global warming—only that this time for the first time it was not the future of global warming presented in a bright red color scheme but the presence in comparison to the past.

From a cartographic and visualization science perspective, the graphic has some general shortcomings—which do not touch the general scientificity of the data and the scientific meaning of the map, but communicative and aesthetic requirements. First, the three classes of certainty (represented as the plus marks) and uncertainty (white regions) make it hard to be interpreted by laypersons. Here, a more comprehensible legend would be beneficial. Second, the color map can be criticized in four aspects:

1. the perceived distances in neighboring colors are not equal, which leads to stronger visual gradients between certain color pairs,
2. less value intervals/colors on the positive difference side would help to keep the colors differentiable,
3. the end of the color map has other tic value differences, which are even stronger highlighted by the purple color tones, and
4. in this case a value range of insignificant differences around zero would make sense, decreasing the visual effect of the very intense colors already at relatively low levels of warming/cooling.

2.1 Survey Redesign of the IPCC Map

For their survey the authors decided to change the map's color scheme only by basing on the color maps from Brewer et al. (2003) and the web portal www.colorbrewer.org, a resource that was designed at the GeoVISTA Center at Penn State, USA, where map designers can try out optimized color schemes adapted to their nature of data. In this case the authors had to look for alternative color schemes for *diverging* data, because this is the nature of the data given here: data that allows the emphasis of a quantitative data display that progresses outward from the reference period of the data range—that is from degrees below zero to degrees plus zero. We retained the number of data classes from the original map, that is 13 different temperature bands ranging from −0.6 °C to 2.5 °C, with a slight change in step size above 1.25 °C (from that point on the steps are changing from 0.2 to 0.25 °C). We maintained the general design and coloring of the map: white squares mark geographical regions where the data set is not robust enough to tell about temperature changes during this period of time (e.g. above the poles, the Pacific Ocean, central Africa and small areas in Asia and South America). Dark little

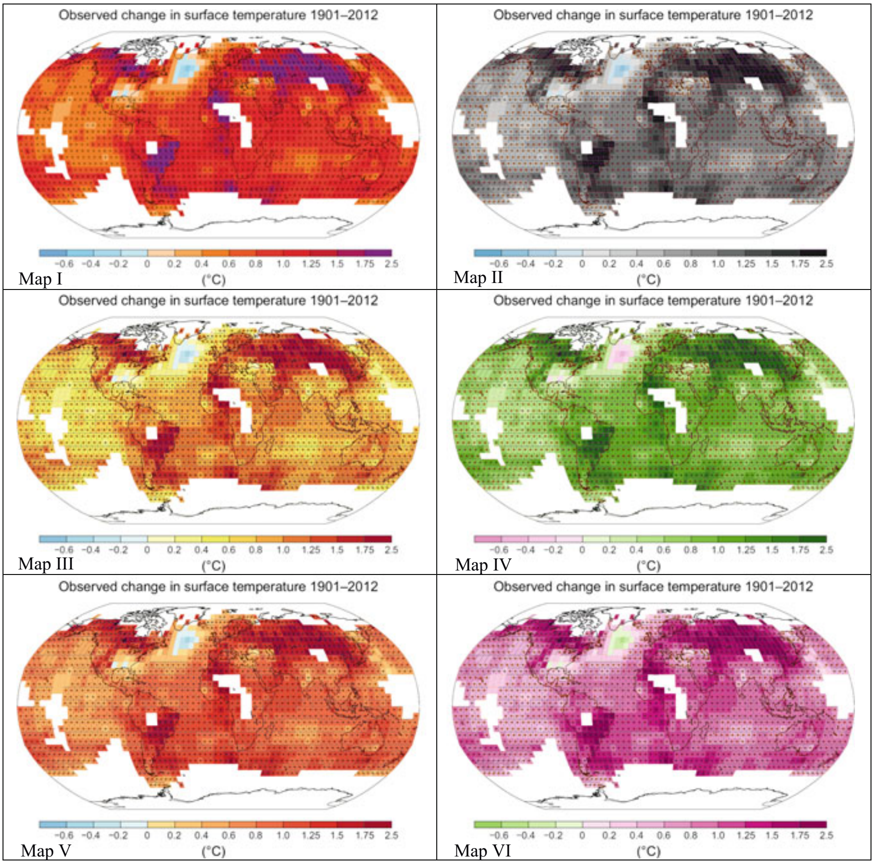


Fig. 2 Color-coded maps tested in the survey: the original color map from the IPCC AR5 WG1-SPM (Map I), and four alternate versions basing on the color schemes by Brewer et al. (Map II, IV–VI) and a yellow version (Map III) altering Map V in the orange part

crosses in each colored square highlight those regions where observations permit an especially robust estimate.

For the purpose of testing a broad range of different color schemes, the authors created five alternative options for the global climate map, which could then be tested against the original IPCC-map (see Fig. 2).

1. **Map I (Blue/Red/Purple):** original color scheme of the IPCC.
2. **Map II (Blue/Black, "less color"):** In this case a map scheme varying from blue (cooling) to black (heating) was developed, in order to analyze how perception would change if colors were reduced as far as possible. One has to note that it was not possible to dispense with color completely because of the diverging nature of the data between cooling and warming temperatures. This is

why the authors created a color scheme that uses as less color as possible by diverging from blue to dark gray.[1]

3. **Map IV (Purple/Green, "anti-intuitive"):** The authors purposely chose a contra-intuitive map scheme ranging from purple (cooling) to green (heating). By symbolizing heat with green and cooling with a warm color they wanted to underrun the impact of intuitively chosen colors in the field. The color spectrum stands in contrast to the highly conventionalized color scheme in map design that range from blue to red to symbolize cool resp. warm temperatures.
4. **Map V (Blue/Red, "cleared red without purple extremes"):** For this version the authors tried to optimize the existing color scheme by cutting out the purple part of the legend and by finding a clearer graduation in red hues. The authors will discuss this version and offer a constructive critique of the original map in the "discussions".
5. **Map VI (Green/Purple: "anti-intuitive-inversed"):** Here the color scheme of Map IV was reversed. Now the color scheme runs from green (cooling) to purple (heating).

In the first place the authors also tried out brownish colors, different shades of red, and a reversed scheme of red and blue. Testing with the different versions proved that the survey got to complex by using more than one anti-intuitive color scheme.

3 Study Design

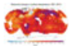
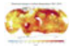
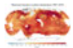
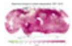
The authors prepared a tabular form with ten short questions relating to the maps and two questions at the end asking for a general estimation of climate change science. Four different selections of six color-coded maps had been prepared, including the original map of the IPCC, varying in choice and order. Figure one shows the six color maps.

As study participants a sample of 22 persons from Germany was recruited. Most of the participants had studied at Universities but did not have anything to do with climate research in their job. The study procedure was conducted by an interviewer who started with explaining the general meaning of the map to a singular interviewee in the first place. After the general meaning was explained the interviewer started to pose the prepared questions regarding colors and their impact. Each interview took approx. 20 min to complete. The interviews were not undertaken by the authors but transferred to a research assistant who was not involved in the research process.

For the first task six questions were presented with four selected visual stimuli in comparison. The interviewees were asked to structure the maps regarding different

[1]In the original red-grey color map from the brewer color set we replaced the red part with blue values from another color scheme.

Table 1 The answers to the six questions comparing multiple images together. Numbers denote mean values for each Fig. (1–10), ranging answers from 1 for “weak/small” to 10 for “strong”; percentages depict—if only one picture could be selected—the number of chosen images in relation of the total number of participants this picture was shown to

Question	Map I 	Map II 	Map III 	Map IV 	Map V 	Map VI 
How severe would you estimate the global temperature increase with respect to the appeal of colors?” (1–10)	**8.3**	4.3	**6.4**	4.8	**6.7**	4.6
Can you discern the different data values given by the color in one map more clearly than in the others? choose one	23%	8%	**50%**	18%	19%	0%
Which color scheme appeals to you the most intuitive one for the topic? (1–10)	**6.2**	4,5	**8.0**	3,9	**7.7**	5.2
Please estimate the effect of the maps according to their scientific appearance. Which version seems to be the most scientific to you?” (1–10)	5.9	5.8	6.2	5.1	5.6	5.2
Which version appeals rhetoric/ judgmental to you? (1–10)	**6.9**	4.2	5.5	3.9	4.8	**3.4**
Which map would you choose to affect policy makers to take more action in climate protection? choose one	**43%**	15%	**35%**	6%	27%	0%

questions by either rating them on a scale from 10 (strong) to 1 (weak/small) or by selecting one individual image. All questions focus on the influence of color on different levels of meaning, taking into account emotional effects and image impressions like readability, intuitiveness, visual rhetoric and effectiveness of color concerning the subject of the map. The detailed questions can be found in Table 1 in the next section.

For the second part of the survey we reduced the selection and concentrated on two maps one after the other in order to go into a more profound interpretation of two singular maps:

1. The first question was posed rather open to find out about the understanding of color in the map: “How do you understand the employment of color in the map?”
2. Secondly the interviewees were asked to pick a word that best described their reaction to the map relating to the question: “What emotional reactions does the image evoke in you?” The choice of words was “call for action”, “concern”;

“fear”; “alarmism”; “powerlessness” but also left a blank space for other feelings.

3. The following task consisted in naming any free associations that came when looking at the image. A final task gave space to any other idea that did not have space until now (“Any other thoughts concerning the maps you want to share?”).

Afterwards we asked two questions to find out about the individual believe or distrust in climate change findings and personal general sorrows connected to the findings:

1. “Do you trust the findings of climate researchers about human induced climate change?”
2. “How much are you concerned about the current global warming?”

again by rating the answers on a scale from 10 (strong) to 1 (weak/small).

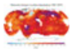
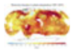
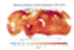
4 Results

For the interpretation the authors averaged all figures in relation to the frequency of presented image stimuli and the specific number of participants who were presented a certain selection of images. It becomes obvious that for certain maps tendencies are more significant than for others. Those are marked with bold lettering.

The increase of temperatures in relation to the coloring was most severely perceived in maps with a blue-red color scheme (see Table 1). Map I was perceived to present the temperature increase most drastically (8.3). Concerning readability of data through color map III (Blue/Yellow/Red) was conceived to offer the clearest perception. It is also map III which was rated to employ the most intuitive color scheme for the topic, closely followed by map V (Blue/Red), while it is map IV (Purple/Green) that was rated to be at least intuitive. It was not possible within the framework of the survey to determine an influence of color perception on the scientific appearance of the map. The results here are not significant. Map I was chosen to be the most judgmental (6.9), whereas map VI (Green/Purple) in contrast turns up to be at least judgmental. To influence policy makers most participants chose map I and III, the least convincing in contrast turned out to be maps VI and IV (Table 2).

In the second part of the interview participants were asked to concentrate on singular maps. Significantly more interviewees rated map III and V as a “call for action” compared to map I. A general concern was felt most clearly for map III. The most alarming figure is map I. This is also true for the impression of “powerlessness” and “fear”. Supplemented impressions brought up by the interviewees affirm this reading: Map I was said to be disillusioning and discouraging. Map III was said to be confusing but to comprise also positive connotations, while map V was evaluated to be calmer, more concise and to allow more hope.

Table 2 Listing of emotions the interviewed associate with the three reddish map versions; percentages depict the number of emotions associated in relation of the total number of participants this picture was shown to

Questioned emotion	Map I 	Map III 	Map V 
Call for action	25%	**44%**	**43%**
Concern	55%	**69%**	43%
Alarming	**75%**	63%	43%
Powerlessness	**30%**	19%	14%
Fear	**50%**	31%	33%
Further free emotions	Disillusioning; discouraging	Confusing; comprising also positive connotations	Calmer; clearer; more hope

When asked for their free associations for the maps I, III resp. V,[2] interviewees connected map I with terms like alarm, uncontrolled heat, fire, drought, boiling over (9 out of 15 interviewees). The impression of heat and drought was also connected to map III (6 out of 17) but here more associations of desert zones were brought up (4). Map V was described with the associations of burning embers and lava (2 out of 7). At the same time the interviewees estimated map III (8 out of 15) and map V (4 out of 7) in comparison to map I as being less threatening and allowing more space to think about future solutions for human life on Earth. Two persons mentioned that in map III in comparison to map I differences in geographical impacts were better readable which were not recognizable in map I. The different associations can be summarized for map I as giving an impression of the Earth irreversibly steering into a future of extreme drought and heat zones that destroy human life, while in map III and V the problem is still shown in its severity but might leave space for hope and solutions.

Only one interviewee was skeptical about climate change research, all others rated their trust in science very high (8–10). The evaluation of the maps of the skeptical person did not allow to draw conclusions about the impact of colors.

5 Discussion

The authors are aware that the survey undertaken has limitations in size, diversity of interviewed people (mainly living in Berlin with a bias towards academic and arts professions) and the survey setup with a limited number of testable color schemes. However, it can be seen as a test case for the general question how to investigate emotional impacts and interpretations of color schemes in climate change maps by laypeople quantitatively for the goal to constructively criticize and redesign climate

[2] From 22 interviewees 15 person were prestented map I and III in comparison, 5 persons saw I and V and 2 were presented map III and V in comparison.

change visualizations. In the following the authors will interpret the results we achieved by the survey for each map individually and then turn to some general remarks.

***Map I (Blue/Red/Purple, original color scheme of the IPCC)*:** Lead by the outcome of the image analysis from the humanity's perspective (Schneider 2016), the authors were expecting to find map I to be alerting by emphasizing present climate change as grave risk that affects the notion of climate normality by at the same time being the most disillusioning and disempowering. From an informational design standpoint, the authors also had evaluated map I to offer an undistinguishable perception of the different hues especially in the temperature coding of the three highest temperature steps (dark shades of red and purple). Some of the underlying theses were approved by the new methodology of qualitative interviews of the study at hand but also complemented by new insights. For example, the purple shade at the end of the color scale was perceived as disturbing and also as an irregular continuation of the red color spectrum. As a result of the study at hand, it must be taken into account that this version of the map has difficulties in the possibility of a nuanced reading of colors: it does not facilitate to relate certain increases of temperatures to specific regions, with a tendency to amplify an impression of high temperature increases that seem to flow into each other. To summarize, the survey results indicate that the color scheme of Map I tends to present climate change in a rhetoric and alerting manner. In addition, the viewer is confronted with the map's restricted readability, which might turn the map into a warning without conveying the full knowledge about the distribution of climate change visually. The two arguments might explain the reading of the map by many interviewees in terms of visually presenting Earth as a differentiable arid zone of droughts and heat.

Map II (Blue/Black, "less color"): The authors wanted to find out about the impression of greyscale maps in contrast to colored maps, although it was clear to us that a pure greyscale color scheme was not possible because of the diverged nature of the data given. Most clearly rated was the problem of poor readability for this color scheme (for the multitude of color intervals provided by the original map I). Also for many interviewees the scheme did not seem to present climate change as severe as the red maps. This correlated with the evaluation of map II as being not intuitive for the topic of the map. At the same time, map II was said to be much less judgmental than the red maps and some interviewees pointed to the neutrality of the map because it does not employ bright colors. Then again, only very few interviewees would choose this map design to influence policy makers.

Map III (Blue/Yellow/Red, "more nuances"): Interviewees rated this map to be the most readable map. Based on the feedback of the interviewees we conclude that this map design – although we are aware that it does not use an equally distributed color spectrum with respect to the luminosity value, and thus the yellow color band is strongly highlighted—in comparison to map I draws a more nuanced picture of the geographical difference of increasing temperatures above land regions and oceans. It very clearly shows where current climate change has taken place (the land regions). Therefore, we might say that this map gives a most concise geographical impression of climate change connected to specific regions of the world. At the same time the map in comparison to Map I was estimated to be less alarming by at the same time allowing feelings of concern and call for action.

Map IV (Purple/Green, "anti-intuitive"): The green map does not tell the story of an alarming and severe climate change taking place. The color scheme is not intuitive for the topic. The authors were surprised that interviewees did not rate this map to be rhetorical also, because from their perspective it could also be estimated to downplay the results of global warming. Then again, interviewees would not choose this map to show it to policy makers in order to convince them to take more actions.

Map V (Blue/Red, "cleared red without purple extremes"): This version seemed to the authors, when we were redesigning the map, to offer a good balance between intuitive color scheme and meeting the challenges of information design in maps (using equidistantly perceived color differences, less intensive than Map I in the lower positive values). Interestingly the map was not rated to be readable as good as map III but even worse than map I. Then again, the intuitiveness of the color scheme was rated high by at the same time not being very judgmental. The map was not chosen by a significant number of interviewees to be presented to policy makers.

Map VI (Green/Purple: "anti-intuitive-inversed"): The most significant finding concerning the purple color scheme was that it was rated even less intuitive than the green one. Nobody would use a pink map to influence policy makers. At the same time, it was chosen to be the at least rhetoric map – maybe because the color pink does not highlight any symbolic layer of the topic in a significant way like heat = red, plant growth = green.

A discussion of the free associations that were told by the interviewees in relation to Map I, III and V in the second part of the survey, is also fruitful. The associations of map I (Blue/Red/Purple) were most significant. Individual interviewees told us the following impressions: it is too late to act; it is too warm everywhere; the impression of over boiling; feelings of fatalism and being trapped; deadly danger; drought; fire; threatening scenario for the future; extreme heat; no trees, no growth of plants anymore; devastation; the color purple was connected to the notion of "rotten" but also to the radioactive pollution symbolized on maps after Chernobyl. Map V was said to produce an image of fire and lava, but being less frightening and alarming. The same was said for Map III.

At this point the authors should like to emphasize what they could not find out by their survey. The authors were not able to get significant numbers in relation to differences in the scientific appearance of the maps. Many interviewees said that the scientific nature of the map, being a data map, would not be touched by different color schemes. This might be the reason why they rated the different maps similarly. Secondly, it would be interesting to find out about the correlation of a particular aesthetic ("beautiful") impression of a certain map and the evaluation of its intuitiveness. This might give some more detailed insights in the good rating of map III, because this map drops out in the "gestalt" it draws of global climate change. Here we do not see a red world map but a yellow map with red continents.

6 Conclusion

In their study the authors took arguments and interpretations derived from an art historian and visual study's approach and tried to test them with qualitative interviewing methods. For this purpose, a main geographical visualization of present climate change taken from the recent summary for policy makers published by the IPCC was altered according to its color spectrum. With a set of questions 22 interviewees were asked to compare different colorations in respect to the impact of color on the comprehension of the map, its credibility, the gravity of climate change as a risk, free associations to the color and different emotional reactions to the map.

The authors found some of the interpretations derived by image analysis from a humanities' approach (Schneider 2016) confirmed by the survey, but also new insights could be brought up. The original map used by the IPCC in the Summary for Policy Makers (Map I)—as the results from the survey also suggest—is the most alerting by at the same time calling up disillusioning associations of powerlessness, fear, global heat waves and devastation. Several interviewees criticized it for its problematic nuanced differentiation of colors but at the same time suggested to be chosen for the purpose of influencing policy makers to act. The blue-yellow-red color map version (Map III) scored considerably better in several aspects like the readability, and by at the same time not appearing as disillusioning as the original IPCC version (Map I).

The authors already stated that the aim of the study is not a simple criticism of the original map, but the attempt to take into account the complexity of visual climate change communication, because there cannot be an all-in-one solution that works similarly for all possible recipients of the map. Still, the authors think that their study has shown that in order to balance out possible emotional reactions with the comprehensibility and the key message of the visualization, it might be useful to establish a dialogue integrating manifold expertise—art history, visual studies, interface design, computer graphics to assess the polyphony of meaning that visualizations can unfold beyond science.

If the authors could recommend a new map design for the original IPCC map (Map I), they would propose to take less colors and equally distributed interval values, around zero an interval with a color close to white, and a blue-white-red color map (because of its standardization) with visually equally distributed colors, and which avoids too dark colors at the highest temperature differences.

For future work, it might be interesting to incorporate maps of possible climate futures and their employment of red color schemes into a broader study design. It would be fruitful to study laypeople's perceptions and interpretations of the different future RCP scenarios in relation to the color scheme used for the map visualizing past observed warming. In addition, it would be necessary to study a larger and more culturally diverse group of participants, and to see what arguments can be universalized. But it would be even more fruitful to study a group of different policy makers on the level of NGOs, stake holders or different administrators in relation to color perception and policy implementation.

Acknowledgements The authors especially thank Desiree Förster who helped them conducting and assessing the interviews.

References

Bertin J (1983) Semiology of graphics. diagrams, networks, maps. University of Wisconsin Press, Madison, Wis

Bredekamp H, Dünkel V, Schneider B (2015) The technical image: a history of styles in scientific imagery. Chicago Press, Chicago

Brewer CA, Hatchard GW, Harrower MA (2003) Color brewer in print: a catalog of color schemes for maps. Cartogr Geogr Inf Sci 30(1): 5–32

Daston L, Galison P (2007) Objectivity. Zone Books, New York

Gage J (1993) Colour and culture: practice and meaning from antiquity to abstraction. Thames & Hudson, London

Gage J (2000) Color and meaning. Art, science and symbolism. University of California Press, Oakland, California

Hatt M, Klonk C (2006) Art history. A critical introduction to its methods. Manchester University Press, Manchester et al.

Horn E (2014) Zukunft als Katastrophe, S. Fischer, Frankfurt a. M

Hulme M (2009) Why we disagree about climate change. Understanding controvery, Inaction and opportunity. Cambridge University Press, Cambridge, New York et al.

Meadows CM (2014) A Psychological perspective on joy and emotional fulfillment. Routledge, New York

Palsky G (1996) *Des chiffres et des cartes: naissance et développement de la cartographie quantitative française au XIXe siècle* Comité des Travaux Historiques et Scientifiques, Paris

Panofsky E (1953) Early Netherlandish Painting: its Origins and Character, vol 2. Harvard University Press, Cambridge, MA

Schneider B (2016) Burning worlds of cartography. A critical approach to climate cosmograms of the Anthropocene. GEO Geogr Environ 3(2):e00027

Stauffer R et al (2015) Somewhere over the rainbow. How to make effective use of colors in meteorological visualizations. Bull Am Meteorol Soc 96:203–216

Tufte E (1990) Envisioning information. Graphics Press Chesire, Connecticut

Washington H, Cook J (2011) Climate change denial: heads in the sand earthscan, London/New York

Author Biographies

Birgit Schneider is professor of media ecology at Potsdam University. She worked as a graphic designer from 1998 to 2003 and was research associate in the project “Das Technische Bild” at the Helmholtz-Zentrum für Kulturtechnik at Humboldt University from 2000 to 2007. Since 2008, she has been Dilthey-Fellow of the Fritz Thyssen Foundation at the Institute of Arts and Media, University of Potsdam, in 2009 was a substitute professor for cultural techniques at the Bauhaus-Universität, Weimar, and in 2014 she was visiting fellow at the Rachel Carson Center for Environment and Society and senior fellow at the International Research Institute for Cultural Techniques and Media Philosophy in Weimar. Her current research focus is the visualization of climate since 1800 and a genealogy of climate change visualization inbetween science, aesthetic and politics. She is editor of the volumes “The Technical Image” (Cambridge 2015) and “Image Politics of Climate Change” (Bielefeld 2014).

Thomas Nocke is senior researcher at the Potsdam Institute for Climate Impact Research, holding a Ph.D. in Computer Science, University of Rostock. Since 2002, he has been investigating the topic of climate data visualization, both for visual data analysis and visual climate change communication. Since 2012, he manages the developments of the portals KlimafolgenOnline.com/ClimateImpactsOnline.com (as lead of the ClimateKIC project CIES). His research topics include environmental visual analytics and innovative climate service solutions.

Using Heritage to Engage Antarctic Tourists with Climate Change

Camilla Nichol

1 Introduction

Antarctica is unique. It is regarded as the last great wilderness on Earth; with an ecosystem quite unlike anywhere else; is the theatre for a unique geopolitical effort for peace and science; is recognised as a key driver of the Earth's climate system and is regarded by many to be one of the most vulnerable places on Earth to the effects of climate change. For these, and myriad other reasons, it is also a popular tourist destination for those with the means to make the trip, and is ever growing in popularity.

The opportunity to encounter this unique place and feel the privilege of the 'wilderness experience' is one which is taken up by a relatively small, but growing number of people. This audience might be a self-selecting, privileged tier of society but arguably these are people with influence back home and engaging them in matters concerned with climate change, mitigation and adaptation could be a useful tool in raising awareness of such issues if they are engaged in a meaningful way.

'Expedition tourism' by means of modestly-sized cruise vessels to the Antarctic Peninsula to observe wildlife, explore the landscape and visit historic scientific stations, and learn from on-board experts along the way is the primary means by which most travellers get to see Antarctica. It has been half a century since Lars Eric Lindblad led the first traveller's expedition on a cruise vessel to Antarctica in 1966 (IAATO 2017a, b) and even in its infancy, Antarctic tourism had an educational remit. Lindblad believed that by providing a first-hand experience to tourists you would educate them to the ecological sensitivity of the Antarctic environment and promote a greater understanding of the Earth's resources and the important role of Antarctica in the global environment (IAATO 2017a, b). Fifty years on and those ideals still hold for those operating in the Antarctic but the growth of commercial

C. Nichol (✉)
UK Antarctic Heritage Trust, High Cross, Madingley Road, Cambridge CB3 0ET, UK
e-mail: camilla@ukaht.org

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_20

travel, changing technology and increased tourist demand has changed Antarctic tourism, and perceptions of it, significantly.

During that same time period, much more has changed for Antarctica. The number of signatories to the Antarctic Treaty have grown from the original twelve up to fifty-three; we now have the Protocol on Environmental Protection to the Antarctic Treaty (The Madrid Protocol); the national science programmes are well established and many are focussing specifically on climate change; we have a Marine Protected Area in the Ross Sea, not to mention it is in the Antarctic that the evidence for and effects of climate change are now being observed most strikingly.

Antarctic tourism has both grown and changed markedly over the same period, this brings with it both threats and opportunities for potential engagement with issues around the environment and climate change.

Intertwined with all of that has been how the physical evidence of human activity in Antarctica has been used, abandoned, evaluated and designated (or not) as heritage and what that has meant for our understanding and public appreciation of human endeavour in Antarctica.

What opportunities are there for improving public understanding of climate change through the unique lens offered by visits to Antarctica, specifically through heritage, and what impact might be possible?

2 Historic Sites and Antarctic Heritage

Prior to the Madrid Protocol (signed in 1991 and adopted in 1998) heritage in Antarctica had little or no status, and only through the recognition of the need to manage and protect the environment in Antarctica through responsible activity and management of waste, was heritage acknowledged and the route was set for its preservation. In 2002, Annexe V was finally entered into force and this gave legal protection to sites of outstanding environmental, scientific, historic, aesthetic or wilderness value (CEP 1991) and paved the way for the assessment of abandoned sites for their historic value and thereafter to some being designated as historic sites and monuments (HSMs) under the Antarctic Treaty. This designation means "Listed Historic Sites and Monuments shall not be damaged, removed or destroyed" (CEP 1991). Heritage and the environment are therefore inextricably linked. It can be said that heritage designation has arisen from the need to clean up abandoned bases in light of the Madrid Protocol, but it was a moment that enabled Treaty parties to stop and evaluate their own history of Antarctic endeavour and the material evidence of that history in the form of man-made structures in the landscape.

At the time of writing there are 92 designated HSMs (ATCM 2016) ranging from commemorative plaques, memorials and cairns to landing sites and former scientific stations and refuges. Individual Treaty parties take responsibility for managing each HSM, but the manner of this varies from nation to nation. There are three established not-for-profit organisations in existence which actively manage historic buildings in Antarctica: UK Antarctic Heritage Trust which looks after historic sites on the Antarctic Peninsula from the post-War era; The NZ Antarctic Heritage Trust, which looks after the heroic era huts, including those of Scott and Shackleton, in the Ross Sea; and Mawson's Huts Foundation which looks after Mawson's huts in Commonwealth Bay. Between them, these organisations, and the heritage they conserve, chart the 20th century explosion of human endeavour in Antarctica.

3 Historical Science in Antarctica

Volumes could be written on this topic, however, focussing on British activity in the Antarctic, scientific observations were made during almost every expedition to the Antarctic but this really intensified at the turn of the 20th century with Captain Scott. His expedition in 1911 introduced a wide-ranging programme of scientific investigation, more so than previous expeditions, including zoology, geology, glaciology and geomorphology, atmospheric studies and meteorology. Since then detailed scientific observations were made on each expedition and more data collected and published.

The purpose of each expedition was rarely science until the *Discovery Investigations* 1918–1951. Sponsored by the British Colonial Office, these were primarily intended to provide a scientific basis for fisheries management in the Southern Ocean. Later state-sponsored programmes, rather than the privately supported expeditions of the heroic era, developed through the first half of the 20th century, but it was during the Second World War, when it became necessary to establish a permanent British presence in Antarctica that a formal, continuous scientific programme was launched.

4 Operation Tabarin

Operation Tabarin was the codename for a secret wartime operation to establish a permanent British presence in the Antarctic, in what was considered British Territory, to be known as the Falkland Island Dependencies. British bases built in strategic locations on the Antarctic Peninsula would allow for monitoring and deterrence of Argentine activity in the same territory. They would also provide meteorological data for Allied shipping in the South Atlantic.

Sponsored again by the British Colonial Office along with the Admiralty, this was not an official Naval operation, but the leader, Lt James Marr, picked a group of men who were scientists; men who could occupy themselves with meaningful activity during their long deployments in these remote locations.

The first of these locations was Base A at Port Lockroy, established in 1944 with nine men overwintering. Immediately, observations of geology, botany, meteorology and topographic survey were made, and in the 1950s, ionospheric research was conducted there and continued until its closure in 1962. Under the same operation, four bases were established on and around the Antarctic Peninsula, and this programme continued for the next two decades (UKAHT 2013).

In 1945, once war was over, the expedition was made permanent and became known as the Falkland Island Dependences Survey (FIDS), an ongoing programme for science and research (and sovereignty) in the Antarctic (BAS 2015). And so, the scientific programme we know today as the British Antarctic Survey, was born.

In 1962 it was renamed the British Antarctic Survey, by which time nineteen bases and three refuges had been established, but in the years following, many would be abandoned, as the (largely survey) work was completed, and left to the elements. Others would stay in continuous operation, the longest being Base F, Faraday, which was the longest continually occupied British base at over 49 years. This is occupied now by the Ukrainian Antarctic Programme, who continue the meteorological data collection, making Base F the site of one of the longest continual meteorological datasets in Antarctica (BAS 2015).

Seven of these former scientific bases have been designated as HSMs:

- Base A, Port Lockroy
- Base B, Whalers' Bay, Deception Island
- Base E, Stonington Island
- Base F, Wordie House
- Base W, Detaille Island
- Base Y, Horseshoe Island
- Damoy Hut, Dorian Bay

Much of our current understanding of our changing climate derives from the science undertaken at these early scientific stations. The early science and the early technological innovations for data collection in this environment paved the way for the landmark scientific discoveries made since. The glaciological work leading to deep ice coring, observations of the upper atmosphere leading to the discovery of the hole in the ozone layer, the long meteorological datasets displaying long term trends. Not to mention the proxy data: changing wildlife populations and behaviours or sea level and sea ice observations; records of which go back to the earliest scientific records in Antarctica. Because these historic sites are the places where these discoveries and observations (or their precursors) were made, it makes them potentially a powerful tool for public understanding of climate change.

These sites are managed as historic sites, six by UKAHT and one (Whalers' Bay) a collaboration between the UK, Norway and Chile. The huts, associated structures and artefacts are conserved and monitored by UKAHT and inside the huts there are interpretation panels to tell the story of the site. Base A at Port Lockroy, is staffed every Austral summer and is run as a museum and visitor site, the others are unstaffed save for visiting conservation field parties who visit on a programme to maintain the site. They are all in the Antarctic Peninsula region and therefore, very much on the tourist map, presenting an opportunity for engagement.

5 Antarctic Tourism

Over 40,000 tourists visit Antarctica each Austral summer (IAATO 2016). The majority travel by cruise ship from South America spending on average two weeks visiting sites on and around the Antarctic Peninsula.

The profile of visitors to Antarctica has changed strikingly over the last twenty years: the total numbers of visitors have leapt from under 10,000 to almost 50,000 and their modes of travel have diversified from cruise ships to fly-cruise, land-based, yachts and non-landing cruises with passengers >500.

The nationalities, which make up the visitors has also seen a substantial shift

1994–95 (total visits 8210) (%)		2015–16 (total visits 48,478) (%)	
USA	36	USA	37
Germany	18	Australia	18
Argentina	7	China	7
UK	5	UK	5
Brazil	4.5	Germany	4
Australia	4.5	Canada	4
Japan	3	France	3
Others	22	Others	22

Statistics from IAATO (2016)

From this data, we can observe some significant changes. Firstly, a fivefold increase in total numbers; a shift away from Antarctica's immediate neighbours in South America, a massive introduction of visitors from China (in fact, in 2014–15 they were second in the table having not even featured prior to 2011), there has been a marked increase in visitors from Australia both numerically and proportionally, and of course, a huge material rise in the number of visitors from the USA yet they maintain a similar proportion. A detailed analysis of the causes of these changes is beyond the scope of this paper, but the impact this potentially has on an engagement strategy and the efficacy of messaging around climate change could be significant.

The most common trips, the landing cruises tend to be concentrated at ice-free coastal zones and tourists will make 1–3 landings each day in groups of between 50–100 at sites of wildlife, heritage or aesthetic interest which are conducted by experienced expedition teams with expert staff including biologists, geologists, glaciologists and historians. Each cruise is managed as a 'wilderness' experience and is promoted and conducted with very high environmental values. The majority of operators are members of the International Association of Antarctica Tour Operators (IAATO) an organisation dedicated to '*advocate, promote and practice environmentally responsible private sector travel to Antarctica*' (IAATO 2017a, b). Each operator is required by the Antarctic Treaty to obtain a permit from a competent national authority and is obligated to provide a report at the end of each season on their activities (ATCM 1994). All landings and site visits are guided by strict visitor site guidelines published under the Antarctic Treaty (ATCM 2006) and activity and behaviour is monitored by peers, Treaty Party inspections and other operators in the region.

The high level of responsibility and environmental awareness, in what is very much a commercial activity, is notable and is something in which each operator seeks to stand out. Their ethos, environmental values and commitment to responsible tourism has commercial value in a competitive environment like Antarctic tourism. Also, activities during trips which engage with current environmental topics through the lens of being there makes for unique and memorable trips for passengers. Operators therefore seek opportunities to engage in environmental initiatives or to affiliate themselves with scientific or charitable organisations and introduce elements to each trip which connect with these issues.

6 Citizen Science

Citizen Science is a model that has been adopted quite successfully in the Antarctic Tourism industry. The concept of citizen science defined as "*scientific work undertaken by members of the general public, often in collaboration with or under the direction of professional scientists and scientific institutions*." (OED 2014). A couple of good examples of Citizen Science are in force in the Antarctic: Penguin Lifelines (www.penguinlifelines.org) and Happy Whale (www.happywhale.com). Both involve getting visitors (and, in the case of the penguins, armchair enthusiasts) to help gather data on two types of Antarctic animal the analysis of which informs longitudinal scientific studies. *Penguin Lifelines* is overt in its purpose to study and campaign on climate change through the study of penguin colonies and has successfully engaged people 'in the field' whilst on an Antarctic trip as well as people around the World clicking penguins on their computers. *Happy Whale* is slightly different, it offers visitors to Antarctica the chance of a personal connection with whales they sight and, crucially, photograph in that they can upload their images and discover the identity and life history of their whale sighting and follows its fortunes afterwards.

These, and other initiatives, provide an environment in which visitors can engage on a highly personal level with matters concerned with the Antarctic environment and of course, climate change. The impact of this is potentially twofold: it inspires in the passengers a sense of endeavour, engagement and involves them in the campaign; it also softens the perception of the environmental impact of Antarctic tourism—instead of being a problem, it becomes part of the solution.

7 Antarctic Heritage and Tourism

Similar issues apply when it comes to heritage sites in Antarctica. These sites are the places where humans have had a significant impact on the landscape; erecting buildings, masts and other structures, whaling, sealing, tales of men eating penguins and seals, importing soil and plants, running large sledge dog teams, storing (and inevitably leaking) fuel and then abandoning the bass, often in a hurry, and leaving them to decay in the harsh Antarctic climate. The impression this gives can be difficult to overcome, after all these abandoned sites are a tangible reminder of human impact on a pristine environment. However, they are also the places where the human spirit of endurance has conquered an unforgiving natural environment, where the limits of human endeavour were tested and where the foundations of climate science were laid, and these can be incredibly inspiring.

It is the telling of such stories and creating that human connection between the modern visitor and the individuals of the past and their accomplishments that we can hope to inspire and educate. The nature of the visit and how the historical sites are interpreted can have a big impact on how they are perceived. As with heritage sites the world over, a range of strategies needs to be adopted in order to be successful in communicating our key messages.

8 Engagement Strategies

The aim is to develop a range of strategies to build relationships with the audience to achieve the organisational vision. This is standard practice in cultural organisations and the same principles apply in this context.

It is important first to identify the objectives of the engagement strategy and then analyse both the audience and the opportunities for engagement that are available, before then creating the journey.

8.1 Objectives

The objectives for engagement here, as the UKAHT, in engaging with its audience in Antarctica is twofold:

- to enable visitors to understand the heritage sites they are visiting and their significance
- to inspire visitors to a lifelong engagement with Antarctic matters (including climate change).

The first is about storytelling, about connecting experiences—those of the visitors with those of the men who went before—and about setting what they are seeing in a much greater, global context.

The second is also about human connection; appealing to them on an emotional level to inspire activism and then offering ways in which can get involved, make a difference and stay connected long after they have returned home.

8.2 Audience

When thinking about the audience, there are number of factors to consider, which include:

- Where are they from?
- Why are they coming?
- What language(s) do they speak?
- What is their level of engagement currently with heritage and the environment?

Building a picture of the audience allows us to develop successful strategies for engagement. This includes factors such as language, cultural values and motivations for visiting. The latter actually varies quite widely; for some it is the realisation of a lifelong dream, for others it is a wildlife observing trip, for others is it for the wilderness experience, for some it is the chance to 'tick off' the seventh continent and for a few it is a business junket. For very few it is a trip to explore heritage, apart from those retracing Shackleton's steps from Elephant Island to South Georgia.

8.3 Interpretation Opportunities

There are several touchpoints during the visitor journey, which we can use to engage visitors and provide them with stories, information and the chance to consider the wider issues.

The key moments are:

- When they are researching their trip
- During the trip itself
- Once they return home.

Each of these presents an opportunity to spark their interest, give them experiences and then inspire action and give them the means to act. Integrating the information visitors receive during their visit with that they can access beforehand and then follow up on afterwards is crucial. So, using the web, social media, sharing content with the travel operators for use in their printed materials are effective means by which we can warm up visitors to our messages.

During their visit to Antarctica, they receive lectures and briefings on board ship for which we can provide content, imagery, short films and printed materials. However, their physical visits to the historic sites are where the important experiences occur. What they see at the site, how we tell the stories and the lasting impression we give them is where we can capture them.

We maintain and run our flagship site Port Lockroy as a museum. The hut and surrounding structures have been restored to their 1950s condition and visitors are completely immersed in an environment where those early scientists and engineers lived and worked. The rooms have been restored and contain displays of clothing, equipment, scientific instruments, in fact, everything they needed to live and in each room interpretive panels and labels unfold the story. At this stage, this is a simple story of base life, of the science they conducted there and some of the characters (including animals) who lived there for the twenty years it was open. We also have staff on site during the Austral summer who tell the stories in more detail, in multiple languages, and guide visitors during their landing.

At our other heritage sites, where we have no staff, we rely on the ship expedition teams to deliver the same messages and tell the stories, so we are working on ways in which we can help them do that effectively to communicate the significance of the bases and the scientific accomplishments that were made. This is challenging, and is an area we are developing so that the messages can be more effective.

9 Inspiring Action

This is an objective common to many stakeholders in Antarctica. Initiatives like *Happy Whale* and *Penguin Lifelines* offer opportunities for visitors to contribute directly to science and by proxy support environmental conservation efforts. A scheme promoted by IAATO is *Antarctic Ambassadors*; a scheme which urges anyone who has visited Antarctica to

> take part and follow developments in the news and in your governments regarding the science and management of climate change, particularly as it affects Polar Regions. Learn more about climate change, its implications for the global commons and what you can do to help minimize and mitigate the changes (IAATO website 2017a, b).

Through the website, member promotion, and through social media the initiative seeks to channel the experiences of Antarctica into activism. It is in its early development as a more formal network, but the membership is growing and more tour operators, particularly, are using it in their presentations.

In our own organisation we take a lead also from our wildlife partners. We have a '*Friends of Antarctica*' scheme, which we invite visitors to sign up to either during or after their visit enabling them to support to our work, contribute to, and hear about conservation initiatives and raise awareness of matters like climate change through our own heritage-based perspective.

There is much more that we can do, particularly around 'joining the dots' between organisations

10 Challenges

There are challenges for heritage in being part of the climate change story. Managing perceptions and answering those who consider heritage to be more or less pollution can be difficult, Fundamentally, we are preserving sites where humans have impacted the pristine landscape and so answering the question as to why—isn't it expensive, what about the air miles, wouldn't it be better just to remove them and let nature return…?—strikes to the heart of why heritage is preserved.

Allied with this is also the argument, by preserving and promoting these heritage sites aren't we merely encouraging more tourism and therefore increasing pollution and contributing to climate change? Again, we have to be sensitive and clear in explaining the purpose of preserving heritage in Antarctica for future generations and the importance of understanding the past to inform the future.

Greatest of all is the public perception of Antarctic tourism. Exclusive tourism for a small group of the wealthy who visit this pristine wilderness in great polluting cruise ships. In the press, there are regular stories of the potential damage that could be done and how changing demographics, particularly with the growth of visitors from China. Those differences in environmental awareness between cultures between East and West, might make for irresponsible behaviour. However, there are strong arguments in favour of well-managed Antarctic tourism and many success stories of how Antarctic Ambassadors have been born across the globe.

11 Conclusion

Heritage is not a natural vehicle for communicating contemporary science, but heritage in Antarctica has a unique opportunity to contribute to scientific debate about climate change. As a component of the Antarctic tourism sector, Antarctic heritage is also a potentially effective means by which visitors to Antarctica can be better informed and engaged by the 'bigger picture' of the climate change debate and the science underpinning it. In turn they might be inspired to take action.

There is a need for organisations to work more closely together tell a compelling story and for tourism to grasp further the opportunity to be a catalyst for activism. Tourism is a huge opportunity for engagement and heritage, within the tourist experience can play a significant role in connecting human activity and the impact on the environment.

From here, it is a question of monitoring and measuring the impact, continuing to fight for those who visit to do so responsibly, to understand what they are seeing and to leave with a mission to share what they have learned. If we in the heritage sphere can play some part in that, then we are doing something right.

References

ATCM (Antarctic Treaty Consultative Meeting) (1994) ATCM XVIII Final report, Measure 4. Guidelines for Tourism. Available at http://www.ats.aq/devAS/ats_meetings_meeting_measure.aspx?lang=e

ATCM (Antarctic Treaty Consultative Meeting) (2006) Site guidelines for visitors (ATCM XXIX Resolution 2). Antarctic Treaty Consultative Parties, Edinburgh. Available at www.ats.aq

ATCM (Antarctic Treaty Consultative Meeting) (2016) ATCM XXXIX Final report, Measure 9. Revised list of Antarctic historic sites and monuments. Available at http://www.ats.aq/documents/recatt/att596_e.pdf

British Antarctic Survey (2015) History of British stations and refuges. Available at https://www.bas.ac.uk/about/about-bas/our-history/british-research-stations-and-refuges/

Committee for Environmental Protection (CEP) (1991) Annex V to the protocol on environmental protection to the Antarctic treaty: area protection and management. Available at http://www.ats.aq/documents/recatt/Att004_e.pdf

IAATO (International Association of Antarctica Tour Operators) (2016) Tourism statistics. Available at https://iaato.org/tourism-statistics

IAATO (International Association of Antarctica Tour Operators) (2017a) Tourism overview; scope of Antarctic tourism—a background presentation. Available at https://iaato.org/en_GB/tourism-overview

IAATO (International Association of Antarctica Tour Operators) (2017b) http://www.iaato.org

OED (2014) "Citizen science, n.". OED Online. Oxford University Press, Oxford

UKAHT (UK Antarctic Heritage Trust) (2013) Base A visitor guide. UKAHT

Calm Before the Storm: Assessing Climate Change and Sustainability in Saudi Arabian Universities

Naif Alghamdi

1 Introduction

As a developing country, Saudi Arabia is greatly challenged by climate change and sustainability. In light of these challenges, the purpose of this research is to look at the extent to which the Saudi higher education institutions communicate climate change and sustainability. It explores to what extent climate change and sustainability issues are addressed in public universities in the Kingdom. This research is imperative because very little is known about the contribution of universities in Saudi Arabia, even though the country has 28 public universities. This indicates a need to establish whether or not universities have some policies in place and are fully engaged in promoting more sustainable approaches to help the country cope with climate change. Moreover, observing the university is a valuable vantage point to assess how much a country engages with sustainable development, in view of the fact that the university has a key role in not only educating, training, and raising public awareness of climate change and sustainability, but also in looking for best possibilities to accelerate the efforts of going greener environmentally and economically (Lotz-Sisitka et al. 2015; Ketlhoilwe and Jeremiah 2010; Down 2006; UNESCO 2005).

This research emanates from two broader currents, one of which is the popular discourse about the relationship between climate change and sustainability; Yohe et al. (2007, 813):

N. Alghamdi (✉)
Department of Architecture and Building Sciences, College of Architecture and Planning, King Saud University, P.O. Box 230670, Riyadh 11321, Saudi Arabia
e-mail: naag@ksu.edu.sa

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_21

> Efforts to cope with the impacts of climate change and attempts to promote sustainable development share common goals and determinants including access to resources (including information and technology), equity in the distribution of resources, stocks of human and social capital, access to risk-sharing mechanisms and abilities of decision-support mechanisms to cope with uncertainty.

The second current is an ongoing Ph.D. research project that focuses on environmental sustainability in university campuses in Saudi Arabia. The research project was carried out in almost one-third of public universities in the Kingdom. The ultimate goals of the project are to assess as well as to address environmental sustainability issues in public universities. Having reviewed 12 sustainability assessment tools for universities (Alghamdi et al. 2017), an assessment tool was developed and used in the research project. The main issues evaluated in the Ph.D. research project include (i) Management aspects (sustainability indicators e.g. vision, aims, policy, commitments, supply and demand planning, and investments), (ii) Engagement aspects (sustainability indicators e.g. knowledge, awareness, attitude, behaviour, and willingness to change), and (iii) Environmental aspects (sustainability indicators e.g. sustainable planning and design principles, location, transportation, environmental quality, indoor quality, flexibility, and space utilisation). Building on the Ph.D. project, this paper presents the findings of three key parts of the research project: management aspects (vision, aims, policy, commitments, and measurements), engagement aspects (knowledge and awareness of policy- and decision-makers), and environmental aspects (green-building schemes). Therefore, the findings of this paper underline some sustainability issues in the Kingdom of Saudi Arabia that policy- and decision-makers should take into account when addressing climate change and sustainability issues.

The outline of this paper takes the form of five sections: Section two introduces climate change and sustainability in Saudi Arabia, underlining some critical information about climate change and some sustainable measures taken in the Kingdom. The following section highlights some key facts and figures about higher education institutions in Saudi Arabia, showing some historical developments in the higher education system supported by some statistics emphasising the size of the sector. The fourth section presents the methodology, highlighting the research design and approach. The fifth section presents the findings of the research in which the analysis and the discussion parts are outlined. The concluding section gives some conclusions and recommendations, providing some proposed solutions for the Saudi government and the public universities in order to advance their efforts in dealing with climate and be more sustainable. Additionally, there is a discussion about the limitations of this research and highlights the need for further research to shed light on other aspects of sustainability.

2 Climate Change and Sustainability in Saudi Arabia

2.1 Overview of Climate Change

Climate change has been defined as 'a change of climate which is attributed directly or indirectly to human activity that alters the composition of the global atmosphere and which is in addition to natural climate variability observed over comparable time periods' (UN 1992, 03). Sustainable development, on the other hand, is known as a development that 'meets the needs of the present without compromising the ability of future generations to meet their own needs' (WCED 1987, 16). The Intergovernmental Panel on Climate Change (IPCC) states clearly in their Synthesis Report (IPCC 2014, 31) that 'climate change is a threat to sustainable development'. Therefore, the issue of climate change has to be taken seriously in order to be effectively mitigated.

Given that 'man-made climate change is real and that it poses a great threat to the planet and its inhabitants' (CIWF 2016), climate change needs urgent and collective actions to deal with (Bhaskar et al. 2010). For more than three decades, the United Nations has been taken major actions to deal with this complex problem. The initial step taken was the First World Climate Conference in 1979. To address the deterioration of the environment and natural resources, the UN established the Brundtland Commission, through which sustainable development was defined (WCED 1987). In 1988, the Intergovernmental Panel on Climate Change (IPCC) was set up with the aim of providing a scientific perspective on climate change and its impacts both politically and economically. The United Nations Framework Convention on Climate Change (UNFCCC) was known to be one of the first international agreements to control global warming and the resulting climate change. The UNFCCC was opened for signature in 1992 at the Earth Summit in Rio de Janeiro, Brazil. Since 1994, where the UNFCCC entered into force, there have been a number of negotiations towards a climate agreement. Kyoto Protocol (1997), Marrakesh Accords (2001), Nairobi Work Programme on Adaptation (2005), Bali Road Map (2007), Copenhagen Accord (2009), Cancun Agreements (2010), Durban Platform (2011), Doha Amendment (2012), and Paris Agreement (2015) are all cases in point (UN 2016).

The United Nations Framework Convention on Climate Change (UNFCCC) has 26 Articles. The ultimate aim of this Convention, mentioned in Article 2, was to achieve stabilisation of the greenhouse gas concentration in the atmosphere within a sufficient time frame to allow ecosystems to adapt naturally to climate change in order to ensure food security and economic development in a sustainable manner (UN 1992). Article 6, highlights the importance of education, training, and public awareness. In this Article, the most important messages were:

'Promote and facilitate…

- *the development and implementation of educational and public awareness programmes on climate change and its effects*
- *public access to information on climate change and its effects*

- *public participation in addressing climate change and its effects and developing adequate responses, and*
- *training of scientific, technical and managerial personnel'* (Ibid., 10).

'Cooperate in and promote…

- *the development and exchange of educational and public awareness material on climate change and its effects, and*
- *the development and implementation of education and training programmes, including the strengthening of national institutions and the exchange or secondment of personnel to train experts in this field, in particular for developing countries'* (Ibid., 10).

2.2 The Effect of Climate Change on Saudi Arabia

Saudi Arabia is particularly vulnerable to climate change (CAT 2016). The question is what makes the Kingdom seriously challenged by global warming. The top three causes, inter alia, are:

- First, much of the landscape of Saudi Arabia is typified by semi- to hyper aridity climate with very low rainfall (FAOUN 2016). It has limited groundwater and about 2% of the country's land area is arable, challenging national food sources (Darfaoui and Al Assiri 2010, 01). Additionally, Saudi Arabia is classified by the United Nations as a water-scarce nation (UNDCWS 2016, 210).
- Second, the Kingdom has the world's largest oil reserves and it is the biggest oil exporter (WTEx 2016). Therefore, the backbone of Saudi economy is based mainly on exporting fossil fuels. The latter is considered to be one of the major causes of global warming (LSE 2016).
- Third, as a fast-growing economy, Saudi Arabian government is in a race to meet the internal demand of energy and water, given the rapid growth in urbanisation in which some of its cities are characterised globally by being one of the 'fastest growing cities' (World Bank 2016).

The Kingdom's efforts towards climate change have been classified by Climate Action Tracker as 'Inadequate' (CAT 2016). This was because, in general, the country has not shown clear commitments, pledges, and targets. For example, in its plans and actions outlined in the Intended Nationally Determined Contribution (INDC) submitted to the UNFCCC Secretariat on November 10th 2015, Saudi Arabia did not provide quantified measures (e.g. its energy efficiency, renewable energy, carbon capture and storage) (Ibid).

Saudi Arabia is very sensitive to climate change. Yet, the Saudi efforts to deal with climate change are not satisfying enough. According to the Climate Action Tracker (CAT 2016):

> The Saudi climate plans are highly inconsistent with the projected climate impacts for the region, an area where average warming is higher than the global average. In a 3-4 °C world, three quarters of the country will suffer from excessive dryness by the end of the century… Yet the Saudi government still has no policies in place to begin – or encourage – this shift to renewable energy.

Against such challenges, Saudi Arabia has made significant moves to address climate change. According to the United Nations Development Programme, 'Saudi Arabia is party to the following conventions: Climate Change, Climate Change-Kyoto Protocol, Desertification, Endangered Species, Hazardous Wastes, Law of the Sea, Marine Dumping, Ozone Layer Protection, [and] Ship Pollution' (UNDP 2016, 01). Moreover, the government of Saudi Arabia has taken steps to address climate change issues through a number of sustainability programmes. The top ten actions and measures taken, among others, are:

- 2005—Saudi Arabia became a member of the Carbon Sequestration Leadership Forum, Washington, DC, U.S.A. (CSLF 2016).
- 2008—Saudi Arabia along with other oil exporting Kingdoms' including Netherlands, Norway, and the United Kingdom established the 'Four Kingdoms Initiative' for Carbon Capture Utilisation and Storage (CCUS). The country plans to build the world's largest carbon capture and use plant (PRC 2016).
- 2008—Saudi Arabia launched a National Energy Efficiency Programme (NEEP) to initiate and promote energy efficiency measures (Alyousef and Varnham 2010).
- 2010—Saudi Arabia created The Saudi Energy Efficiency Centre (SEEC) to develop a national program to rationalise and raise the efficiency of energy consumption through proposing plans and policies to achieve such aim (SEEC 2016).
- 2010—Saudi Arabia established King Abdullah City for Atomic and Renewable Energy (KACARE). KACARE conducts research and sets and implements national atomic and renewable energy policies with an ultimate aim of building a sustainable future for Saudi Arabia by developing a substantial alternative energy capacity fully supported by world-class local industries (KACARE 2016).
- 2012—Saudi Arabia started an internal engagement to further address climate change and sustainability issues with its national research centres (e.g. King Abdulaziz City for Science and Technology and King Abdullah Petroleum Studies and Research Centre), public universities (e.g. King Saud University, King Fahd University for Petroleum and Minerals, and King Abdulaziz University), and private universities (e.g. King Abdullah University for Science and Technology).
- 2014—Saudi Arabia joined the 'Global Methane Initiative' (GMI) for the purpose of knowledge sharing in Methane gas capture and reuse in the areas of flare management and fugitive emissions control for oil and gas operations (GMI 2016).

- 2015—Saudi Arabia launched its Vision 2030 aiming at a vibrant society, thriving economy away from depending merely on oil-exporting, and more sustainable developments. Among many targets, the vision states an initial target of 9.5 gigawatts of renewable energy by 2030 (CEDA 2016). Under the umbrella of King Salman Renewable Energy Initiative, the vision speaks of localising not only the manufacturing of renewable facilities, but also research and development in renewable energy. Research on renewable energy has been underway for a number of years now by King Abdulaziz City for Science and Technology (KACST) and King Abdullah University of Science and Technology (KAUST). One of the ultimate aims of this joint research program is for Saudi Arabia, the world's top crude oil producer, to become a top solar energy exporter. It was reported that the former Saudi Arabian Oil Minister, who headed the country's climate planning, said in a conference in Paris that 'the government planned to be a global leader in solar and wind energy' (King 2015).
- 2016—Saudi Arabia signed the Paris Agreement indicating its willingness to be responsible and act accordingly (UNFCCC 2016).
- 2017—Saudi Arabian giant oil company Saudi Aramco installed the country's first wind turbine in Turaif in north-western Saudi Arabia. The project, developed in partnership with General Electric, marked a new milestone in Saudi Aramco's plan towards realising the 9.5-gigawatt national renewable energy target defined in Saudi Vision 2030 (Saudi Aramco 2017).

However, despite the above initiatives, much more is needed from the Kingdom. The precariousness circumstances that Saudi Arabia finds itself in demands a more robust approach to sustainability. This has been confirmed by a number of analysts; one of which was a report to the Food and Agriculture Organization of the United Nations (FAO) and Regional Office for the Near East and North Africa (RNE), Darfaoui and Al Assiri (2010) concluded that:

> Saudi Arabia is particularly vulnerable to climate change as most of its ecosystems are sensitive, its renewable water resources are limited and its economy remains highly dependent on fossil fuel exports, while significant demographic pressures (2.3% increase), continue to affect the government's ability to provide for the needs of its population. The KSA Government is engaging in various mitigation and adaptation measures to cope with adverse impacts of climate change as well as with response measures especially by the Annex 1 parties of the UNFCCC, which are expected to have diverse economic and social impacts on the country. However, a great deal remains to be done to contribute in the mitigation programmes in order to face this global and national challenge.

3 Higher Education in Saudi Arabia

Having established the basis for what challenges Saudi Arabia is facing, the next step in this research is to explore these issues in public universities in Saudi Arabia. First, a brief overview of higher education institutions is given to shed light on

Table 1 Public universities in Saudi Arabia, ordered chronologically

No.	Name of the institution	Code	Location	Year of foundation
01	King Saud University	KSU	Riyadh	1957
02	Islamic University of Medina	IUM	Medina	1961
03	King Fahd University for Petroleum and Minerals	KFUPM	Dhahran	1963
04	King Faisal University	KFU	Alhasa	1964
05	King Abdulaziz University	KAU	Jeddah	1967
06	Imam Muhammad Ibn Saud Islamic University	IMSIU	Riyadh	1974
07	Umm Al Qura University	UQU	Makkah	1981
08	King Khalid University	KKU	Abha	1998
09	Qassim University	QU	Buraydah	2003
10	Taibah University	THU	Medina	2003
11	Taif University	TFU	Taif	2003
12	King Saud bin Abdulaziz University for Health Sciences	KSAUHS	Riyadh	2005
13	Jazan University	JNU	Jazan	2005
14	University of Hail	UH	Hail	2005
15	Al Jouf University	AJU	Skaka	2005
16	Al Baha University	ABU	Albaha	2005
17	University of Tabuk	TKU	Tabuk	2006
18	Najran University	NU	Najran	2006
19	Northern Border University	NBU	Arar	2007
20	Princess Nourah bint Abdulrahman University	PNU	Riyadh	2008
21	Shaqra University	SU	Shaqra	2009
22	Prince Sattam Bin Abdulaziz University	PSAU	Alkharj	2009
23	Imam Abdulrahman Bin Faisal University	UD	Dammam	2009
24	Majmaah University	MU	Majmaah	2009
25	Saudi Electronic University	SEU	Riyadh	2011
26	University of Hafr Al Batin	UHB	Hafr Albatin	2014
27	University of Bisha	BU	Bishah	2014
28	University of Jeddah	UJ	Jeddah	2014

some facts and figures of the tertiary education providers in the country. Table 1 shows that the Kingdom has 28 public universities, established between 1957 and 2014. This indicates that the Kingdom's higher education system is relatively young compared with that of other nations. These 28 public universities are the subject of this research.

These 28 public universities are funded directly by the Saudi Ministry of Education (MOE). These public universities tend to be comprehensive; providing a wide range of disciplines. These universities serve 1,323,692 students (MOE 2015). However, there are other higher education institutions that are managed and funded by other ministries and government agencies. These institutions focus on some technical, industrial, medical, and administrative aspects, offering higher education to 125,279 students in the country.

On the other hand, private higher education in the Kingdom is expanding rapidly. Currently, the country has 11 private universities and 18 private colleges, covering a whole range of areas including medical, administrative, scientific and technological subjects. There are over 78,798 students in private universities and colleges in Saudi Arabia (Ibid.).

According to the Ministry's Statistic Centre, there were in total 1,527,769 students, 76,985 faculty members, and 77,130 administrative and technical staff in higher education institutions, both public and private (Ibid.).

4 Research Methodology

This section gives an account of how this research was carried out. This study collected data in two steps: The first step involved a desk study, in which the literature was scanned particularly the strategic plans of all public universities in the country. This was to explore the commitments and targets of these universities concerning climate change and sustainability. The second step involved a field trip to eight public university campuses to interview key decision makers in these institutions. By doing so, this research is using case study strategy through what is referred to as the 'triangulation technique'; 'looking in from different angles and vantage points' (Thomas 2011, 68).

4.1 Examining the Strategic Plans of Universities

The aim was to explore the issues of climate change and sustainability in public universities in Saudi Arabia and how these issues are communicated. The data collection technique used was a desk study, through which the strategic plans of each institution was reviewed and analysed. This was a web-based method in which data was obtained through internet research (Reips and Bosnjak 2001). The search mainly focuses on whether climate change and sustainability are underlined in the strategic plans and also whether there are policies, commitments, and targets to meet in dealing with these issues. It explores the idea of 'leading by example' and the use of 'university campus as a living lab' for applied research and teaching around the topic of sustainability (König 2013). The scope of research included all 28 public universities in the Kingdom. The type of data collected was mainly qualitative.

4.2 Examining Knowledge and Awareness of Policy- and Decision-Makers in Universities

The aim of undertaking interviews with policy- and decision-makers in public universities is to provide valuable information about their knowledge and awareness of climate change and sustainability. These influential individuals have the potential to influence communication of such issues at the university level and beyond. The approach involved a field study in which eight universities were selected as case studies. The technique employed was conducting face-to-face semi-structured interviews. The reasons for choosing this type of interview were because (i) 'participants can provide important historical information and background' (Creswell 2003, 186), (ii) 'interviewees are briefed about the main issues to cover during the interview, rather than giving them specific questions. This gives more freedom to follow up points as necessary. Such structure encourages the interviewees to say more on these follow-up questions' (Thomas 2011, 163), (iii) 'interview is focused, because certain areas are questioned with scope for respondents to express themselves at a reasonable length' (Collins 2010, 134), and (iv) 'interview is open-ended and assumed a conversational manner' (Yin 2014, 111).

The process of planning and undertaking interviews went as follow: first, given the fact that the interviews were with people who tend to have very busy schedules; all interviews were planned in advance. Appointments were made with respondents or with their assistants to discuss the interview arrangements. Second, a copy of the interview's main topics or questions was sent to each participant beforehand. The copy also included one page that introduces some definitions of key terms and descriptions of all acronyms.

At the interview, an overview was presented to introduce the research project briefly, re-confirm the purpose of the interview and its structure, and assure confidentiality. Before starting the interview, candidates were asked for their permission to record the interview. The records were supplemented by handwritten notes taken during the interviews to ensure accuracy. Each interview took an average of one hour.

At the end of each interview, candidates were asked to add any further comments. Candidates were informed that the interview audio will be typed up and sent to them for proof-reading/editing the transcriptions, especially after the translation from Arabic into English. This was because all the interviews were in Arabic. Of the 19 interviews carried out, only two candidates did not want the interview to be recorded. The 17 recorded interviews were transcribed, after having systematically listened to their contents from the electronic recorder. The 19 interviewees were asked to review their interview transcripts within a period of one month. Only six people responded indicating that they had reviewed the transcript and had no revisions to make.

The interview transcriptions were organised, labelled, and coded using the qualitative analysis software Atlas.ti®. Significant parts of each interview document were coded in order to avoid overlooking points that may seem to unimportant at a particular moment, but would become valuable as the project progressed (Friese 2014). Each interview transcription was deductively coded based on the topics or areas of interest for the research. However, inductive way of coding was also employed, since during the course of reading the interview transcription, new interesting topics emerged. Therefore, these emerging topics were also coded and analysed.

5 Results and Discussion

In this section, the findings are presented, evaluated, and discussed. The results and analysis of both the strategic plans of universities and the interviews were combined to prevent repetition.

In total, there were 19 people interviewed, which is almost 50% of the 40 officials planned to be interviewed in the selected eight public universities. The interviewees were selected based on their key roles in decision making in their institutions. Because of their different roles and responsibilities, they have been divided into three groups; strategic, tactical, and operational. The strategic group included Deans of Development and Quality, Vice Rectors, and Rectors or Acting Rectors. The tactical group involved Heads of Directorate of Study and Design, whereas the operational group comprised of Facility Managers, Project Managers, and Operation and Maintenance Supervisors. Table 2 presents the positions of participants. It shows that more than half of the people interviewed were from the operational group (53%), while very few people were from the tactical group (10%). Key decision makers were represented by seven participants (37%), indicating that the strategic group was well represented giving this research more value.

There were eight universities that have been studied in this research, which is almost one-third of public universities in Saudi Arabia. Table 3 illustrates the positions of interviewees from each university. It shows that on average there are two people interviewed per university, even though much effort had been devoted to organise these interviews. For no particular reason, the highest numbers of interviewees were from Jazan University (JNU), Al Baha University (ABU), and University of Hail (UH).

Table 2 Information about positions

No.	Position of participants	Number of participants	Management levels
01	Rectors/acting rectors	3	Strategic
02	Vice Rector/Dean of Development and Quality	4	
03	Head of Directorate of Study and Design	2	Tactical
04	Facility or Project Managers	8	Operational
05	Operation and Maintenance Supervisor	2	

Table 3 Participants from the eight public universities

No.	University code	Participants					Total
		Facility or project manager	Operation and maintenance supervisor	Head of directorate of study and design	Vice rector or dean of development and quality	Rector	
01	KSU	✓			✓		2
02	JNU	✓		✓	✓	✓	4
03	UH	✓			✓	✓	3
04	AJU	✓					1
05	ABU	✓	✓			✓	3
06	NU	✓		✓			2
07	PSAU	✓			✓		2
08	UHB	✓	✓				2
		8	2	2	4	3	19

Table 4 presents background information about the 19 interviewees. The majority of the interviewees were Project Managers, eight in total. Other positions include three rectors (two of them were acting rectors), three vice rectors (two were assistants vice rector), two Operation and Maintenance Supervisors and two Heads of Studies and Design Department. The average years of experience of participants in general were 18 years, whereas the average years of experience in their positions were three years. The later indicates that the majority of managers, supervisors, vice rectors, and rectors in most Saudi public universities were appointed recently. This comes with no surprise since 70% of public universities in the Kingdom are recently established. Regarding the level of education, 42% of the interviewees hold bachelor degrees, whereas 58% hold postgraduate degrees, Masters (10%) or Ph.D. (48%). Concerning the qualification, most of the managers and supervisors are engineers or architects, whereas rectors or vice rectors vary in their majors.

In light of (i) Article 6 in the UN Convention, known as UNFCCC (UN 1992), which underlines the importance of education and public awareness, (ii) the importance of decision makers' knowledge and awareness, and (iii) the vulnerability of Saudi Arabia to climate change, this study emphasises the role of higher education institutions in addressing climate change and sustainability. It examines the concept of utilising 'university campus as a living lab' for applied research and teaching around the topic of sustainability. Therefore, this research explored, through the evaluation of strategic plans and conducting interviews, a number of issues such as vision, aim, policy, commitment, sustainability measurement, green-building schemes, and measuring awareness of decision makers about some recent sustainability developments in higher education.

Table 4 Background information about interviewees

No.	University code	Position	Years of experience in		Level of education	Qualification (major)
			General	Position		
01	KSU	Ass. of Vice Rector for Projects	39	4	Ph.D.	Architecture
02	KSU	Project Manager	9	8	Bachelor	Architecture
03	JNU	Acting Rector	35	2	Ph.D.	Biology
04	JNU	Vice Rector	26	3	Ph.D.	Arabic language
05	JNU	Head of Studies and Design Dep.	11	3	Master	Architectural engineering
06	JNU	Project Manager	9	1	Master	Architectural design
07	UH	Rector	30	5	Ph.D.	Archaeology
08	UH	Dean of Quality and Development	14	3	Ph.D.	Curriculum and instruction
09	UH	Project Manager	9	1	Bachelor	Architecture
10	AJU	Project Manager	33	5	Ph.D.	Environmental design
11	ABU	Acting Rector	35	2	Ph.D.	Islamic and comparative education
12	ABU	Project Manager	10	1	Ph.D.	Environmental engineering
13	ABU	Operation and maintenance Sup.	15	1	Bachelor	Electrical engineering
14	NU	Head of Studies and Design Dep.	10	6	Bachelor	Architecture
15	NU	Project Manager	8	5	Bachelor	Civil engineering
16	PSAU	Assistant General Sup. for Projects	24	2	Ph.D.	Psychology
17	PSAU	Project Manager	9	5	Bachelor	Architecture

(continued)

Table 4 (continued)

No.	University code	Position	Years of experience in		Level of education	Qualification (major)
			General	Position		
18	UHB	Project Manager	13	1	Bachelor	Architectural Engineering
19	UHB	Operation and Maintenance Sup.	14	2	Bachelor	Industrial management

5.1 Vision for Sustainability

One of the first issues to examine was the institutional vision of sustainability. The analysis shows that the Saudi higher education institutions are unified in their vision to provide distinctive education that meets the needs of the society and labor market and hence contribute effectively to the sustainable development through applied research, optimal use of modern technologies, and active partnership at different levels: locally, regionally, and internationally.

Furthermore, it is clear that the vision of public universities in Saudi Arabia is not only to educate the population on the domestic front, but also to compete in the global arena through investing heavily in the higher education sector.

As for their campuses, the common vision of public Saudi universities is to create an environment that is appealing, smart, and sustainable. The enormous investment is visible in the physical solutions that demonstrate the commitment to a shared vision of the future. The investment in the physical solutions has been justified as being one of the most important tools for the success of the university.

What can be also noticed is that in newly founded universities, sustainability as a concept has been applied through some initiatives at an individual level, but not at the institutional level. This means that a number of sustainable initiatives have been taken by individuals at some universities in the absence of the top-down comprehensive sustainability approach, that deals with sustainability holistically.

5.2 Aim and Objectives for Sustainability

One of the first issues to be explored was (i) the aim of the institution in general and (ii) the aim of the institution for its campus from a sustainability perspective. The analysis indicates that the majority of Saudi universities share almost the same goals of:

- outstanding academic programs and leadership in research in order to actively participate in the Kingdom's aim of achieving a 'knowledge-based society' and 'knowledge-based economy',
- physical assets: providing not only suitable purpose-built higher educational facilities for learning and research for each region and its provinces, but also much needed community services such as hospitals, housing, libraries, conference centres, museums, hotels, and sport facilities,
- human capital: investing in our human resources, which are regarded as a significant asset, through which the institution's aims cannot be achieved without, and
- meeting the ever-increasing demand for university education.

As for the campus, the aims are:

- having a campus that is attractive, well-eqipped, efficently operated, easly maintained, and environmentally friendly and
- executing construction projects of the university's main campus and its satellite campuses (branches) in different provinces.

Having said that, very few universities have indicated clear and defined aims of sustainability for their university campuses. This is due to (i) lack of interest, (ii) scarcity in expertise, (iii) differing priorities, and (iv) insufficient knowledge of climate change and sustainability.

It can be also seen that each Saudi university recognises the fact that its campus is one of the most important tools to achieve the institution's main aims. A project manager emphsises this saying "*Our campus will be used as one of the means to pursue [our aim]*". Den Heijer (2011) has proven that each university goal can be frustrated by the physical setting of the campus. This indicates the significance of university facilitites, which can be moblised to help achieve the institutions' aims and objectives and ultimately a more sustainable development.

5.3 Policy for Sustainability

Another aspect evaluated was the policy through which the vision and aim can be achieved. The analysis shows a number of policies adopted by some public universities to become more sustainable and hence carbon neutral. These policies, which can be found in campuses of new and well-established universities, are for example:

- indicating the aims and visions of the university for sustainability aspects as clearly defined as possible in the project brief (known as the planning and design reference),
- involving the end-users at early stage of the construction project in order to incorporate the ideas and expertise of users, and

- establishing a department, unit, administration or office of sustainability to guarantee integrating policies of sustainability into the university's planning, construction, operation, and maintenance along with the education, research, engagement and outreach aspects of sustainability.

Other technical policies include:

- rethinking the design of many university campuses through which a number of planning issues can be addressed such as orienting some buildings, ensuring optimum use of spaces in college buildings, and reducing the parking zones and the hardscaping in general,
- using the pre-cast concrete almost in all elements of the building, including, columns, beams, slabs, claddings, internal walls, and stairs to ensure quality, speed, and resilience, and
- investing in alternative ways of transportation such as bicycles, especially within the campus zones. For example, King Saud University is considering such a move to ease accessibility within its campus.

However, even though strategic plans of some universities indicate a vision for sustainability, these plans clearly lack the defined policies to achieve this vision. A project manager points out saying "*I can confirm that at the rectorate level, sustainability as a concept is new and they have no comprehensive sustainability plan for the campus*". This can be clearly noticed in some of the strategic plans of Saudi public universities.

5.4 Commitments for Sustainability

Another issue examined was whether public universities are committed to climate change and sustainable development. In other words, what measures universities have been taken or will take to promote aspects of sustainability and raise awareness of climate change. The analysis illustrates some of the commitments made by some Saudi universities. There are strategic and technical commitments. Strategic commitments include:

- raising awareness starting by educating the educators through setting up events, exhibitions, campaigns, and public lectures to equip faculty members with the necessary level of knowledge and tools,
- some public universities are committed to green building schemes such as Leadership in Energy and Environmental Design (LEED). For example, in the tendering document for some proposed college buildings, Jazan University (JNU) has indicated that the building has to be certified by any green building schemes such as the LEED, and
- some public universities are committed to sustainability through commissioning well-known engineering consultancies. For example, Al Jouf University (AJU) has appointed a Spanish Engineering Consultancy, TYPSA, to provide technical supports to manage the campus as sustainable as possible.

Technical commitments made include:

- automating buildings' systems including the heating, ventilation, and air conditioning (HVAC), water, and lighting in both the existing and proposed building on campus to conserve energy and water use,
- using renewable energy facilities such as the solar panels and wind turbine on campus and hence not depending totally on the conventional way of using fossil fuel to generate power for the campus facilities, and
- less is more: resizing some proposed college buildings to reduce any wasted spaces.

Nevertheless, over 60% of the campus managers and supervisors have indicated that there are no documented sustainability commitments in their universities. This can be true in the majority of Saudi public universities; both well-established and recently founded ones. Sustainability "*has not been taken comprehensively as an approach for the University for its Campus*", a project manager says. The absence of strategic commitment for sustainability comes as no surprise given the lack of clear aims of sustainability and lack of defined policies for sustainability.

5.5 *Measuring Sustainability Aspects*

How public universities measure sustainability aspects has been also explored. It is known that there are many existing tools, frameworks, and instruments to gauge sustainability aspects designed specifically for higher education institutions (Alshuwaikhat and Abubakar 2008; Caeiro et al. 2013; Kamal and Asmuss 2013; Shriberg 2002; Wright 2002). The analysis shows that the vast majority of public universities have no proper instrument to measure how sustainable they are. The young age of institutions has been always blamed, especially by recently established universities. Saudi universities, both new and old, have neither developed a sustainability tool nor adopted an existing one to measure their advancement effort to become more sustainable.

However, some common practices mentioned by a number of universities for measuring sustainability advancement including:

- monitoring and comparing the level of consumptions of energy, gas, and water, and
- observing and comparing the cost of operation and maintenance over a period of time.

More focus on the environmental aspects of sustainability can be noticed in this group of interviewees. It was expected given that the majority of them are engineers and architects. Although there were other people who have different qualifications (majors), the emphasis was mainly on the operation and maintenance aspects. Other aspects of measuring sustainability academically, socially, and economically were seldom mentioned.

5.6 Green-Building Certification Schemes

The next issue to observe was the number of buildings on campus that have been or will be recognised by one of the world's leading environmental assessment methods for buildings including BREEAM (UK), LEED (US), GREEN STAR (AU), and DIGNB (GR). These green-building certification schemes assess, rate, and certify buildings based on their sustainable performance, value, and efficiency. The analysis shows that the vast majority of Saudi public universities have no certified facilities by any global green-building schemes. However, some universities do indeed have some LEED certified buildings such as:

- King Saud University (KSU) (old public university),
- Princess Nourah bint Abdul Rahman University (PNU) (new public university),
- King Saud bin Abdulaziz University (new public university), and
- King Abdullah University for Science and Technology (new private university).

Additionally, some of the recently established universities are making considerable progress in this regards; through highlighting this issue in their tendering documents for proposed buildings. For example, Fig. 1 shows a small part of the project brief of the Medical Zone at Jazan University (JNU), known as the Planning and Design Reference. It indicates some of the bidding requirements and conditions for green-building certification scheme. In this contract for design services, Jazan University stipulates a number of 'green' considerations including:

- Using energy modelling software to stimulate the energy use of college buildings.
- Identifying sustainability initiatives and guidelines.
- Developing preliminary environmental and green building strategies.
- Using applicable LEED checklists as the base for green design.

الإدارة العامة للمشاريع
وثائق تعاقدية

جامعة جازان
الإدارة العامة للمشاريع
إدارة الدراسات والتصاميم

48	Produce Preliminary MEP systems and special support systems. With BIM, 3D sections to show the systems and identify any clashes I interferences with architectural and structural components.
49	Utilize acclaimed Energy Models and simulations software to steer the project towards sustainable design (i.e. Eco tech and IES)
50	Identify sustainability initiatives and guidelines.
51	Develop preliminary environmental and 'Green Building' strategies.
52	Utilize applicable LEED checklists as the basis for green design.

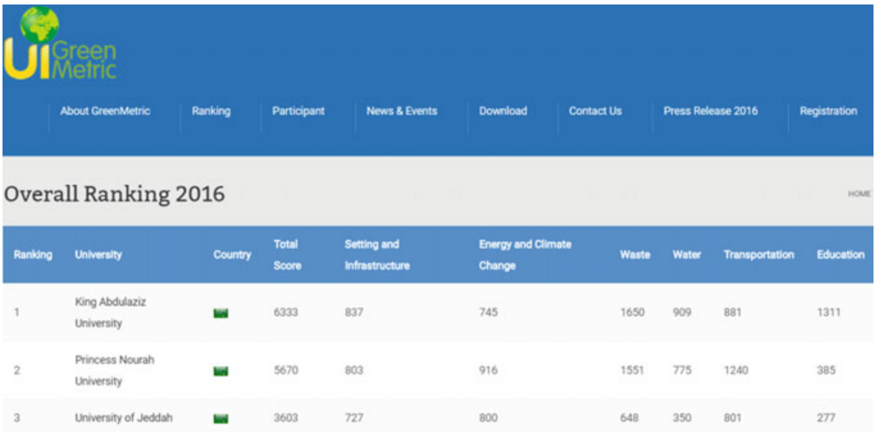
Fig. 1 Some of the planning and design requirements for the Medical Zone Project at Jazan University (JNU)

5.7 Recent Sustainability Developments in University Campuses Worldwide

The knowledge and awareness of decision makers were asked about the recent sustainability developments in university campuses. All participants were asked whether their universities have involved in or at least have considered participating in the following developments presented below.

- First is signing one (or maybe more) of the international declarations, charters, or partnerships, which are written agreements to (a) inculcate environmental, social, economic, and educational sustainability in colleges and universities and (b) advance all aspects of sustainability in higher education institutions. Declarations include, but not limited to, Stockholm, Talloires, Halifax, Tokyo, and the UN (Lozano et al. 2013). None of the Saudi public universities has signed such declarations or charters. Facility and project managers along with the heads of design and study department believe that this is the rectorate's responsibility. Sustainability needs leadership; a top-down approach. They emphasise that sustainability has become a necessity, it is no longer just 'nice to have'. Decision-makers have to be aware of the great benefits of sustainability and its implication for the campus and beyond.
- Second is having an 'Office of Sustainability' headed by experts who specialise in sustainable issues. Such an office only exists in one well-established public university, King Abdulaziz University, although named as the 'General Administration of Sustainability' (KAU 2016). However, this shows that public universities, both old and new, are falling behind in this regard, blaming limited resources and expertise along with the young age of their institutions. King Saud University (KSU) has recently established a new department named as Sustainability Administration and Environmental Development.
- Third is applying one of the Environmental Management Systems (EMS) such as the International Organisation for Standardisation (ISO 14001) Standard or the Environmental Management and Auditing System (EMAS) Regulation. Many of the well-established public universities and only a few of the recently established ones have achieved the certification of such standards.
- Fourth is participating in—or holding—one of the specialised conferences that are organised annually to address sustainability in universities and discuss the latest developments in the field such as International Sustainable Campus Network (ISCN), Environmental Management for Sustainable Universities (EMSU) and Association for the Advancement of Sustainability in Higher Education (AASHE). Some interviewees indicated that they have participated in some sustainability conferences, but not in one of the abovementioned conferences. However, these participants pointed out that they have been to such conferences on their own expenditure, having tried to be sponsored by their universities, but failed. This shows that 'sustainability might not be on the rectorate's agenda for the time being', some interviewees argued.

- Fifth is using one of the sustainability assessment tools, frameworks, and systems such as Sustainability Assessment Questionnaire (SAQ), Sustainable University Model (SUM), Benchmarking Indicators Questions—Alternative University Appraisal (BIQ-AUA), Unit-based Sustainability Assessment Tool (USAT), and Adaptable Model for Assessing Sustainability in Higher Education (AMAS) (Alshuwaikhat and Abubakar 2008; Caeiro et al. 2013; Kamal and Asmuss 2013; Shriberg 2002; Wright 2002). None of the universities is either using one of the abovementioned tools or developing their own tailored tools. In many cases, the interviewees indicated the lack of knowledge of such instruments and systems.
- Sixth is applying for one of the sustainability ranking systems for university campuses such as the UI Green Metric, Green League, and Sustainability Tracking, Assessment and Rating System (STARS). Figure 2 shows that there are three public universities, King Abdulaziz University (KAU), Princess Nourah bint Abdulrahman University (PNU), and University of Jeddah (UJ) were ranked among the top 400 greenest campuses in the world in the UI Green Metric (2016). However, other sustainable universities that can apply for such ranking systems include King Saud bin Abdulaziz University for Health Sciences (KSAUHS) and King Abdullah University for Science and Technology (KAUST). The latter is known to be very sustainable; the first LEED-certified project in Saudi Arabia and the largest LEED-Platinum project in the world (U.S. Green Building Council 2012; HOK 2016).
- Joining in one (or more) of the professional bodies or associations of campus facilities and college buildings such as Society of College and University Planners (SCUP) and Association of Higher Education Facilities Officers (APPA). None of the interviewees is a member of one of the mentioned professional bodies or associations. However, they all show some interest in joining



Overall Ranking 2016

Ranking	University	Country	Total Score	Setting and Infrastructure	Energy and Climate Change	Waste	Water	Transportation	Education
1	King Abdulaziz University		6333	837	745	1650	909	881	1311
2	Princess Nourah University		5670	803	916	1551	775	1240	385
3	University of Jeddah		3603	727	800	648	350	801	277

Fig. 2 Three Saudi public universities were among the top 400 greenest campuses (UI Green Metric 2016)

such societies. Reinforcing the sustainability commitment on- and off-campus by (i) bring in experts as guests speakers on sustainability, (ii) arranging training sustainability courses and workshops, (iii) celebrating the Earth Day and so on. Very few interviewees had indicated that such events and activities took place in their campuses. Some interviewees had blamed their rectorates for failing to draw attention to such events and activities on- and off-campus.

In summary, the overall reaction of Saudi universities towards global sustainability developments is uninspiring; it can be said that the vast majority of Saudi public universities—both recently founded universities and well-established universities—are failing to match global norms. The interviewees had emphasised repeatedly that sustainability needs a top-down management approach in order to advance it in universities and beyond.

6 Conclusions and Recommendations

The purpose of the current study was to explore the role of higher education institutions in Saudi Arabia in addressing climate change and sustainability, given the sensitivity of Saudi Arabia to climate change. This research looked at the concept of using the university campus as 'a living lab'. Through the evaluation of strategic plans and conducting interviews, this research evaluated a number of sustainability aspects including vision, aim, policy, commitment, measurement, green-building schemes, and knowledge and awareness. It showed how Saudi public universities responded to the challenges of climate change through a number of sustainable initiatives.

The study has identified that Saudi Arabia is in a challenging position. The Kingdom needs to double its efforts to move towards a greener economy and sustainable development. Although it shows some commitments, there is a long way to go. One key step that has to be taken is to put more sustainable policies in place. Setting targets for renewable energy should go hand in hand with less investment in the conventional sources of energy (e.g. fossil fuels). The government hopes to become a 'solar energy exporter'. In order to convert this vision into reality, the government has to significantly increase its efforts. The world is moving fast on investment in low carbon energy to tackle climate change and this could be yet another opportunity for Saudi Arabia to use its abundance of sunshine to produce more than it consumes (King 2015).

This study has shown that the reaction of public universities in Saudi Arabia to the challenges of climate change and sustainability is modest, slow, and insufficient. The country is facing tough choices and yet universities are not rising up to the challenge. Universities have to exercise their leading role in not only efficiently and effectively communicating the issues of climate change, but also developing mitigation and adaptation measures to deal with it; Cortese (2003, 19) says 'If higher education does not lead the sustainability effort in society, who will?'

The other major findings show that the majority of decision-makers in public universities have limited knowledge of sustainability. Very few interviewees have indicated their awareness of the recent sustainability developments in universities worldwide. Reasons for such problem are:

- absence of top-down sustainability approach
- lack of sustainability commitment
- lack of specialist knowledge, expertise, and adequate training
- dearth of resources principally for sustainability
- lack of follow up to recent sustainability developments.

The investigation has found that very few universities have indicated clear and defined aims of sustainability for their university campuses. This is resulting from (a) lack of interest, (b) scarcity in expertise, (c) differing priorities, and (d) insufficient knowledge of sustainability. The research has shown that Saudi universities have a common vision to create an environment that is appealing, smart, and sustainable. Although policy- and decision-makers believe in the importance of sustainable campus, they lack the means to translate this belief into reality.

One of the more significant findings to emerge from this study is that even though strategic plans of some universities indicate a vision for sustainability, these plans clearly lack the defined policies to achieve this vision. The main issue lies in the fact that sustainability as a concept is not widely known and the majority of universities have no comprehensive sustainability plan for their campuses to be used as a 'living lab'.

Taken together, these results suggest that in general, there are many sustainability issues challenging most public universities in Saudi Arabia. The top issues can be summarised as:

- Saudi policy- and decision-makers have inadequate knowledge and awareness about the recent sustainability developments in university campuses worldwide.
- The vast majority of Saudi public universities have no clear sustainability aim for their campuses. Although these universities show a common vision to create a learning environment that is appealing, smart, and sustainable, they lack defined policies to achieve such vision. This goes along with having no documented sustainability commitments.
- The vast majority of Saudi public universities have no proper instrument to gauge how sustainable they are. These universities, both old and new, have neither developed a sustainability tool nor adopted an existing one to measure their advancement efforts towards becoming more sustainable.
- Very few universities have started and made the effort to become more sustainable.

Given that there are some limitations in this study, there is a need for further research. A key limitation in this study was it looked at only the environmental aspect of sustainability. Consequently, other research is required to cover other aspects of sustainability such as social and economic. Another limitation is that it explored the challenges of climate change and sustainability in eight public universities, while there are 28 public universities in Saudi Arabia. Therefore, additional study is needed to explore such issues in the rest of the Kingdom's universities.

References

Alghamdi N, den Heijer A, de Jonge H (2017) Assessment tools' indicators for sustainability in universities: an analytical overview. Int J Sustain High Educ 18(1):84–115

Alshuwaikhat HM, Abubakar I (2008) An integrated approach to achieving campus sustainability: assessment of the current campus environmental management practices. J Cleaner Prod 16 (16):1777–1785

Alyousef Y, Varnham A (2010) Saudi Arabia's National Energy Efficiency Programme: description, achievements and way forward. Int J Low-Carbon Technol 5(4):291–297

Bhaskar R, Frank C, Høyer KG, Næss P, Parker J (2010) Interdisciplinarity and climate change: transforming knowledge and practice for our global future. Routledge, London

Caeiro S, Walter L, Charbel J, Azeiteiro U (2013) Sustainability assessment tools in higher education institutions: mapping trends and good practices around the world. Springer International Publishing, Switzerland

CAT (Climate Action Tracker) (2016) Saudi Arabia. Available from http://climateactiontracker.org/countries/saudiarabia.html. Accessed 11 Dec 2016

CEDA (Council of Economic and Development Affairs) (2016) Saudi Arabia's Vision 2030. Available from http://vision2030.gov.sa/en. Accessed 11 Nov 2016

CIWF (Compassion in World Farming) (2016) Environmental damage. Available from http://www.ciwf.org.uk/factory-farming/environmental-damage/#Footer. Accessed 12 Dec 2016

Collins H (2010) Creative research: the theory and practice of research for creative industries. AVA Publishing, Singapore

Cortese A (2003) The critical role of higher education in creating a sustainable future. Plan High Edu 31(3):15–22

Creswell J (2003) Research design: qualitative, quantitative, and mixed methods approaches, 2nd edn. SAGE Publications Inc., London

CSLF (Carbon Sequestration Leadership Forum) (2016) CSLF members. Available from https://www.cslforum.org/cslf/Members. Accessed 11 Dec 2016

Darfaoui E, Al Assiri A (2010) Response to climate change in the Kingdom of Saudi Arabia. Available from http://www.fao.org/forestry/29157-0d03d7abbb7f341972e8c6ebd2b25a181.pdf. Accessed 11 Dec 2016

Den Heijer AC (2011) Managing the university campus: information to support real estate decisions. Eburon Academic Publisher, Delft

Down L (2006) Addressing the challenges of mainstreaming education for sustainable development in higher education. Int J Sustain High Edu 7(4):390–399

FAOUN (Food and Agricultural Organisation of the UN) (2016) Saudi Arabia. Available from http://www.fao.org/nr/water/aquastat/countries_regions/sau/index.stm. Accessed 11 Dec 2016

Friese S (2014) Qualitative data analysis with ATLAS.ti. (2nd ed). SAGE Publications Inc., London

GMI (Global Methane Initiative) (2016) Saudi Arabia. Available from https://www.globalmethane.org/partners/country.aspx?country=saudiarabia. Accessed 12 Dec 2016

HOK (2016) King Abdullah University of Science and Technology. Available from http://www.hok.com/design/type/science-technology/king-abdullah-university-of-science-and-technology/. Accessed 4 July 2016

IPCC (Intergovernmental Panel on Climate Change) (2014) Climate change: synthesis report. In: Pachauri RK, Meyer LA (eds) Contribution of Working Groups I, II and III to the Fifth

Assessment Report of the Intergovernmental panel on climate change. IPCC, Geneva, Switzerland, 151 pp. Available from https://www.ipcc.ch/pdf/assessment-report/ar5/syr/SYR_AR5_FINAL_full.pdf. Accessed 12 Dec 2016
KACARE (King Abdullah City for Atomic and Renewable Energy) (2016) The establishing order. Available from https://www.kacare.gov.sa/en/Pages/default.aspx. Accessed 13 Dec 2016
Kamal A, Asmuss M (2013) Benchmarking tools for assessing and tracking sustainability in higher education institutions: identifying an effective tool for University of Saskatchewan. Int J Sustain High Educ 14(4):449–465
KAU (King Abdulaziz University) (2016) General administration of sustainability. Available form http://sty.kau.edu.sa/Default.aspx?Site_ID=994&lng=EN. Accessed 12 Dec 2016
Ketlhoilwe MJ, Jeremiah K (2010) Mainstreaming environment and sustainability issues in institutions of higher education: the case of the University of Botswana. Int J Sci Res Educ 3 (1):1–9
King E (2015) Saudi Arabia solar power exports: 'absolutely realistic', climate home. Available from http://www.climatechangenews.com/2015/05/28/saudi-arabia-solar-power-exports-absolutely-realistic/. Accessed 12 Dec 2016
König A (2013) Regenerative sustainable development of universities and cities: the role of living laboratories. Edward Elgar Publishing Limited, Cheltenham
Lotz-Sisitka H, Hlengwa A, Ward M, Salami A, Ogbuigwe A, Pradhan M, Neeser M, Lauriks S (eds) (2015) Mainstreaming environment and sustainability in African Universities: stories of change. Rhodes University Environmental Learning Research Centre, Grahamstown
Lozano R, Lukman R, Lozano F, Huisingh D, Lambrechts W (2013) Declarations for sustainability in higher education: becoming better leaders, through addressing the university system. J Clean Prod 48:10–19
LSE (London School of Economy) (2016) Saudi Arabia. Available from http://www.lse.ac.uk/GranthamInstitute/legislation/countries/saudi-arabia/. Accessed 11 Dec 2016
MOE (Ministry of Education) (2015) Higher education statistics. Available at http://www.moe.gov.sa/ar/Ministry/Deputy-Ministry-for-Planning-and-Information-affairs/HESC/Ehsaat/Pages/default.aspx. Accessed 12 Dec 2016
PRC (Paris Reality Check) (2016) Intended Nationally Determined Contributions (INDC) and carbon capture and storage. Available from https://www.pik-potsdam.de/paris-reality-check/indcs-carbon-capture-and-storage/. Accessed 12 Dec 2016
Reips UD, Bosnjak M (2001) Dimensions of internet science. Pabst Science, Lengerich
Saudi Aramco (2017) Commissioning of First Wind Turbine in Turaif. Available from: http://www.saudiaramco.com/en/home/news-media/news/first-wind-turbine.html. Accessed 18 Jan 2017
SEEC (Saudi Energy Efficiency Centre) (2016). Available from http://www.seec.gov.sa/en. Accessed 12 Dec 2016.
Shriberg M (2002) Institutional assessment tools for sustainability in higher education: strengths, weaknesses, and implications for practice and theory. Int J Sustaina High Educ 03(3):254–270
Thomas G (2011) How to do your case study: a guide for students and researchers. SAGE Publications Ltd., London
UI Green Metric (2016) Overall ranking 2016. Available from http://greenmetric.ui.ac.id/overall-ranking-2016/. Accessed 18 Jan 2017
UN (United Nations) (1992) United Nations framework convention on climate change. Available from https://unfccc.int/resource/docs/convkp/conveng.pdf. Accessed 12 Dec 2016
UN (United Nations) (2016) UN and climate change: towards a climate agreement. Available from http://www.un.org/climatechange/towards-a-climate-agreement/. Accessed 11 Dec 2016
UNDCWS (UN-Documentation Centre on Water and Sanitation) (2016) Managing water report under uncertainty and risk: The United Nations World Water Development Report 4, vol 1. Available from http://www.unesco.org/new/fileadmin/MULTIMEDIA/HQ/SC/pdf/WWDR4%20Volume%201-Managing%20Water%20under%20Uncertainty%20and%20Risk.pdf. Accessed 12 Dec 2016

UNDP (United Nations Development Programme) (2016) Saudi Arabia: energy and environment. Available from http://www.sa.undp.org/content/dam/saudi_arabia/img/Publications%20pictures/Project%20Documents%20E&E/ee%20fast%20facts.pdf. Accessed 12 Dec 2016
UNESCO (United Nations Educational, Scientific and Cultural Organization) (2005), UN Decade of ESD, Available at http://en.unesco.org/themes/education-sustainable-development/what-is-esd/un-decade-of-esd (Accessed 15th Aug. 2016)
UNFCCC (United Nations Framework Convention on Climate Change) (2016), Available from http://unfccc.int/paris_agreement/items/9444.php. Accessed 15th Aug 2016
U.S. Green Building Council (2012) With end of oil in sight, Saudi Arabia's LEED community is vision of sustainable future. Written by Anica Landreneau. Available from http://www.usgbc.org/articles/end-oil-sight-saudi-arabia%E2%80%99s-leed-community-vision-sustainable-future. Accessed 4 July 2016
WCED (World Commission on Environment and Development) (1987) Our common future. Available from http://www.un-documents.net/our-common-future.pdf. Accessed 12 Dec 2016
World Bank (2016) Planning integrated urban transport for Saudi's Busiest Cities. Available from http://www.worldbank.org/en/news/feature/2016/06/15/planning-integrated-urban-transport-for-saudis-busiest-cities. Accessed 5 Oct 2016
Wright TSA (2002) Definitions and frameworks for environmental sustainability in higher education. Int J Sustain High Educ 03(3):203–220
WTEx (World's Top Exports) (2016) Crude oil exports by country. Available from http://www.worldstopexports.com/worlds-top-oil-exports-country/. Accessed 10 Dec 2016
Yin R (2014) Case study research: design and methods. SAGE Publications Inc., California
Yohe GW, Lasco RD, Ahmad QK, Arnell NW, Cohen SJ, Hope C, Janetos AC, Perez RT (2007) Perspectives on climate change and sustainability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Climate change 2007: impacts, adaptation and vulnerability. Contribution of Working Group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, UK, 811–841. Available from https://www.ipcc.ch/pdf/assessment-report/ar4/wg2/ar4-wg2-chapter20.pdf. Accessed 10 Dec 2016

Author Biography

Naif Alghamdi is a lecturer at the Faculty of Architecture and Planning, King Saud University, Riyadh, Saudi Arabia. As an architect, he works part-time with several professional practices in Saudi Arabia providing consultation. Naif holds postgraduate degrees in both Project Management and Architecture from the Bartlett, University College London, United Kingdom. Naif's main interest is in sustainability on university campuses in Saudi Arabia. Currently, he is doing his Ph.D. at Delft University of Technology, Netherlands, looking at sustainability in Saudi Arabian university campuses. Professional memberships include the Society of College and University Planners (SCUP), the Association of Higher Education Facilities Officers (APPA), the Saudi Umran Society of Architects (SUSA) and the Saudi Council of Engineers (SCE).

'Committees', a Promising Institution in Climate Change Communication and Adaptation?

Sabine Tröger

1 Introduction: 'Committees', Institutional Frameworks of NRM/CCA

Coinciding with the claim for decentralization together with the mainstreaming of participatory approaches in development practice, we can observe a shift in policies to advocate local actors and resource users play a more active role in NRM, which in many cases today means climate change adaptation (CCA). Decentralization describes the process by which bundles of entrustments, like regulatory and executive powers, responsibility and authority in decision-making, are transferred to local agents, which again calls for new institutions and processes of institution building.

These processes of decentralization come about in the shape of 'committees'. Committees have mushroomed up in various development contexts all over Africa focusing environments of obvious global change, which force local actors to unanimously and fundamentally adapt to the irreversible changes in nature. Informed by the 'Western' ideal of democracy, the committees mirror the principal idea of equal representation and equal voice. The ideal of 'participation' has developed to be the counter-balance to the socio-political institution of 'committees', which again, following prominent discourses on participation, claims to 'give people a voice'. The notion of 'voice' unambiguously links the concepts of 'committee' and 'participation' with the need for 'communication', true communication, which enables inter-subjectivity via a mutual exchange of people's perceptions, interpretations and valuations, in short: social constructions. In summary, committees are taken to be the platform for participation in realization of the demand for 'communication' regarding 'giving people a voice'.

S. Tröger (✉)
Geography Department, University of Bonn, Meckenheimer Allee 166, 53115 Bonn, Germany
e-mail: troeger@geographie.uni-bonn.de

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_22

The presented case study from Ethiopia/South Omo reflects on the ambiguous effect of those 'Western' democratic ideals in their meaning for processes of CC-communication in African environments. The paper argues that societies, which envisage human dignity in a less individualistic and more cooperative way, do also have a different way of interpreting the role of democratic institutions. Communication in processes of CCA is to be based on the recognition of a plurality of forms of democracy and socially adapted institutions of power and trust.

The argument outlines as follows: Following this introduction of the question in focus, the overarching idea of 'climate change communication' is related to the one of 'participation'. These perspectives are deducted from both, socio-philosophical as well as political theses, as these coincide in their impact on meaningful agency towards climate change adaptation (1). Subsequently, this overarching ideal of participation through communication is bound to the national context and related to the history of the 'development narrative' in Ethiopia and the way this narrative has been and is being communicated. This narrative has ever centered around the interplay between the Government and government agents on the one and the actors in local environments, the citizenry both in rural and urban environments, on the other hand (2). In continuation, the argument depicts the 'development narrative', ever defined by the political power, along its historic pathway and further develops and outlines towards the present situation, when institution-building shows up in the shape of 'committees' (3). When the argument turns towards the case study of the Nyangatom community, an indigenous pastoralist society right in the south of Ethiopia is observed and analyzed in its realization of the claimed for climate change communication 'on the ground'. People, individuals are given a voice, and they are listened to when reflecting on their perceptions and interpretations of climate change adaptation communication as of their experience. The argument concentrates on the articulation of social constructions, i.e. people's interpretations of their experiences with the newly introduced 'model' for climate change adaptation, the model of enclosed rangeland management. The data is taken from semi-structured interviews conducted in March 2015. It reflects interpretations and perceptions articulated by Nyangatom pastoralists with relation to a climate change adaptation 'model', rangeland enclosures, which had been introduced to the community in 2011 until 2012. The interviewees depict interpretations, which directly relate to themselves and indirectly to the government agents, who were the ones to administratively introduce the technological innovation. The interview-sample was taken at random. The data assessment cannot claim to be representative quantitatively, but it is considered valid, as it was triangulated. Only a small collection of answers and interpretative perspective is presented in the paper in consideration of gender and age (4). As a sixth step, the argument refers to a theoretical, overarching perspective. It follows the idea of 'dispositiv', which Foucault understands as an assemblage of heterogeneous elements like discourses, institutions, administrative settings, and philosophical as well as morale guidelines. In accordance with this thesis of discourses, which turn into a justification of set programs, the analysis aims at a thorough understanding of the functional impact of climate change communication facilitated by the 'political' in contrast to the 'police' in the interpretation of Rancière (5). Concluding, perspectives towards some way out of the trap of de-politization enforced by westernized committees are offered. The argument reflects on one of the most recent discourses centered on ideas of re-politicization with reference to Mouffe (2013: 32). She states: “*Societies that envisage human dignity in a way that differs from the Western understanding of human rights also have a different way of envisaging the nature and role of democratic institutions*” (6).

2 ‘Communication’ and ‘Participation’, Two Meaningful Concepts Related to Adaptation to Changing Environments and Climate Change

Only if people can meet on equal grounds of understanding and interpretation as well as in freedom to articulate their voice they can realize true communication and, in consequence, true participation. The argument links the here focal perspective of ‘communication’ with the democratic ideal of participation. People can only participate in environmental or climate change adaptation, if they move on common grounds of understanding and interpretation. There is no meaning in a message except what people put into it. Because of this reason, climate change adaptation initiatives should take care of common grounds of understanding! Furthermore, to understand human communication processes one must understand how people relate to each other and to which framework they refer to. Communication is realized against the social construction of meaning, which is to be shared and participated in, for the sake of true understanding.

But processes of communication do not manifest in the open and freed from structural power, dominance and, on the other hand, exclusion and voicelessness. Sen (1999) differentiates between the two basic notions of ‘functionings’ and ‘capabilities’. Functionings he defines as the state of being and living, while he conceptualizes ‘capabilities’ as the actual freedom to access and choose between different alternative combinations of activities or ways of live, alternative opportunities to choose between different combinations of ‘beings and doings’. And, as Paolo Freire claims in his ‘Pedagogy of the Oppressed’ (1970), only when humans can meet in a space with no dominant authority they can contribute to dialogue. In this context, Freire differentiates between three levels of consciousness: the naïve-transitive, the semi-transitive, and the critical-transitive. Only the critical-transitive consciousness allows its holder to ultimately reach a situation of transformation from being a former object to a self-determined subject, which will be able to truly and freely communicate in a given societal setting, and only at this moment, participation in this understanding means empowerment.

Against this background and as a consequence the quest for CCAC can only be fulfilled if attention is given to the question of which type of consciousness is possibly reached by the ways and means of 'communication' realized in committee meetings and activities.

3 The 'Development Narrative'—Past and Present Pathways and Means of Development Communication in Ethiopia

The challenge of 'development' has ever and explicitly been the agenda of the 'Ethiopia People Revolutionary Democratic Front (EPRDF), the up to today and since 1991 ruling party of Ethiopia. It has turned into the 'development narrative', which in thematic variations guidelines the government policies. This 'development narrative' has evolved from its deep roots in the government and people nexus in Ethiopia. It is the story of how policy ideas travel from the top to the bottom (Rottenburg 2009). With its emphasis on the environmental protection context, the development narrative focuses on rehabilitating degraded watersheds and promoting water-harvesting measures. The current status of the natural resource management program is a result of the state's use of a combination of hegemony and governmentality projects to conform citizens into its developmental state ideology. The constitution allows the regional governments to establish sub-regional governments to ensure people's participation in their own administration and to provide essential services to the citizens (FDRE 1995). Hence, in principle, the local governments are presumed to be autonomous, representing and defending the interest of their constituents.

However, as Ayele (2011) argues, local governments continue to be part of the controlling apparatus of the state, rather than the representatives of interests of their constituents. This is due to an absence of constitutional provisions on the power and jurisdiction of regional governments and district governments, as well as the exclusive budgetary dependence of districts on regional governments. Thus, the centralized party decisions determine the national development agenda. Delivery and control of socio-economic advantages such as education, health, agricultural extension and food-for-work schemes have led the party to keep its grip on popular support both in rural and urban areas.

The more or less same interventions were and still are being promoted by the governments in succession, labeled NRM, and very often farmers and their backward practices have been blamed as prime drivers of degradation (Dessalegn 2003). Following the 2005 elections, EPRDF was even more explicit with its developmental state ideology. According to Gebresenbet (2015), the state started to portray its development plans as a matter of national security. The number of party members grew from 760,000 to 5 million in 2010 (Bach 2011). Party loyalty, especially in rural areas, is demonstrated by taking up agricultural practices promoted by the state. The thus identified 'model farmers', as argued by Lefort (2012), have more to do with party loyalty than with farming competence. Hence, the penetration of the developmental ideology of the state depends on the legitimacy and competence in communication of its party members at the community level. However, when people refused to take part in development related activities, the leaders were advised to convince the people on the ground by the establishment of by-laws and regulatory principles of punishment. This mind-set is, as argued by Hurni et al. (2010), in general, and all over Ethiopia evident in slow adoption of soil conservation measures and the failure of farmers to understand the importance of sustainably using their natural environment. Very obviously, communication in favor of the development narrative has reached its limits!

4 Committees: Institutionalizing the ‘Development Narrative’!

> Ethiopia, as a democratic country, has been striving to work for the realization of good governance from which the public benefit from all spheres. … Indeed, democratic institutions could make a critical contribution towards promoting good governance and human rights protection (The Ethiopian Herald 2016).

This citation is taken from the Ethiopian Herald, one of the Ethiopian daily newspapers in English, and accordingly meant for the educated upper class, mentions three key-words of today’s ‘development narrative in the country: ‘good governance’, ‘democratic’ and ‘institution’. The argument of the paper will now primarily follow these three notions and connect these with the ideal of ‘development’, as analyzed above.

‘Governance’ and ‘good governance’, these two related terms indicate the approach towards ‘development’, which is guided by a transparent regulatory framework led by rules and regulations and watched by authorities, which have preferably been elected in an egalitarian, democratic way. These notions again introduce the need for institutions, understood as “*systems of established and prevalent social rules that structure social interactions*” (Hodgson 2006: 1), in order to govern the processes of defining the regulatory framework. The conundrum of ensuring the sustainability of development interventions, again, is assumed to be solvable by the proper involvement of beneficiaries in the supply and management of resources, services and facilities. Participation has become an act of faith in development, something, which is believed in and rarely questioned. ‘Participation’ is even claimed to be the new paradigm of development. Taking the concepts of institutions and participation together theorizes that institutions help to formalize mutual expectations and cooperative behavior, allow the exercise of sanctions for non-cooperation and thereby reduce the costs of individual transactions. Associations, committees and by-laws channel participation in predictable and recognizable ways, the aim of many development interventions apparently being community structures that most clearly mirror bureaucratic structures.

Organizational approaches to institutions again contain two strong and conflicting ideas about participation. The focus on committee-like institutions is associated with participation through democratic representation and on the process of election or selection of the committee members. And, additionally, there is also a strong assumption that meaningful participation in community meetings realizes by verbal contributions, i.e. verbal communication. It is assumed that people will find it in their rational and individual interest to participate by giving themselves a voice, due to the assurance of benefits to ensue—with relation to the material benefits of public goods—or, to a lesser degree, to take over responsibility. Paraphrases like: "*a village-level committee as the primary CBNRM* (*community based natural resource management*) *organizations*", or "*The local community steering committee is the representative body that screens all proposals for community development grants*" (Ruhweza 2009: 4) match with the Ethiopian perspective in democracy development, as expressed above.

Natural resource management, as can be concluded, has in general been handed over to the governance of the local community. This governance will articulate in the very same constellation of a democratic ideal irrespective of given specific social and cultural frameworks. Informed by the 'Western' ideal of democracy, the committees mirror the principal idea of equal representation and equal voice.

5 Giving People a Voice: Committees, Pathways of Communication for CCA-Adaptation Among the Nyangatom?

The outlined and to our 'Western European' eyes normal and customized ideal of democracy meets social constellations on the ground, which had known some means and ways of mutual consensus finding by their own constitution as such. The Nyangatom, one of the unique pastoralist ethnic groups of Ethiopia's south, situated in South Omo, numbering about 10,000 people and classified as UNESCO World Cultural Heritage, has, like its neighboring pastoralist communities, ever since been guided by an 'age-group system'. The system is constituted by five age-groups: children, youths, herders of 25–50 years, the political class of the 'elephants' aged 50–65 years, and the very old and wise men in the role of spiritual guides.

Members of pastoralist communities interpret this system as follows:

> The elders used to manage the grazing land by telling the herders to shift from pasture to pasture. They sent young herders to check the condition of the grass, and then they decided on the migration paths. If someone was seen taking his animals to the forbidden areas, he would be punished. But punishment is not constant. It will vary from people to people and it depends on the severity of the action (Soya Kurupa, man—14th March 2015, approx. 42 years).

> The cultural management has no written rules and regulations, because once the elders pass the decision, no one will disobey. It is a management, where everyone has to obey. We have grown up with it, so we like it very much (Moru Lomarle, woman—12th March 2015, approx. 55 years).

By listening to the people's voice the modern idea of committees does not match with the culturally established and believed in articulation of authority and representation. Seen from a western perspective the expressed obedience might not appear 'right' and equivalent, but it represents customary regulations and a sense of belonging. Especially the emphasis on a fair, socially reflected and balanced execution of established rules and regulation contrasts the perception of today's realization of power and authority, as will be demonstrated below.

By the numerous anthropological studies conducted in South Omo pastoralist ethnic environments the pastoralist age-group system, as depicted in the citation, is to be considered semi-democratic, as it initially bases on processes of mutual consensus finding among the age groups and within the politically decisive age-group of the 'elephants', the 4th age-group. This political age-group is initiated on agreement of the whole community. On the other hand does the system not integrate women or young men into decision taking, though women do have a voice and are listened to with relation to their specific fields of tasks and responsibilities. The pastoralist age-group system is not 'democratic' and 'egalitarian' in a 'Western' understanding, but it is surely representative in the sense of mutual consensus finding among the most respected group of well recognized wise community members, the elders and as well the wise women.

The Global Environmental Change is ever present and has a serious impact. The Nyangatom inhabit an environment, which is one of the most threatened by the climate change imperative in the country. As unanimously highlighted by empirical qualitative data from 2009 and 2010 (Troeger et al. 2011), this impact has explicitly taken shape for about the last 20 years by now. Especially, when paralleled by El Niño effects, the climate change imperative does not leave any space for maneuver to the actors within their pastoralist livelihood system. In spite of the notion of a pastoralism as "*the finely-honed symbiotic relationship between local ecology, domesticated livestock and people in resource-scarce, climatically marginal and highly variable conditions*" (Nori and Davies 2007: 7). In contrast to this optimistic interpretation does the climate change imperative of recent dimensions emphasize that 'coping' with climate 'variation', as exercised by generations, does not work as it used to. Climate 'variation' has been replaced by climate 'change', which turns former coping measures inadequate and meaningless. In consequence, measures for climate change 'adaptation' were the demand of the hour especially in 2011, when climate change impacts paired with El Niño effects. This crisis scenario seemingly was and still is being repeated in 2016 until today, 2017, which again evokes memories of the 1984 famine.

Answering the ultimate challenge of this scenario, the very 'model' of climate change adaptation (Troeger 2016) in pastoralist environments and livelihood systems, the Enclosed Rangeland Management Scheme, was introduced to the Nyangatom community in 2011,[1] accompanied by the installment of a 'committee'

[1]The initiative was conducted by the author and funded by the German Embassy (Climate Fund '11).

in 2013 in accordance with the above outlined pattern to democratically govern this technical innovation.

To reflect on the meaning of this step, the following benchmarks accompanying the idea of 'enclosure' are to be considered: Pasture is a pastoralist resource, and also a key social resource. The worry is that this means of survival will find its way into markets as a commercial commodity. Nowadays, enclosures are the most important (and negative) change within the customary pastoralist domain (Dida 2010). An enclosure does not represent a formal private property (full ownership), but it fulfills the first four bundles of rights classified by Schlager and Ostrom (1992) as "*access*, *withdrawal*, *exclusion and management*". Customarily, the legitimate 'owner' unit of an enclosure is a village or some households or families, but there is a growing tendency for elite pastoralists to fence an area arguing that they have huge herds and need extra pasture. As pressures increase on open ranges, the effectiveness of traditional enclosures is getting weaker and trespassers have become more frequent.

In general, property rights among (agro-) pastoralists in Ethiopia are recognized as a clan-based common property. Reserving a section of rangeland for later use has always been an integral part of the pastoralist land use system. But this reservation was done by to follow customary arrangements as described above. In consequence, the most important change in pastoralist livelihoods is the physical fencing of areas. Since the mid-1970s, the expansion of range enclosure has been observed among different pastoralist groups in Ethiopia, primarily in eastern Ethiopia and Borana territory. As communal rangelands support multiple users, roaming around to fulfill the biological needs of their herd, the expansion of enclosure and private land use has started to reshape the relationship between multiple users. An attempt to examine the effects of enclosure reminds us Hardin's statement that "*every new enclosure of the commons involves the infringement of somebody*'*s personal liberty*" (1968: 1248).

The negative effects of rangeland enclosures are not limited to the enclosures as such. Processes of societal transformation are taking place as emphasized by Dida (2010): '*livestock was initially monetized*, *then livestock products like milk*, *meat*, *hides*, *now the resources that support livestock production are being monetized*'. Since investment in enclosing land requires the use of trees from communal land to construct thorn fences, serving as a demarcation of the boundary of the enclosed area, it reduces the resource base for browsers. This leads to conflicts of interest between those enclosing and others rearing browsers like goat and camel over resource use (Beyene 2010: 485). "*Enclosing becomes a strategic action to isolate a resource unit from the commons*, *serving the purpose of* '*legitimizing*' *individual action*" (ibid.: 487). As a consequence, the system of rangeland enclosures has created a new threat to herders' livelihood security when practiced on a large scale. Land use policies that favor private grazing enclosures, using informal practices as entry points, can potentially contribute to rangeland degradation and a rise in internal disputes (Fig. 1).

A mid-term summary of the argument above highlights a potential conflict line demarcated by the structural logic and power rooted in the confrontation between

Fig. 1 Woman collecting fencing material for a range enclosure

the basic constituents of the institution ‘committee’ on the one and intra-generationally transferred and long established rules and regulations in the field of political power and representation in the Nyangatom society, on the other hand. Embedded in these two demarcation lines, we find the agro-technical innovation of ‘rangeland enclosures’, which by their disposition enforce the establishment of some societal institution to govern these threats, which are rooted in the very structural power of any enclosure established on formerly mutually reclaimed grazing grounds, the commons (Fig. 2).

Starting from this recognition, the following argument turns towards the perspective of ‘communication’ in the tentative realization of climate change adaptation, here coming about in the shape of ‘rangeland enclosure’.

To get closer to the meaning of ‘governance’ and ‘participation’ facilitated by processes of communication in given frameworks of the committee the argument turns again to the people, the ‘voices of the people’. Perceptions and Interpretations are singled out in line with the perspectives of: ‘structural forces and governance’, ‘modes of “participation”’ and ‘articulation of social correctness’.[2]

> I myself had the idea of establishing rules to govern the enclosures, but then I heard that the Woreda people (district administration) are coming to establish the rules and regulations. And there were some people from Addis Ababa, who gave us some papers, which listed the rules. They asked the people to add on it, and of course, everything was clear and nobody added anything on top of the by-laws, and the committee was selected from different age-groups (Soya Kurupa, man—14th March 2015, approx. 42 years).

[2]The data was assessed during fieldwork in March 2015.

Fig. 2 Rangel and enclosure: structural manifestation of societal inclusion and exclusion

Quite in line with the general articulation of the 'development narrative' in Ethiopia, obviously no participation, which could indicate true 'governance', had been sought. One interviewee even claims initial own, self-determined ideas about necessary regulations in the context of the never experienced before range enclosures, but he had no chance to promote these tentative frameworks of governance. No 'freedom to articulate one's own voice' (see 1) was given in this process of communication. This turned out to be an unambiguous top-down message, which had to be 'swallowed' by the people on the ground, this means by those, who in future would be the ones to realize these handed over regulations. Structural forces governed the information instead of true communication processes. No communication in the ideal sense was realized, which is even more emphasized by the following statements:

> Us elders, we were unsure whether to accept the new rules, but the Woreda people made them accept the idea of punishment and the bye-*law* (Dida Lolibes, man—11th March 2015, approx. 64 years).

> The leaders from the Woreda and the people from Addis made us discuss the question of the punishment. So, the discussions were led by the experts, and they were the ones to give a speech on the positive side of the new punishment system and make the community accept the idea. Even me, I accepted it (Ariapa Lokitibo, man—14th March 2015, approx. 38 years).

The so called 'participatory' processes in the pastoralist communities did not only confront the people on the ground with ready made answers and new regulatory frameworks, but excluded some members of the community completely from the wished for democratic process. Thus, neither some 'equal grounds of understanding', nor any 'freedom to articulate one's perceptions' and evaluations of the given social needs in terms of a fair and transparent handling of the new 'structural forces' in the shape of enclosures was sought for:

> My neighbors in our settlement did not participate in the discussions. According to what I now know they are not happy with the decisions because they did not get any clarification on this matter like we did from the Woreda and the people from Addis (Ariapa Lokitibo, man—14th March 2015, approx. 38 years).

People 'on the ground' do not only complain about missing participation in the process of the establishment of the new rules as well as the top-down fixed modes of punishment. They further reflect these set modes of punishment against the background of given socio-economic differentiations within their community. Very obviously, the agents of the state's 'development narrative' had not adapted, and even more so could not adapt and adjust the new structural frameworks of rangeland enclosures to the 'social construction' of community realities. They did not attempt to find a floor of mutual understanding, which would have meant true communication. The answer will be 'murmuring' and 'disobedience'

> The punishment should consider the number of animals someone has, instead of just fixing the punishment. It is good to know the situation of the community! … As far as the power is in the hands of the committee I don't think it will bring a change, rather murmuring and disobedience to the new ideas! (Moru Lomarle, woman—12th March 2015, approx. 55 years).

In the face of the 'committee' paired with the need for Climate Change Adaptation, the Nyangatom pastoralists very obviously have become afraid, worried and mal-oriented. They have been set into a process of societal transformation, which they have not conquered and, maybe, will never be able to conquer, as no true communication has taken place. The question is to be posed, whether a more sensitive and integrative perception of societal structures, which are in place and are part of the indigenous fundament of agreement and consensus finding would be a much more helpful and path-guiding alternative towards a sustainable Climate Change Adaptation?

6 The 'Police'—De-politization of Climate Change Adaptation and NRM

Building on statements of Jaques Rancière and Chantal Mouffe as well as on the idea of 'dispositive' as interpreted by Foucault, the argument finally draws towards the momentum of disagreement and a rejection of the ideal of consensus finding as captured in the societal institution of a 'committee'. In his reflection on

'Disagreement, Politics and Philosophy' Rancière differentiates between two logics of human-being together: 'politics' and 'the police': '*The police is thus first an order of bodies that defines the allocation of ways of doing, ways of being, and ways of saying, and sees that those bodies are assigned by name to a particular place and task. ... most of the measures that our clubs and political "think tanks" relentlessly come up with in a bid to change or revitalize politics by bringing the citizen closer to the state or the state closer to the citizen indeed offer the simplest alternative to politics: the simple police*' (1999: 29 ff).

The current hegemonic way of fighting climate change and reaching climate change adaptation widely depicts as being in the state of de-politicization, the 'police'. There is no doubt about the fatal present and future effects of climate change impacts, which by no means are to be taken seriously. However, scientists and political philosophers like Rancière or Mouffe emphasize the alarming framing of today's climate change discourses. Above all, the apocalyptic imagery nowadays associated with the climate change imperative invokes a post-political condition understood as a way of governing in which there is no way to disagree, with the result that alternative futures and ways of dealing with the predicament are eliminated from debate and practice.

> What makes an action political is not its object or the place where it is carried out, but solely its form, the form in which confirmation of equality is inscribed in the setting up of a dispute, of a community existing solely through being divided (Rancière 1999: 32).

The argument of this paper considers 'committees' as articulations and manifestations of the 'police'. No 'true' communication on solution finding is sought, but the committees are to be taken as non-negotiable entities of set programs as captured by the idea of 'dispositiv. Foucault's concept of 'dispositiv' indicates that the police order extends well beyond its specialized institutions and techniques (1977: 119f). A dispositive in Foucault's understanding is presented as a heterogeneous ensemble, which can comprise of discourses, institutions, laws, administrative acts, philosophical and morale statements. It poses itself as a strategic imperative, which primarily answers to a situation of emergency, e.g. the climate change imperative, but finally turns discourses into a justification of set programs. Discourses are faced by 'disagreement in the shadow'. "*We should take disagreement to mean a determined kind of speech situation: one in which one of the interlocutors at once understands and does not understand what the other is saying. Disagreement is not the conflict between one who says white and the other says black. It is the conflict between one who says white and another who also says white but does not understand the same thing by it or does not understand that the other is saying the same thing in the name of whiteness*" (Rancière 1999: X).

In summary, the notion of 'disagreement' indicates a situation, when meant to be partners in communication do not necessarily contradict each other openly, but disagree in the shadow of claimed consensual modes of governance. On the surface, this consensual governance has reduced political conflict and disagreement (Swyngedouw 2011), but in reality, the partners in communication have not reached a common ground of understanding.

The example of the Nyangatom pastoralists in south Ethiopia has unambiguously highlighted given processes of communication to be by far not manifested in the open and freed from structural power, which above was highlighted as the ultimate condition of processes of ‘true communication’ (1). Communication in the committees was dominated by ‘experts’, i.e. the agents of the government following the ‘development narrative’ as outlined above. The actors on the ground resisted the officially outlined principles and practices of climate change adaptation ‘in the shadow’. “*After we completed making the fence*, *there was a gap in between. The people who used to pay us for our work*, *delayed the money and no one of us watched and was interested in the situation of the fence. Then there was a big wind*, *which destroyed the fence. As well some people removed the fence for passing*, *so you will not find it any more*” (Ariapa Lokitibo, man—14th March 2015, approx. 38 years).

Essentially, this argument proposes that governing climate change had been characterized not only by disagreement, but climate change communication is to be understood as subcutaneous resistance, voiced quietly and under cover, answering in the end the ultimate failure in communication.

7 Conclusion

Relating to the outlined perspectives of hidden resistance and disagreement, when those ones, who ‘say white’, do not understand the same thing by it’ (see above) the argument finally draws to the social field of ‘agonistics’ as conceptualized by Mouffe (2013). She objects, in accordance with Rancière (1999) and Swyngedouw (2011), to any notion of cosmopolitism, which postulates the availability of a world beyond hegemony and beyond sovereignty and negates the dimension of the political therefore does not make room for a plurality of alternatives. “*We have to relinquish the claim that the process of democratization should consist in the global implementation of the Western liberal democratic model. Democracy in a multi-polar world can take a variety of forms*, *according to the different modes of the inscription of the democratic ideal in a variety of contexts. … the kind of individualism dominant in Western societies is alien to many other cultures*, *whose traditions are informed by different values. Democracy*, *understood as* ‘*rule by the people*’, *can … take other forms—for instance*, *forms in which the value of community is more meaningful than the idea of individual liberty*” (Mouffe 2013: 29f). In line with the concept of ‘agonistics’ Mouffe envisages the pluri-verse, which she interprets as the space where an agonistic encounter takes place between a diversity of poles, which engage with each other without any one of them having the pretense of being the superior one. “*This agonistic encounter is a confrontation where the aim is neither the annihilation nor the assimilation of the other*, *and where the tensions between the different approaches contribute to enhancing the pluralism that characterizes a multipolar world*” (Mouffe 2013: 41).

In line with this reasoning the argument finally turns towards the perspective of some multipolar arrangement of governance. The challenge of climate and environmental change cannot and should not be answered by ‘set programs’, a dispositive or ‘the police’, but must reflect interests and interpretations of all members of given societies. Means of communication, voiced or non-voiced, are to be taken to the open and are to be made understandable to all. Values and interpretations should not be disguised by any ‘disagreement in the shadow’. These new challenges do not meet ready made answers and patented concepts. Surely, the institutional setting of committees in today’s understanding is to be questioned and adapted to given and culturally based frameworks of representation and according patters of communication.

References

Ayele Z (2011) Local government in Ethiopia: still an apparatus of control? Law Democr Dev 15(1):133

Bach JN (2011) Abyotawi democracy: neither revolutionary nor democratic, a critical review of EPRDF’s conception of revolutionary democracy in post-1991 Ethiopia. J East Afr Stud 5(4):641–663

Beyene F (2010) Locating the adverse effects of rangeland enclosure among herders in eastern Ethiopia. Land Use Policy 27(2):480–488

Dessalegn R (2003) Resettlement in Ethiopia: the tragedy of population relocation in the 1980s, Discussion paper 11. Forum for Social Studies, Addis Ababa, Ethiopia

Dida B (2010) Range enclosures in southern Oromia, Ethiopia: an innovative response or erosion in common property resource tenure? Res Update 4:21–23

FDRE (1995) Constitution of the Federal Republic of Ethiopia. http://www.wipo.int/edocs/lexdocs/laws/en/et/et007en.pdf. Accessed 19 Feb 2017

Foucault M (1977) Dispositive der Macht. Über Sexualität, Wissen und Wahrheit. Merve-Verlag, Berlin

Freire P (1970) Pedagogy of the Oppressed. Continuum 72, New York

Gebresenbet F (2015) Securitization of development in Ethiopia: the discourse and politics of developmentalism. Rev Afr Polit Econ 41(1):64–74

Hardin G (1968) The tragedy of the commons. Science 162(3859):1243–1248

Hodgson G (2006) What are institutions? J Econ Issues XL(1):1–25

Hurni H et al (2010) Land degradation and sustainable development in the highlands of Ethiopia. In: Hurni H, Wiesmann UM (eds) Global change and sustainable development: a synthesis of regional experiences from research, Geographica Bernesia, Bern, pp 187–207

Lefort R (2012) Free market economy, ‘developmental state’ and party-state hegemony in Ethiopia: the case of the ‘model farmers’. Afr Stud 50(4):681–706

Mouffe C (2013) Agonistics: thinking the world politically. Verso, London, New York

Nori M, Davies J (2007) Change of wind or wind of change? Climate change, adaptation and pastoralism. World Initiative for Sustainable Pastoralism, Nairobi

Rancière J (1999) Disagreement: politics and philosophy. University of Minnesota Press, Minneapolis

Rottenburg R (2009) Far-fetched facts: a parable of development aid. MIT Press, Cambridge

Ruhweza A (2009) Using trust funds to channel payments for biodiversity conservation: lessons learned from the Mgahinga and Bwindi impenetrable forest conservation trust ‘Forest Trends/The Katoomba Group: East and Southern Africa, prepared for the WGEAB workshop on innovative international financing for biodiversity conservation and sustainable land use, 2 July 2009

Schlager E, Ostrom E (1992) Property rights regime and natural resource: a conceptional analysis. Land Econ 68(3):249–262

Sen A (1999) Development as freedom. Oxford University Press, UK

Swyngedouw E (2011) Interrogating post-democratization: reclaiming egalitarian political spaces. Polit Geogr 30(7):370–380

The Ethiopian Herald (2016) Ethiopia: more synergy for strong democratic institutions. Editorial: 8 Jan 2016. http://allafrica.com/stories/201601081011.html. Accessed 20 Feb 2017

Troeger S, Grenzebach H, zur Heide F, Kuhnert G, Lang B, Peth S, Pfitzer J, Sefrin C, Thiele, A (2011) Failing seasons, ailing societies: climate change and the meaning of adaptation in Ethiopia. Heinrich Boell Foundation, Addis Ababa

Troeger S, Tröger, S (2016) Societal transformation, buzzy perspectives towards successful climate change adaptation: an appeal to caution. In: Handbook of climate change adaptation. In: Leal Filho W, Adamson K, Dunk RM, Azeiteiro UM, Illingworth S Alves F (eds) Implementing climate change adaptation in cities and communities: integrating strategies and educational approaches. Springer International Publishing, pp 353–365

The SHAPE of Effective Climate Change Communication: Taking a RoundView

Joanne Tippett and Fraser How

1 Introduction

Attempts to answer even simple questions about climate change can lead swiftly to a host of communication issues and challenges. The first of these could be labelled 'fact dispute' and refers to various levels of disagreement about the following:

- The basic nature of the problem
- The existing and potential risks or dangers, and their extent and timescales
- The causes of the problem
- What we need to do about it.

This can range from denial of evidence that the phenomenon is occurring, disagreement about humankind's role in it, through to technical arguments about details of the scientific models or measures used to understand or predict the problem. Turning attention to 'what we need to do about it' reveals a 'wicked' problem created by complex human systems and behaviours, with no obvious or simple solutions.

Dispute or disagreement about the 'facts' can be compounded by psychological responses to the nature of the problem. Faced with a global, wicked problem, it is easy to feel a lack of agency or a lack of hope; it can be overwhelming. There can be 'paralysis' and 'denial', and these can be magnified on levels beyond the

J. Tippett (✉)
Planning and Environmental Management, School of Environment,
Education and Development, The University of Manchester,
Humanities Bridgeford Street Building, Oxford Road, Manchester M13 9PL, UK
e-mail: Joanne.tippett@manchester.ac.uk

F. How
How Creative, Independent Consultant, Manchester, England, UK
e-mail: fraser.how@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_23

individual: organisations, states or international initiatives may all present these symptoms. The urgent and contested nature of the problem exacerbates this further.

Even where there is agreement about the general shape of the solution—i.e. we need both adaptation and mitigation—questions about how to achieve it through specific policies or change initiatives, what to prioritise, and how to develop effective strategies at different levels of scale, form another broad class of obstacles to effective responses. This directly affects climate change communication. Of course, the aim of communication is not simply to proceed towards catastrophe in a more informed manner. Rather, the desired result of communication is change. But what does this change look like? Does this not lead directly back into areas of disagreement and confusion? How can we proceed, if we do not agree on how to proceed?

Regarding the 'fact dispute' there is certainly a vital role for disseminating information broadly. The extent of the scientific consensus that there is a problem, and that human societies are part of the cause, is clear. So the challenge is how to get this information 'out there' more effectively.

Beyond this, it is difficult to construct a simple message suitable for mass distribution. Given that there is a need for action and change, but no shared, un-contested 'recipe' for this change, what does this imply for a general strategy for climate change communication?

> If a problem cannot be solved, enlarge it (commonly attributed to Dwight D. Eisenhower).

If we cannot simply share, promote and implement an agreed solution strategy, then a logical response is to seek to build capability and capacity—everywhere it is needed—for people and organisations to collaborate more creatively and effectively to devise appropriate solutions. This is equally applicable for both adaptation and mitigation, and requires more than just 'communication' in the narrow sense of passing on information; it requires learning. So the question becomes: what needs to be learned, and how can this best be learned?

It is precisely this kind of learning for which SHAPE and the RoundView—introduced in this paper—were devised, during ongoing action research that endeavours to answer the following two overarching questions:

- What are the characteristics of effective learning initiatives for embedding sustainability knowledge, skills and practices in diverse stakeholders and organisations?
- How can the effectiveness of such learning initiatives be assessed, i.e. how can changes in these knowledge, skills and practices be understood and measured?

These questions have shaped and guided three large-scale action research projects and a series of shorter interventions since the year 2000. The foundational research explored participatory ecological design, including the use of sustainability principles based on systems thinking to animate and guide the process (funded by the ESRC and Mersey Basin Campaign, Tippett et al. 2007). This led to action research with 250 staff in Tesco (a major UK supermarket) into developing sustainability skills, knowledge and practices and scaling this process up in large organisations (funded by the Sustainable Consumption Institute, Tippett et al. 2009, 2010).

The ‘RoundView’ identifies three fundamental mechanisms of environmental damage and their opposites, providing a clear framework to understand the essential elements of climate change mitigation. It builds upon decades of others’ practice and research to clarify principles of sustainability, in particular The Natural Step (e.g. Holmberg and Robèrt 2000; Robèrt 2000), as well as Cradle-to-Cradle (McDonough et al. 2003; McDonough and Braungart 2002), Industrial Ecology (Ehrenfeld 2007; Tansey 2006) and Professional Practice For Sustainable Development (Martin 2008).

Although the RoundView is about the broader issue of sustainability, climate change is a central example that can be seen as a proxy for this, because within this framework the underlying mechanisms that cause environmental unsustainability are the same mechanisms that cause climate change. There is, therefore, a significant overlap between the skills, learning and understanding needed to respond to unsustainability in general, and those for climate change mitigation and adaptation.

The research in Tesco also led to the development of a model of five core characteristics of effective learning initiatives for sustainability, referred to as ‘SHAPE’. These characteristics provide a useful guide for the design of any communication or learning initiative for building capability and capacity for climate change adaptation and mitigation. SHAPE is presented in this paper, with a focus on climate change, together with evidence regarding the outcomes of using SHAPE and the RoundView in learning initiatives.

2 The ‘SHAPE’ of Effective Learning Initiatives for Capacity Building for Climate Change Adaptation and Mitigation

The SHAPE model refers to the following characteristics, which are addressed in turn below:

- **S**ocial
- **H**olistic
- **A**wareness-raising
- **P**ositive
- **E**xperience-led.

2.1 Social

The term social learning was first made popular by Bandura (1977), a psychologist widely regarded as having changed the direction of psychology by focussing on the way people learn through the imitation of role models. Research around social learning and creativity has led to a realisation that we need to pay "*more attention to processes through which knowledge and information are transferred and translated within and across our social networks*" (McWilliam and Haukka 2008: 656).

Making changes at an organisational level of scale or beyond, especially re-thinking core assumptions and processes, requires people to coordinate actions and work effectively within and across teams, organisations and institutions. Effective learning initiatives for change encourage exchange of information between people who do not normally communicate, deliberately engaging them in 'learning conversations' that challenge and deepen learning. A key advantage of social learning is that new insights emerge from the process of discussing ideas from different perspectives, which in turn encourages questioning of taken-for-granted mental models (Bleischwitz 2003).

Communication between people is clearly enhanced by a shared language. The RoundView provides a simple vocabulary for evaluating and sharing ideas around climate change and sustainability, supporting effective communication between people in different contexts or roles.

Climate change adaptation often requires building community resilience. Social capital is a key resource for resilience (Pelling and High 2005). A social approach is required to build links between people and organisations to share information, to be able to respond quickly to hazards, to work creatively and to build new ways of thinking.

The Carbon Landscape is a current (2016–2021) project in the 48,000 hectare post-industrial landscape of the Great Manchester Wetlands Partnership, in NorthWest England. It seeks to re-connect people with the landscape to create a better future for themselves and the environment (Carbon Landscape Steering Group 2016). The project includes a RoundView initiative applying the SHAPE model for community engagement, working with landowners, farmers, volunteers, public sector agencies and a wide range of partners to envision large-scale ecological restoration. An important aspect of this project is climate change adaptation, including developing corridors at the landscape level of scale for north-south species migration (Gilchrist et al. 2015).

2.2 Holistic

Here the term holistic refers to the notion of 'wholes' and systems, on different levels of scale and in different contexts. In a learning process, this refers to the 'whole brain', and also to the 'whole system' of the learning organisation or network. For understanding the problems that lead to climate change, and possible solutions to them, it refers to the 'whole system' of the Earth, including its ecosystems and constant input of energy from the sun, as the central frame.

The work of educationalist Dewey (1938) inspired this pedagogical approach. He “focused on the whole complex circuit of organism and environment interactions that makes up our experience, and he showed how experience is at once bodily, social, intellectual, and emotional” (Lakoff and Johnson 1999: 97). This work has been developed by cognitive scientists, in particular Lakoff and Johnson, into the concept of ‘embodied realism’. At the same time as implying a ‘realism’ based on the physical nature of the body and its interactions with its environment, embodied realism implies an active process of constructing meaning through this interaction. Meaning is embodied through the act of engagement.

‘Hands-on’ tools developed in the RoundView represent an attempt to enable more accessible and effective ‘whole-brain’ learning for a wide variety of people with different learning styles and preferences. This engages Gardner’s (2000) multiple intelligences, creating a fertile and productive learning environment. An example of these tools, used to develop systems thinking skills and explore how ecological cycles work, is shown in Fig. 1. They act as epistemic objects, providing a framework for communication “stable enough to enable coordination across communities of practice” (Ewenstein and Whyte 2009: 10), but sufficient flexible to be interpreted differently by different actors.

The strategies required for adaptation and mitigation imply a need for new ways of understanding risk, opportunities for change and our place in the natural world. This requires people to access emotions and think about the whole situation, particularly in terms of nested systems within systems. It requires ability to explore contradictory points of view, seeing things in a new way.

Fig. 1 Hands-on tools for learning the RoundView (author’s own)

2.3 Awareness-Raising

Awareness-raising, in this context, starts with a recognition that there are some 'facts' or information that are established enough, or held to be the case with enough consensus, to be considered essential basic knowledge about the situation. Regarding climate change, there is the fact of the *extent of the scientific consensus* about both the nature of climate change (global warming from increased concentrations of greenhouse gasses) and the cause of this increase (human activity) (e.g. Doran and Zimmerman 2009).

Discussing sustainable development and learning, Gough and Scott (2003: 9) state that although their approach sees the world as "socially constructed, it is not saying the world can be any way we want it to be. It is not saying we can know nothing, only that we cannot know everything." It is possible to link together a process of creating and exploring meaning in a social context with teaching clear principles based in science.

The Natural Step has established a framework of widely agreed science principles, together with what they imply regarding the unsustainability of human activities (Holmberg and Robèrt 2000). The RoundView took this robust research as a starting point, reinterpreting the core concepts in order to represent them in more accessible terms. This offers a clear understanding of three distinct (orthogonal) causes of climate change: (1) overwhelming the climate's homeostatic balance with unbalanced flows of naturally occurring greenhouses gasses (in the main CO_2, CH_4 and Nitrous oxides); (2) a build-up of persistent, human made compounds such as HFCs ('poisonous' to the system), and (3) destruction of the ecosystems that help regulate climate (shown below in Fig. 2).

The clarity of this model supports more effective thinking and communication about the possible actions needed to mitigate further climate change. The RoundView also enables proposed adaptation measures to be systematically tested for long-term sustainability, helping to avoid unintended consequences that can arise when not taking a holistic view of future options. An example of this was the promotion of biofuels from monoculture palm oil, a measure intended to reduce the emission of CO_2 from fossil fuels, but having negative implications for biodiversity, many human's ability to meet their food needs, and resulting in increases of toxic and persistent compounds in the form of pesticides (Fitzherbert et al. 2008; Fargione et al. 2008).

For adaptation, there is also a critical need for situational awareness-raising. We need to understand our cities and landscapes differently. For example in the Carbon Landscape, we need to see maps of flood risk under different greenhouse-gas emissions scenarios, and visualise how much rain falls now over the seasons and how much *could* fall. Is where you are standing likely to be under water in an extreme flood event? How much water can these wetlands hold? How could restoring wetlands and mosslands help protect the nearby houses and infrastructure?

Fig. 2 The RoundView's whole system view of the underlying mechanisms of unsustainability (© RoundView)

2.4 Positive

This characteristic recognises the value of appreciating the existing positive aspects of a situation when seeking to inspire change, which forms the bedrock of appreciative inquiry (Cooperrider and Whitney 1999; Bushe and Coetzer 1995).

When applied in the RoundView, the learning process starts with questions to draw out people's thoughts and then provides stepping stones and a process to link these perceptions to the wider framework that is being introduced, recognising that "we interpret new information and experiences in terms of our existing mental constructs" (Jarvis et al. 2005: 162). Attention is paid to sequencing and to the tone of inquiry. Starting by asking what is going well—rather than about the challenges—allows new ideas to build upon, and make the most of, what is already working. This echoes a key insight into the value of an asset based approach to promote effective, locally suitable climate change adaptation in informal settlements, as developed by Stein and Moser (2014).

Furthermore, as the late systems thinker, Meadows (1996: 118) said:

> Environmentalists have failed perhaps more than any other set of advocates to project vision. Most people associate environmentalism with restriction, prohibition, regulation, and sacrifice… There may be motivation in escaping doom, but there is even more in creating a better world.

The Natural Step defines ecological 'unsustainability' as three 'system conditions' that define the behaviours of society that—according to widely accepted science principles—cannot be sustained. The RoundView extends this clear foundation into a set of positive guidelines for what we are aiming for: a description, in broad terms, of the behaviours of society that *could* be sustained indefinitely without systematic undesired effects, including climate change.

This leads to the core concept of 'changing direction', which forms the heart of the RoundView. Having a clear understanding of behaviours that are taking us further into problems, plus an articulation of their opposites, gives us a practical tool for navigation towards a desired future. We can assess any decision or course of action to give us a solid indication of the likely implications for environmental change and climate change. This sense of direction is more fundamentally important than detailed understanding of the 'rate of travel' (in the words of Covey 1994, in a business context): "Because Where You're Headed is More Important Than How Fast You're Going".

This is of particular relevance to communication about climate change mitigation. Much of the focus around mitigation could be described as 'reducing the damage'—doing less of what is causing the problem. While vital, this misses an opportunity to engage and motivate people through the shared task of actively imagining and considering a future that is 'good' rather than just 'less bad' (McDonough and Braungart 2002). The positive approach is also important for adaptation. For example, we can emphasise the possibility of realising multi-functional benefits from connecting up Green Infrastructure throughout our urban landscapes (Carter et al. 2015).

A positive approach was particularly appealing to Tesco staff, as expressed in this comment by a Head Office participant:

> This is why I've been so interested in the RoundView, because everything about sustainability is usually being told what we should stop doing, not what to do. As human beings we rail against that. This can be very powerful, especially as it says we can carry on living and enjoying ourselves but in a better and more clever way.

Antal and Hukkinen (2010: 942) discuss the value of "imagining long term sustainability" in terms of the cognitive basis of transformation. A positive framing of the tasks of climate change mitigation and adaptation helps to engage people in the face of the psychological demands of such a potentially overwhelming challenge.

2.5 Experience-Led

Kolb's (1984) concept of the learning cycle has had a deep influence on learning theories. The RoundView learning process includes cycles of action, reflection for deepening of learning, and planning for further action. This draws on Dewey's (1938) focus on experience as the basis for learning, with participation seen as "a core element in meaningful knowledge creation processes" (Greenwood and Levin 2000: 95). This Experience-led cycle is important in any learning initiative for climate change adaptation or mitigation because:

> Both research and applied work within companies has shown that to create true, lasting, institutional change, both vision and action must be tightly intertwined and performed in tandem. Since the pursuit of sustainability generates major changes in an organization, this vision-action bond is critical (Smith 2003: 93).

In order to motivate and enable change, learning opportunities need to open up spaces for people to question what *they* can do. Learners need to translate new ideas into their own context, in order for them to be useful (Jonassen and Rohrer-Murphy 1999). Within a focus on building capability for people to determine their own actions, there is a need for clear guidance on what it is possible to do with the ideas, for instance.

As citizens: we can support the process of applying this knowledge through individual choices or actions; by holding policy and decision-makers to account on these issues; and through our collective purchasing power, increasing demand for new solutions while decreasing demand for problem-causing products and services.

As employees, or directors of companies, or providers of goods and services: we need to re-design the ways we use space, energy and materials to align with this new 'design brief'. This will form the new 'rules of the game' for our future economy, and the potential markets for these re-imagined/re-designed products and services are vast (Ellen MacArthur Foundation 2014).

As policy and decision-makers: sooner or later we will need to make these changes, and we can look at all levels of policy to see how to support them. Further delays to a serious and concerted focus on doing so will not serve anyone in the long run.

To engage with climate change adaptation inherently means moving into uncertainty—both in terms of future climate projections and in terms of the unknown effects of changes we make. This means that we will need to learn from experience—a core concept of adaptive management (Walters and Holling 1990; Gregory 2006). An example is peat restoration in the Carbon Landscape: we don't really know if it can be restored from its current low levels following extraction. This prompts a strategy of proceeding through trying out small steps, such as experimenting with windbreaks to reduce desiccation in dry conditions and wave damage to moss when there is too much water. Open and ongoing dialogue between everyone involved about what the possibilities are, what has worked and what has not, is essential.

2.6 Evaluating SHAPE and the RoundView

The 14 month research project with Tesco involved 250 members of staff from the shop floor to senior management in a sustainability learning initiative. Subsequently the hands-on tools of the RoundView were further developed with support from the Ellen MacArthur Foundation. A social enterprise award from UNLTD and HEFCE enabled this learning approach to be tested with a wide range of participants. To date, over 80 workshops have been run with over 1600 participants, including senior management in corporations and the public sector, academics, change management professionals, students (from Ph.D.s to primary school children), volunteers, community members and homeless people.

There was extensive data gathering from participant feedback and observation by the researchers during the research in Tesco. There was evidence of improved understanding and skills, and greater enthusiasm for change and actions being taken, as the following statements made by course participants illustrate.

- *"A new business model for Tesco is required; the whole world needs to make the changes now. I am surprised how much I have changed my work and personal life with the knowledge I have."*
- *"I didn't realise how quickly we are destroying the ability to sustain life on our own planet. I didn't expect that I would want to pass on what have learnt so eagerly, and to engage everyone else."*
- *"You see the bigger picture… really did help make you think, see what might happen and what we can make happen."*
- *"It's always in your head now—is this sustainable?"*

Participating staff in Tesco stores reported gains in confidence and enthusiasm for communicating with others about sustainability issues, including climate change.

- *"Through influencing other people, progress will be made."*
- *"People might ask me questions about sustaining the environment and recycling and why it's important. The more I know the more I can try and influence people that don't want to do it."*
- *"The more we learn the more it makes me want to influence people around me. It also makes me want to be more sustainable."*

Subsequent feedback about the RoundView has been similarly positive. Figure 3 consolidates results from 350 workshop participants who were asked to give feedback on a Likert scale.

Analysis of qualitative comments about the workshops to date supports this evidence of perceived value, with 715 positive comments, 180 challenges and 217 suggestions for possible solutions to these.

The challenges ranged from comments about the teaching approach, e.g. needing to take more account of people's different levels of scientific awareness, or more time for discussion; through to more fundamental challenges with the model. These were largely about what it does *not* cover (e.g. "It doesn't connect with

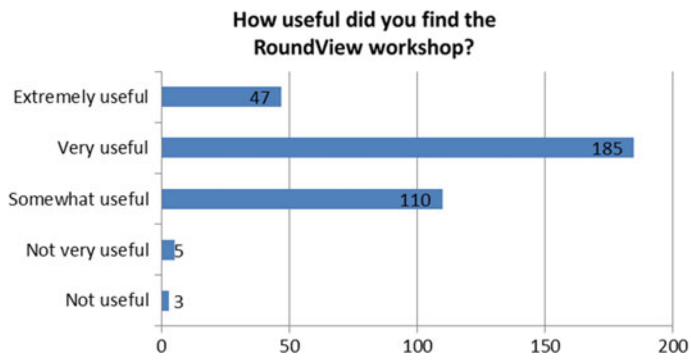


Fig. 3 Feedback on the usefulness of the RoundView in participants' work and studies (author's own)

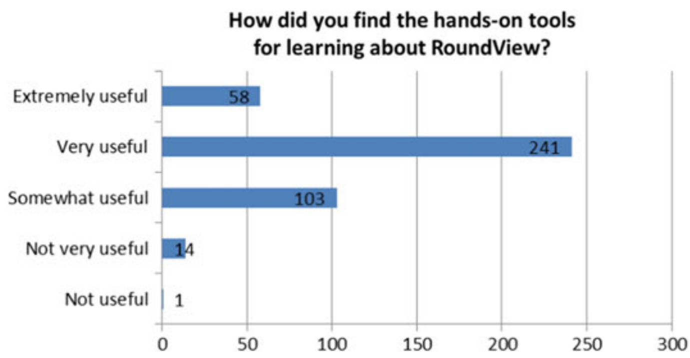


Fig. 4 Feedback on hands-on learning tools (author's own)

political + economic structure—very much focused on environment" or "Doesn't answer how it can be accomplished"—but with a solution offered: "Provides the necessary info and view as to what steps should be taken").

Feedback specifically about the hands-on learning tools has been gathered from 417 participants and shows an assessment of high value. This is summarised in Fig. 4.

The following gives a flavour of the qualitative feedback about use of these tools:

- *"Different learning styles were accessed. I learnt kinaesthetically, visually and audibly, which made the workshop easy to absorb".*
- *"I think this is a very useful tool for public education and awareness, with a view to change mainstream thinking"'.*
- *"The hands-on experience learning and group discussions really made me consider the wider aspects of science and policy and changing behaviour towards sustainability".*

The most recent project employing the RoundView has been engaging with community members and a range of partners to inform a vision for the large-scale restoration of the Carbon Landscape. In the development phase, the RoundView was piloted in 14 workshops as an approach to engage and motivate community members to engage with restoration activity.

Feedback indicates that the workshops helped people gain a deeper appreciation of the heritage of the local landscape and its significance for future sustainability, together with increased understanding and decision-making skills. After a 1.5 h workshop, participants reported an increase of between 40–110% in ‘big picture sustainability thinking skills’, and an increase of 10–30% in motivation to be involved and connect with the Carbon Landscape. Feedback demonstrated keen support for a wider outreach programme based on this learning. For example: “I would like to see this delivered to all leading council officials” and this workshop should be given to “every school in the Borough—catch them young. Older groups and organisations. Scouts, guides and colleges” and many participants said that the workshop should be available to “everyone”.

2.7 Limitations

Exploring the first overarching research question that guided these action research projects led to development of the SHAPE framework of the characteristics of effective learning initiatives. Two main types of limitation have been identified: those pertaining to the *application* of the SHAPE model in learning initiatives, and those regarding what we are able to measure and evidence regarding the *effectiveness* of this approach.

A key limitation to the application of this model is that it requires time—to contact and bring together stakeholders, and to do the learning and communication itself. Through many cycles of development, we have reached the point where we have developed RoundView sessions as short as 1–2 hours, which reflect all of the characteristics of SHAPE. These have demonstrated useful changes in perception, albeit without the depth of thought or opportunity for visioning that a longer process would afford.

A related limitation is the skill and knowledge required to facilitate or train a SHAPE-based learning initiative. For people with some facilitation aptitude and experience, who have learned about the subject themselves, this is of course achievable with sufficient investment of time and resource in training. The hands-on tools developed as part of the RoundView training package assist with this process by reducing the demands placed on the facilitator, through encoding significant parts of the learning experience into a portable and replicable methodology.

The second overarching research question can be summarised as: How do we know if what we are doing is actually effective? The ultimate measure of effectiveness of a learning initiative that seeks to build capacity and motivation for change, is change itself. But there are complexities in attempting to attribute cause and effect between changes in the state of the physical environment, or in behaviours of varied groups of people, and a learning initiative participated in by some individuals in those groups. Many other factors contribute to change, such as shifts in regulation, economic conditions or newsworthy environmental disasters.

One strategy for responding to this difficulty is to instead focus efforts upon measuring capacity and motivation for change in individuals, with the understanding that 'joining the dots' between this and real system change is a complex and shared challenge that will require innovative research projects and methodologies on a broad scale. Measuring such change is far from trivial. In the rounds of action research reported here, there is a clear limitation that there has not been any longitudinal study to assess changes in attitudes, understanding and behaviours over time. It is resource intensive to gather such data, and not always possible to contact participants several years later. It would require a longer-term research project, ideally one in which there was assessment before and after the interventions, with people who were not involved as well as those who were.

Prior to any such long-term research, our strategy has been to develop ways to build data collection for assessing change into the design of the learning initiative; for example capturing participants' self-assessment of their skills and attitudes before and after the sessions, and capturing data about their thoughts via ideas developed in the hands-on learning process. A limit of such self-assessment is that it does not always mirror an objective assessment of learning and changes in behaviour and skills.

2.8 Conclusions

The action research reported here has involved work with people from international and national organisations through to local authorities and community groups, with people of all ages and extremely varied educational levels. It suggests that approaches to climate change communication informed by the SHAPE framework have significant potential to build motivation and capacity for engagement in locally-appropriate adaptation and mitigation activity.

Such an approach involves social-learning rather than isolated, individual or 'book' learning; it requires taking a holistic, systems-based view of problems, solutions and the learning process itself. It suggests that there are 'facts' or information that are sufficiently widely agreed-upon or evidenced to be considered 'essential-information' in need of widespread awareness-raising. It recommends taking a positive orientation towards people's experiences and capabilities, towards local and global situations, and especially towards the future. Finally, it reminds us that in the face of uncertainty we can only progress through ongoing cycles of action and learning from results and experience, rather than by thinking that we can simply make a plan and stick to it.

This approach has been piloted and tested through development of the RoundView, with positive results to date. Despite the limitations presented above, this framework is intended to be coherent enough, with sufficient supporting evidence, that it will be used to inform future initiatives and further research.

Future rounds of this action research will seek to provide a more thorough assessment of change in capacity and motivation over time, from a much wider sample of people, to triangulate findings and test for anomalies. It would be valuable to go beyond measuring people's attitudes and understandings, towards gathering evidence of actual behavioural or system changes. A broad frame for the kinds of things that could be measured is provided by the RoundView Guidelines themselves. Examples of such measures could include the CO_2 emissions from the operations of the groups involved, the percentage of their energy requirements met from renewable sources, or the extent of land area devoted to resilient ecosystems.

A challenge shared among those seeking to communicate about climate change is finding sufficient opportunities and avenues to do this. It is our experience that people are often more interested and willing to participate in something that is clearly about making things better, than they are to engage with something that is presented as being about making things 'less bad'. The positive framing suggested by SHAPE and applied in the RoundView—that the task is not to try to stop things getting worse, but rather *to collectively re-imagine and re-design the way we do things to create a better future*—could be used or adapted for other climate change communication initiatives. This could help reach more people, including those who may not be particularly inclined to engage with something presented directly as a climate change or environmental concern.

Acknowledgements Foundational research was funded by the ESRC (PTA-026-27-0068, S42200124048), Mersey Basin Campaign, the Sustainable Consumption Institute and Tesco. Thanks to the research team on the Sustainable Consumption Institute project: Ebenhaezer le Roux, Graeme Sherriff, Pete Mann and Valerie Farnsworth. The Ellen McArthur Foundation, UNLTD, HEFCE, UMI3 and CEEBL have supported development of the RoundView learning tools. The Heritage Lottery Fund funds the Carbon Landscape project. For more information, see www.roundview.org and www.carbonlandscape.org.uk.

References

Antal M, Hukkinen JI (2010) The Art of the cognitive war to save the planet. Ecol Econ 69(5):937–943

Bandura A (1977) Social learning theory. Prentice Hall, Englewood Cliffs, New Jersey

Bleischwitz R (2003) Cognitive and institutional perspectives of eco-efficiency. Ecol Econ 46(3): 453–467

Bushe GR, Coetzer G (1995) Appreciative inquiry as a team-development intervention: a controlled experiment. J Appl Behav Sci 31(1):13–31

Carbon Landscape Steering Group (2016) The carbon landscape: landscape conservation action plan. Part 1 Wigan, Great Manchester Wetlands Partnership, UK. http://www.lancswt.org.uk/carbon-landscape-project

Carter JG, Cavan G, Connelly A, Guy S, Handley J, Kazmierczak A (2015) Climate change and the city: building capacity for urban adaptation. Prog Plan 95:1–66

Cooperrider DL, Diana W (1999) A positive revolution in change: appreciative inquiry. In: Appreciative inquiry: rethinking human organization toward a positive theory of change, Stipes Publishing Co, Champaign, pp 3–29
Covey SR (1994) First things first. Simon and Schuster, New York
Dewey John (1938) Experience and education. MacMillan, New York
Doran PT, Zimmerman MK (2009) Examining the scientific consensus on climate change. Eos Trans Am Geophys Union 90(3):22–23
Ehrenfeld JR (2007) Would industrial ecology exist without sustainability in the background? J Ind Ecol 11(1):73–84
Ellen MacArthur Foundation (2014) Towards the circular economy—accelerating the scale-up across global supply chains. World Economic Forum, McKinsey & Company, England. https://www.ellenmacarthurfoundation.org/assets/downloads/publications/Towards-the-circular-economy-volume-3.pdf
Ewenstein B, Whyte J (2009) Knowledge practices in design: the role of visual representations as `epistemic objects'. Organ Stud 30(1):07–30
Fargione J, Hill J, Tilman D, Polasky S, Hawthorne P (2008) Land clearing and the biofuel carbon debt. Science 319(5867):1235
Fitzherbert EB, Struebig MA, Morel A, Danielsen F, Brühl CA, Donald PF, Phalan B (2008) How will oil palm expansion affect biodiversity? Trends Ecol Evol 23(10):538–545
Gardner H (2000) Intelligence reframed: multiple intelligences for the 21st century. Basic Books, New York
Gilchrist A, Barker A, Handley JF (2015) Pathways through the landscape in a changing climate: the role of landscape structure in facilitating species range expansion through an urbanised region. Landsc Res 4(1):26–44
Gough S, Scott W (eds) (2003) Key issues in sustainable development and learning: a critical review. Routledge, London
Greenwood DJ, Morton L (2000) Reconstructing the relationships between universities and society through action research In: Handbook of qualitative research, 2nd edn. Sage Publications, California, pp 85–106
Gregory R, Failing L, Higgins P (2006) Adaptive management and environmental decision making: a case study application to water use planning. Ecol Econ 58(2):434–447
Holmberg J, Robèrt KH (2000) Backcasting from non-overlapping sustainability principles—a framework for strategic planning. Int J Sustain Dev World Ecol 7:291–308
Jarvis P, Holford J, Griffin C (2005) The theory and practice of learning. RoutledgeFalmer, London
Jonassen L, Rohrer-Murphy (1999) activity theory as a framework for designing constructivist learning environments. Educ Tech Res Dev 47(1):61–79
Kolb DA (1984) Experiential learning: experience as the source of learning and development. Prentice Hall, New Jersey
Lakoff G, Johnson M (1999) Philosophy in the flesh, the embodied mind and its challenge to western thought. Basic Books, New York
Martin S (2008) Sustainable development, systems thinking and professional practice. J Educ Sustain Dev 2(1):31–40
McDonough W, Braungart M (2002) Cradle to cradle: remaking the way we make things. North Point Press, New York
McDonough W, Braungart M, Anastas PT, Zimmerman JB (2003) Peer reviewed: applying the principles of green engineering to cradle-to-cradle design. Environ Sci Technol 37(23): 434A–441A
McWilliam E, Haukka S (2008) Educating the creative workforce: new directions for twenty-first century schooling. Br Edu Res J 34(5):651
Meadows D (1996) Envisioning a sustainable world. In: Costanza R, Segura O, Martinez-Alier O (eds) Getting down to earth, practical applications of ecological economics. Island Press, Washington DC, pp 117–128

Pelling M, High C (2005) Understanding adaptation: what can social capital offer assessments of adaptive capacity? Glob Environ Chang Part A 15(4):308–319

Robèrt KH (2000) Tools and concepts for sustainable development, how do they relate to a general framework for sustainable development, and to each other? J Clean Prod 8(3):243–254

Smith D (2003) Engaging in change management—transformation through sustainability strategy at Norm Thompson outfitters. In: Ants, Galileo, Gandhi (eds) Designing the future of business through nature, Genius and Compassion, Green Leaf Publishing Ltd, Sheffield, pp 93–108

Stein A, Moser C (2014) Asset planning for climate change adaptation: lessons from cartagena, Colombia. Environ Urban 26(1):166–183

Tansey J (2006) Industrial ecology and planning: assessing and socially embedding green technological systems. Environ Plan 33(3):381–392

Tippett J, Valerie F, Fraser H, Ebenhaezer Le R, Pete M, and Graeme S. 2009. Improving sustainability skills and knowledge in the workplace- final project report. Sustainable Consumption Institute, Manchester. http://roundview.org/wp-content/uploads/2012/05/Skills_in_the_workplace_SCI_Project_Report_July20091.pdf

Tippett J (2010) Scaling-up: learning to embed sustainability skills and knowledge in the workplace—final project report, Sustainable Consumption Institute, Manchester. http://roundview.org/wp-content/uploads/2012/05/Skills_in_the_workplace_SCI_Project_Report_July20091.pdf

Tippett J, Handley JF, Ravetz J (2007) Meeting the challenges of sustainable development—a conceptual appraisal of a new methodology for participatory ecological planning. Prog Plan 67(1):1–98

Walters CJ, Holling CS (1990) Large-scale management experiments and learning by doing. Ecology 71(6):2060

Communication Strategies for Building Climate-Smart Farming Communities

Jemima M. Mandapati

1 Introduction: Need for Building Climate-Smart Farming Communities

Climate change is no longer some distant possibility. Its effects are already being felt, especially in the semi-arid tropics in Africa and Asia, where rising temperatures, recurrent droughts, extreme climate events, dry spells during rainy season on one hand and unseasonal rains on the other have negatively impacted farmers, especially smallholders. This shift in climate patterns has caught farmers unawares. Low crop yields, severe household food shortages, malnutrition among children and women, forced migration of farmers to cities for work due to the resultant poverty are some of the climate change issues that have to be addressed. Future climate predictions for these regions are also bleak. Predicted temperature increases range from 2 to 4.5 degrees centigrade and the geographies may experience unseasonal rains and floods or substantial decrease as much as up to 11% in rainfall (ICRISAT 2016).

Climate change needs urgent redressal because the agriculture sector will be hardest hit economically as it heavily relies on weather. Several studies have revealed the impact of global warming on crop yields and their nutritive value. By 2050 climate change could cause yields of irrigated wheat, rice and maize (the three cereal crops with high market demand, commonly known as the Big 3) to drop by 10–20% (Thornton 2012). **Not only will yields decrease but also the nutritive**

J. M. Mandapati (✉)
Strategic Marketing and Communication, International Crops Research Institute
for the Semi-Arid Tropics (ICRISAT), Patancheru, Telangana, India
e-mail: Jemima@cigar.org

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_24

value of crops are likely to decrease, says a study (Myers et al. 2014). To add to the problem, **new crop diseases and pests** are likely to emerge and need to be addressed (Luck et al. 2011; Sharma and Prabhakar 2014). Climate change will not only affect crops but also livestock, fisheries and, in fact, the entire ecosystem (FAO). Therefore a holistic **agroecosystem approach** gives the best results for climate adaptation and mitigation interventions.

For long, the issue of climate change had been on the backburner, but the UN global call for action on climate change (COP 21) in 2015 has resulted in many nations working towards zero net anthropogenic GHGs by 2030–50 in a bid to limit global warming to less than 2 degrees centigrade.

Agriculture contributes to a major share of GHGs. CGIAR research shows that the global food system, from fertilizer manufacture to food storage and packaging, is responsible for up to one-third of all human-caused greenhouse-gas emissions (Vermeulen et al. 2012).

2 Role of Development Communication in Building Climate Smart Farming Communities

A. **Motivation**: Preparing the community for change
B. **Mobilization**: Connecting communities to a wide network of experts
C. **Facilitation**: Setting up facilitating groups to build capacity of farmers and link stakeholders to farming community
D. **Sharing of knowledge and synchronization of activities**: Engaging all stakeholders by sharing of information and synchronizing activities to maximize efficiency of delivery
E. **Evaluation**: Having a built-in monitoring and evaluation system to identify barriers for technology adoption and rectifying procedures

A. **Motivation**: Preparing the community for climate change

- Awaken a community to a potential problem—get them thinking—raise awareness on the issue
- Involve the community by creating forums/groups for discussions on how to use existing knowledge and the need to adopt new technologies. Prepare a climate action plan
- Gain and establish trust within the community by starting off with interventions that deliver quick results
- Educate opinion leaders of a community for quicker adoption
- As trust builds introduce interventions that bring in medium-term and long-term benefits
- Train communities to sustain the interventions and modify them when the situation demands it.

B. **Mobilization: Connecting farming communities to a wide network of agricultural experts, technology providers, policy makers and markets** such as

- Global research institutes focusing on crops, livestock, fisheries, water, land management, socio-economics (a consortium approach facilitates multidisciplinary interventions)
- Local government institutions and universities, especially for meteorological data
- NGOs
- Markets

C. **Organization**: Setting up facilitating groups linking stakeholders to farming community such as

- Innovation platforms
- Technology parks
- Farmer production groups/councils
- Climate warning committees
- Farmer field schools

D. **Synchronization**: Engaging all players to facilitate sharing of technological knowhow and synchronizing activities to maximize efficiency of delivery, for example

- Analyzing climate information, creating crop advisories and disseminating the information to farmers
- Research stations develop advisories using crop and climate modeling, these are communicated to farmers to help them make timely decisions in the wake of changing weather patterns
- Developing market demand for farm produce, synchronizing market operations
- Using the latest technology to share information quickly and on time

E. **Evaluation**: Having a built-in monitoring and evaluation system to identify barriers for technology adoption and rectifying procedures

- Identify and address social and cultural barriers
- Critical issues of marginalized population, women and youth.

3 The Communication Process

(A broad representation of the process)

1. **Raise awareness** on the urgency to address climate change among farmers, all actors along the agricultural value chain and policy makers
2. **Motivate and elicit farming community participation**. Involve them in planning, execution and monitoring of a climate change action plan

3. **Identify interventions through a participatory approach** to reduce carbon footprint of agriculture and identify climate-smart technologies needed to address immediate and long-term issues
4. **Build a network** of all agricultural stakeholders i.e. from weather information providers, crop and livelihood diversification experts from research institutes, National Agricultural Research Systems (NARS) and farm produce processors to markets and policy makers
5. **Connect farming communities to technology providers, policy makers and markets**
6. **Facilitate the creation of a customized plan** to build a climate smart community in line with the country strategy that has been developed for each region
7. **Catalyze the adoption of the plan** by building facilitating groups
8. **Aid implementation of the plan**, identify communication barriers and bottlenecks and resolve issues. Work towards gender inclusiveness and attracting youth to agriculture. Employ the latest digital technologies to simplify and speed up dissemination of information and on-farm techniques
9. **Communicate feedback** to team members for discussion on what needs to be modified
10. **Document the process** and lessons learnt.

The below illustration shows the various communication components involved and how climate information is used to build resilient agroecosystems (ICRISAT 2016) (see Diagram 1, *Source* ICRISAT, accessed on http://www.icrisat.org/wp-content/uploads/2016/11/Building-Climate-Smart-Villages.pdf).

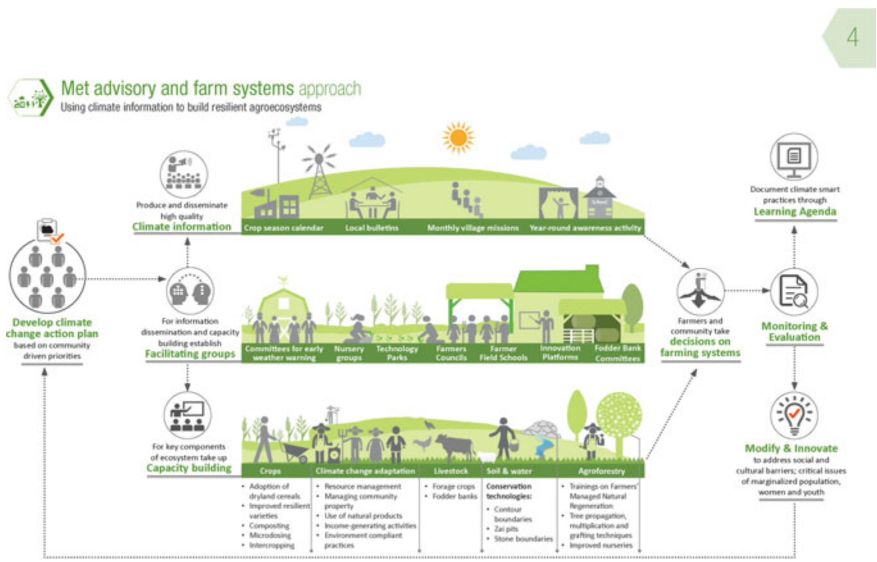


Diagram 1 The meteorological advisory and farm systems approach: using climate information to build resilient agroecosystems

4 The Overarching Communication Goal

This can be defined as follows:

Sharing of information, customized technical knowhow and building capacity of farmers to facilitate the adoption of holistic farm strategies that are environment friendly and at the same time make agriculture a viable business in the immediate and distant future in the face of threats posed by climate change.

This is implemented through:

1. Both short-term and long-term strategies that equip farmers with climate change **adaptation and mitigation technology knowhow**.
2. Connecting the farming community to a network of stakeholders, especially **weather information and knowledge providers, policy influencers and markets**.
3. Joining hands with partners and drawing on the strength of the global movement to address climate change and contribute to the UN Sustainable Goals.

5 Key Messages for Addressing Climate Change

1. **Adopt crops with low carbon footprint and high nutritive value**
2. **Use technologies that increase yields and facilitate optimum use of water**
3. **Reduce chemical fertilizer usage**
4. **Support agroforestry**
5. **Find alternatives to fossil fuels**
6. **Diversify livelihoods**
7. **Conserve the agroecosystem**

Message 1: Adopt crops with low carbon footprint and high nutritive value

Why: To ensure food security, farmers across the globe will probably have to switch to cultivating more climate-hardy crops and climate-smart farming practices (Nelson et al. 2009). The study shows that by 2050 climate change could cause irrigated wheat yields in developing countries to drop by 13%, and irrigated rice could fall by 15%. In Africa, maize yields could drop by 10–20% over the same time frame.

How: ICRISAT's mandate crops—sorghum, millets, groundnut, pigeonpea and chickpea—are inherently climate smart, they have close to the lowest water and carbon footprints of all the crops and are nutrient dense. In addition to this ICRISAT is working with partners on biofortification projects. The **Smart Food initiative** focuses on promoting millets, including sorghum and pulses. The campaign enumerates the nutritional superiority of these crops over the Big 3 (rice, wheat and maize) in terms of micronutrient availability and overall nutrition.

Introducing dryland cereals and legumes to farming communities is the core objective of all of the organizations climate-smart projects. The Smart Food initiative messaging emphasizes on three key aspects:

- **good for you** (i.e. highly nutritious);
- **good for the environment** (e.g. they have a lower water or carbon footprint); and
- **good for the smallholder farmer** (e.g. they are hardier, less prone to crop failures; have greater potential to increase yields; and multiple uses and untapped demand).

Case study: Recently, the critical need for **creating a market pull** for millets was recognized, so that farmers find a ready market for their produce. In India, in partnership with the Government of Karnataka state, efforts are being made for branding *ragi* (finger millet) and popularizing it among food processors targeting mainly urban consumers. The branding efforts also aims at changing the common notion that millets are old fashioned and meant for the rural poor.

In Kenya, **social behavior change communication** approaches are being used to improve the nutritional status of women in the reproductive age and children below five years, an awareness drive under the Smart Food initiative. The aim is to promote increased consumption of nutrient dense, drought tolerant crops (sorghum, millets, pigeonpea, groundnut, cowpea and green gram) and appropriate dietary practices in the project areas.

Message 2: Use technologies that increase yields and facilitate optimum use of water

Why: Climate change has caused receding glaciers, reduced stream and river flow, and shrinking lakes and ponds. Many aquifers have been over-pumped and are not recharging quickly. Although the total fresh water supply is not used up, much has become polluted, salted, unsuitable or otherwise unavailable for drinking, industry and agriculture. To avoid a global water crisis, farmers will have to strive to increase productivity to meet growing demands for food, while industry and cities find ways to use water more efficiently (Chartres and Varma 2010).

How: ICRISAT has developed a pool of climate-smart agri-technologies (see Diagram 2) from which stakeholders can select technologies best suited to their region. **Training and dissemination of knowhow** on the use of these technologies is done through various capacity building programs that include demonstrations, trial plots, farmers field schools, technology parks, innovation platforms, trainings on use of the latest digital technology available, such as farmer to farmer videos, use of sowing apps and apps for disease detection (still in development), etc.

ICRISAT scientists have developed new climate-smart varieties based on farmers' requirements. Varieties with enhanced nutrition (biofortified), drought and heat tolerance, pest resistance, machine-harvestability, and early maturity are a few examples. The release of every new variety and the impacts of new technologies introduced in each region is publicized through ICRISAT's **newsletter** and through the **mass media** of the region for wider awareness and subsequent adoption.

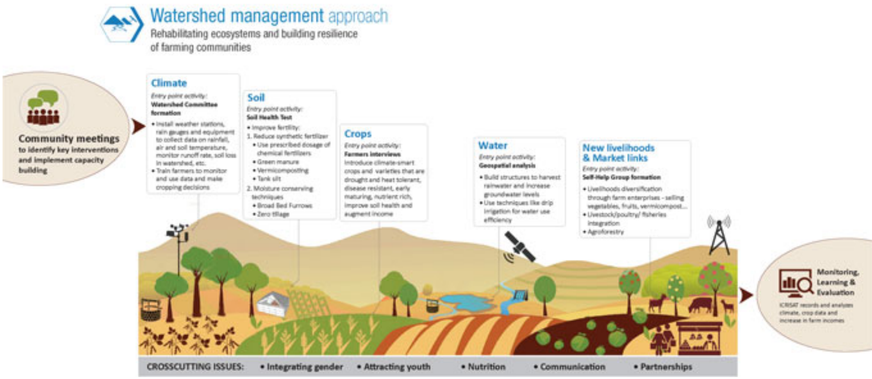


Diagram 2 The watershed management approach: rehabilitating ecosystems and building resilience of farming communities

Watershed management approach illustration (see Diagram 2, *Source* ICRISAT, accessed on http://www.icrisat.org/wp-content/uploads/2016/11/Building-Climate-Smart-Villages.pdf).

Message 3: Reduce synthetic fertilizer usage

Why: According to an FAO (2014) article, GHG emissions generated during the application of synthetic fertilizers accounted for 13% of agricultural emissions (725 Mt CO_2 eq.) in 2011, and are the fastest growing emissions source in agriculture, having increased some 37% since 2001.

How: For reducing chemical fertilizer usage ICRISAT recommends soil chemical analysis to identify limiting concentrations of plant available nutrients and prescribe precise dosages of required fertilizer, intercropping cereals with nitrogen-fixing legumes or growing legumes in the period when lands are usually left fallow, vermicomposting, growing gliricidia for green manure and using tank silt. Soil health tests have been devised as an **entry point activity** in the watershed management approach to reinforce the initial contacts that were made with the farming community in the region. The success of this initiative has led to its replication on a large scale.

Case study:

Upscaling a successful pilot project: The increase in yields after using the prescribed fertilizer dosage in watershed projects in the pilot Bhoochetana project in the Indian state of Karnataka has prompted the state government to upscale the project in all its districts and it also caught the attention of the neighboring Telangana and Andhra Pradesh states. With technical backstopping from ICRISAT the system of issuing **soil health cards** to farmers was initiated. In the states of Telangana and Andhra Pradesh where overuse of fertilizer is a major issue, the cards help educate and inform farmers on the deficiencies in their fields and to apply just the required amount of prescribed fertilizers. Successful experiments from the Indian watershed projects is being replicated in projects in Africa.

Message 4: Support agroforestry

Why: According to an FAO (2014) report, net GHG emissions due to land use *change and deforestation* registered a nearly 10% decrease over the 2001–2010 period, averaging some 3 billion tonnes CO_2 eq/yr over the decade. This was the result of reduced levels of deforestation and increases in the amount of atmospheric carbon being sequestered in many countries.

How: Aligning with country policies is an important aspect of ICRISAT's work. Joining hands with local governments some projects are promoting agroforestry, reclaiming degraded lands and laying special emphasis on growing trees that have biofuel potential.

Use of multimedia for agroforestry promotion: Shamba Shape Up, the Kenyan reality TV show for farmers, has teamed up with World Agroforestry Centre **(ICRAF)** and **ICRISAT** in a Series 6 episode dedicated to highly nutritious **trees** and crops that you can grow on your *shamba* (farm).

Case studies: In Ghana, a sustainable agroforestry system of intercropping jatropha with cowpea has been taken up. In India, successful experiments have been carried on intercropping jatropha and pongamia with pearl millet, pigeonpea and chickpea among other crops. Studies show that an additional income of INR5000 to INR16,000 per ha can be obtained even on low-quality (but reasonably able to support crop growth) soil (Wani et al. 2009).

Message 5: Find alternatives to fossil fuels

Why: Greenhouse gas (GHG) emissions from fossil fuels grew 1.4% in 2011, reaching a record 31.6 $GtCO_2$ eq yr^{-1} in 2012, the highest level in history—as documented by the International Energy Agency (IEA 2013). Also scarce fossil fuel deposits have resulted in a search for other sources of fuel, mainly biofuels that have a low carbon footprint.

How: Communicating research impacts to partners, investors and policy makers is an important component of corporate communication. This is done through presenting conference papers, participation in major workshops, contributions to newsletters both in-house and external and use of the ICRISAT website. At a recent conference, ICRISAT's presentation on two of the mandate crops, sorghum and pearl millet, showing potential for use as biofuel feedstock caught the attention of Government of India officials, who followed it up.

Case study: At a recent workshop conducted by the Department of Biotechnology, India, the advantages of newly developed high biomass sorghum and pearl millet developed by ICRISAT and the Indian Institute of Millets Research (IIMR) for use as feedstock in second generation or lignocellulosic (2G) biofuel production in India was highlighted. It was suggested that 2G biofuel commercial plants proposed to be set up can take the learnings from the organization's sweet sorghum improvement, crop production, supply chain management and commercialization in exclusive distilleries and in sugar mills for ethanol production.

Message 6: Diversify livelihoods

Why: In Africa, IPCC (2007: 13) projected that climate variability and change would severely compromise agricultural production and access to food. This projection was assigned "high confidence." In East and Southeast Asia, IPCC (2007: 13) projected that crop yields could increase up to 20% by the mid-21st century. In Central and South Asia, projections suggested that yields might decrease by up to 30%, over the same time period. These projections were assigned "medium confidence." Taken together, the risk of hunger was projected to remain very high in several developing countries.

How: To provide farmers a buffer against climate shocks, livelihood diversity is being advocated. Horticulture, floriculture and agroforestry are an important component and so is crop-livestock integration. Other avenues include making and selling goods like baskets and other handicrafts from locally available produce and running small farm enterprises such as *dal* and flour mills. **Farmer interviews and baseline surveys** conducted before projects are initiated provide valuable information on what new livelihoods are best suited for the region.

Message 7: Conserve the agroecosystem

Why: It is estimated that up to 40% of the world's agricultural land is seriously degraded (Ian Sample 2007). High population density is not always related to land degradation. Rather, it is the practices of the human population that can cause a landscape to become degraded. Populations can be a benefit to the land and make it more productive than it is in its natural state. Land degradation is an important factor of internal displacement in many African and Asian countries (Bogumil 2011).

How: An activity like this calls for a **community action plan** that taps into local knowledge, emphasizes on strong community linkages to take collective action and generate internal answers to common issues. Formation of facilitating groups like innovation platforms, self-help groups and farmers' councils and committees play a key role. An excellent example is that of the Indian watershed committees which emphasizes on 50% participation of women which aligns with the organization's goal of gender equity,

Case study: In eastern Niger, 241 ha of degraded land was converted into productive farms for 10,770 women through the Bio-reclamation of Degraded Lands (BDL) system. This has resulted in a 50% increase in agri-income over non-BDL participants. The BDL system has an agroforestry component that incorporates high-value trees and vegetables in a holistic system, with the aim of reversing damage to soils caused by overgrazing and intensive farming. It is a climate-smart technology that helps regenerate the landscape by improving soil fertility through carbon sequestration via tree roots and reducing soil erosion.

The technology developed by ICRISAT had two main components—water harvesting techniques and high-value nutritious trees and annual crops. The water harvesting techniques included half-moons (demi-lunes) for trees, zaï pits for annual crops and trenches for leafy vegetables. Through these techniques rain water was stored to sustain crops in the cropping season and trees in the dry period. The system also used micro-dosing of fertilizer in the zaï holes to stimulate root growth of vegetable crops and promote better nutrient utilization. Examples of high-value trees and annual crops include drumstick tree (*Moringa oleifera*), pomme du sahel tree (*Ziziphus mauritania*), okra (*Abelmoschus esculentus*), hibiscus and sicklepod (*Senna obtusifolia*) among others.

6 Major Approaches for Building Climate Smart Farming Communities

As mentioned earlier, with droughts, unseasonal rains and unpredictable dry spells becoming more frequent, reaching farmers with **timely climate information and cropping advice** is crucial as are coping strategies to face future climate shocks. For this **holistic communication strategies** that use best available technologies and target not just farmers but link all the stakeholders along the agricultural value chain are needed. In this context, **partnerships** are invaluable and adopting the consortium approach with public and private entities has helped tap into a wide area of expertise.

Approaches implemented by ICRISAT focus on equipping farmers to use climate-smart scientific interventions and innovations, use climate information for cropping decisions, diversify livelihoods, link to markets, make agriculture profitable, rehabilitate and restore their environment and influence policy makers.

The **watershed management approach** focuses on rehabilitating agroecosystems and deploys a pool of climate-smart agricultural practices developed by ICRISAT which have resulted in increasing crop yields and incomes of farmers. This approach which is gaining momentum in India is also favored by companies for their corporate social responsibility activities. The success of this approach has led to efforts to replicate it in sub-Saharan Africa.

The **futuristic multi-model approach** uses computer simulated scenarios to give policy makers in Zimbabwe the climate scenario up to the year 2050. The result was renewed support for promoting dryland cereals—sorghum and millet and greater support for groundnut value chains. With the support of the Government of Zimbabwe, ICRISAT imported 20 tons of groundnut seed from Malawi which was distributed to farmers for seed multiplication and testing.

The **digital technologies approach** has helped farmers from the Doggoh community in remote Ghana to adopt climate-smart agricultural practices and take up agroforestry in a big way. Farmers who had never used a phone are now using mobiles for climate information to make cropping decisions. About 90% of the farmers find the weather alerts useful and 64% of them also make use of the helpline when needed.

The **metrological advisory and farm systems approach** used in Mopti, Mali, demonstrated that climate change adaptation is achievable by using eco-friendly methods and climate information. Close to 76,000 women and 94,000 men representing all stakeholders in the value chain reported using climate information in their decision making.

The **climate and crop modelling approach** helped farmers who followed crop advisories in the drought-prone district of Kurnool in Andhra Pradesh, India, to earn 20% more than those who did not. The success of this pilot project has led to its expansion in other villages of Andhra Pradesh and the neighboring state of Karnataka.

7 Conclusion

From running awareness campaigns to popularize environment-friendly crops, creating a market pull and using social behavior change communication techniques for subsequent adoption; building capacity of stakeholders through trainings on customized technical knowhow and use of technology parks for demonstrating successful experiments; using innovation platforms to get all stakeholders to share information, knowhow and time their activities; leveraging partnerships to replicate successful projects on a large-scale, using a consortium approach for implementation of multidisciplinary components; and using the latest digital technology for quicker and timely dissemination of climate information, the development communication approach encompasses it all.

Acknowledgements I would like to thank ICRISAT staff Ms Joanna Kane-Potaka, Director, Strategic Communication and Marketing; Scientists—Dr. Anthony Michael Whitbread, Program Director, Innovation Systems for the Drylands, Dr. Suhas P. Wani, Research Program Director, Asia Program and Theme Leader, IDC; Dr. Sabine Homann-Kee Tui, Senior Scientist, Markets, Institutions, Nutrition & Diversity; Birhanu Zemadim Birhanu, Scientist, Land and Water Management; and Dr. Samuel Tetteh Partey, Scientist, Climate Change, Agriculture and Food Security (CCAFS); and all contributors to the ICRISAT Happenings newsletter for sharing information used in this article.

References

Bogumil T (2011) Towards recognition and protection of forced environmental migrants in the public international law: refugee or IDPs umbrella. Policy Studies Organization (PSO) Summit, December 2011

Chartres C, Varma S (2010) Out of water. From abundance to scarcity and how to solve the world's water problems. FT Press, USA

FAO (2014) Agriculture's greenhouse gas emissions on the rise. Accessed on 4 Dec 2016, from http://www.fao.org/news/story/en/item/216137/icode/
FAO. Climate change mitigation and adaptation in agriculture, forestry and fisheries. Accessed on 13 September 2016, from ftp.fao.org/docrep/fao/010/i0142e/i0142e00.pdf
Ian Sample (2007) Global food crisis looms as climate change and population growth strip fertile land. https://www.theguardian.com/environment/2007/aug/31/climatechange.food. Article accessed on 5 Dec 2016
ICRISAT (2016) Building climate-smart villages. Five approaches for helping farmers adapt to climate change. International Crops Research Institute for the Semi-Arid Tropics, Telangana, 28 p
IEA (2013) Redrawing the energy-climate map: world energy outlook special report. International Energy Agency, Paris, p 126
IPCC (2007) Climate change 2007: impacts, adaptation and vulnerability. In: Parry ML, Canziani OF, Palutikof JP, van der Linden PJ, Hanson CE (eds) Contribution of working group II to the fourth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge, 976 p
Luck J, Spackman M, Freeman A, Trebicki P, Griffiths W, Finlay K, Chakraborty S (2011) Climate change and diseases of food crops. Plant Pathol 60:113–121
Myers SS, Zanobetti A, Kloog I, Huybers P, Leakey ADB, Bloom AJ, Carlisle E, Dietterich LH, Fitzgerald G, Hasegawa T, Holbrook NM, Nelson RL, Ottman MJ, Raboy V, Sakai H, Sartor KA, Schwartz J, Seneweera S, Tausz M, Usui Y (2014) Increasing CO_2 threatens human nutrition. Macmillan Publishers Ltd. doi:10.1038/nature13179
Nelson GC, Rosegrant MW, Koo J, Robertson R, Sulser T, Zhu T, Ringler C (2009) Climate change: impact on agriculture and costs of adaptation. International Food Policy Research Institute, Washington, DC. doi:10.2499/0896295354
Sharma HC, Prabhakar CS (2014) Impact of climate change on pest management and food security. In: Integrated pest management: current concepts and ecological perspective. Academic Press, Elsevier, London, pp 23–36. ISBN 978-0123985293
Thornton P (2012) Recalibrating food production in the developing world: global warming will change more than just the climate. CCAFS policy brief no. 6, CGIAR research program on climate change, agriculture and food security, Frederiksberg C, Denmark
Vermeulen SJ, Campbell BM, Ingram JSI (2012) Climate change and food systems. Annu Rev Environ Res 37:195–222. doi:10.1146/annurev-environ-020411-130608
Wani SP, Sreedevi TK, Marimuthu S, Rao AVRK, Vineela C (2009) Harnessing the potential of Jatropha and Pongamia Plantations for improving livelihoods and rehabilitating degraded lands. In: 6th international biofuels conference, New Delhi, India, 4–5 Mar 2009

Engagement in Action: Communicating Climate Change Research to Non-specialist Audiences

Julie Biddlecombe-Brown, Adam Holden and Melissa Swartz

1 Introduction

In 2015, Culture Durham (Durham University's cultural engagement team) created a small exhibition titled *Antarctic Science Today* as a component of the larger exhibition *Antarctica: Explorers, Heroes, Scientists*. The exhibition ran from 17 October 2015 to 7 February 2016 at Palace Green Library and was accompanied by an engagement programme which included the development of educational resources for schools.[1]

Antarctic Science Today used world-leading research from Durham University's Department of Geography to engage with the general public about climate change, and to improve understanding of climate change and Antarctica's role in climate change. The main theme of the exhibition focused on the phrase: "Antarctica's past holds a key to understanding future climate change". This carefully worded headline was an attempt to make clear but open links between the research findings and various publics. Sustained engagement with the general public, with teachers

[1]The exhibition and associated educational materials were based on current research in Antarctica by the Department of Geography at Durham University. Funding for this project was both internal and from a National Environmental Research Council (NERC) grant secured by Professor Mike Bentley (NERC grant NE/K003674/1). The authors would like to thank Professor Bentley and wider group of researchers and Palace Green staff who worked on the project, but we note that any errors in this paper are ours alone.

J. Biddlecombe-Brown · A. Holden (✉) · M. Swartz
Department of Geography, Durham University, South Road, Durham DH1 3LE, UK
e-mail: a.l.holden@durham.ac.uk

J. Biddlecombe-Brown
e-mail: j.m.biddlecombe-brown@durham.ac.uk

M. Swartz
e-mail: meswartz71@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_25

and researchers was essential to ensure that relevant, clear and trustworthy educational materials on climate change could be developed. The motivation for developing the exhibition and educational resources was rooted in a wider set of commitments to fostering engagement and developing research impact. This meant that research findings needed to be communicated beyond the academic and scientific community and that this process of translation-in-action should work towards, for example, the goal of enhancing the capacity of teachers to understand and teach the climate change.

The project also built on a long and deep partnership between Department of Geography and the British Antarctic Survey (BAS) who supported the exhibition through loan of objects, provided images and other materials for the educational resources and delivered engagement with students from local secondary schools.

1.1 Translating the Science

Durham University scientists working in Antarctica focus on understanding the history of Antarctica's ice mass, as well as observing and quantifying its current changes. These observations and measurements—both current and historical—feed into numerical simulations of Antarctica's climate change response, all of which helps scientists model how Antarctica may change in the future.

This work has illuminated the dynamic nature of the Antarctic ice sheet, including the locations of maximum ice mass change, and the links between ice sheet evolution and changes in atmospheric and oceanic circulation. The research challenges the view of the ice sheet as a largely static or slowly-changing feature—a view that is currently dominant in school curriculum materials. The work at Durham has also been part of international efforts quantifying the ongoing contribution of the Antarctic Ice Sheet to sea level rise. Specific papers drawn on to highlight in the exhibition and educational materials include research on past ice sheet extent and response (Bentley et al. 2009), rates of ice mass loss around the East Antarctic Ice Sheet (Miles et al. 2016), the rebound of the Earth in response to ice loss (Whitehouse et al. 2012), and the Antarctic contribution to sea level change (Whitehouse et al. 2012; Shepherd et al. 2012).

Linking recent research on Antarctica and climate change with teachers and the general public is essential, yet difficult, as most research findings are published in academic journals unread by non-academics. While academics often have the will to write popular science articles or example lesson plans, they often lack the time given their other pressures. For *Antarctic Science Today*, we used an independent contractor to act as a link between the researchers and the general public, especially teachers.

We trialed a number of activities for communicating this research on Antarctica to the general public, as summarised in Table 1. While our strategy focused on the exhibition and educational materials, we also used social media, hosted a lecture series and engaged with student volunteers. Only some of these modes of

Table 1 Learning and impact activities for *Antarctic Science Today*

			Lessons Learned		
Activity	What we did	Evidence of success	Pros	Cons	Worth doing?
Exhibition	Exhibition at Palace Green Library, Durham	Footfall during exhibition (at least 4467 plus other visitors)	Well attended; excellent centrally-located space	Footfall limited by Durham location; duration of exhibition	Yes: exhibition links well to education
		Voting tokens issued to measure visitor knowledge	Useful means of measuring visitor views of subject	Questions must be carefully asked to avoid leading answer	Yes: easy and effective, but needs more focused design
		Visitor questionnaire to measure visitor knowledge	Useful means of measuring impact of exhibition on visitor knowledge	Limited space on questionnaire; questions general rather than about specific aspects of science	Yes: easy and effective, but needs more focused design
Education outreach	Primary School engagement	Number of schools engaged (10 schools)	Excellent reputation of Learning Team	Timing—a longer exhibition would have brought more schools in	Yes: teachers and students loved sessions
	Secondary school engagement	Number of schools engaged (6 schools)	Schools loved bespoke days	Difficult for schools to visit without added benefit of University visit	Maybe: high effort needed to organise wider event
	Teacher training	Teacher conferences attended	Easy means of reaching a number of teachers	Limited amount can be conveyed in one session	Yes: low effort for large reach of teachers
	Free outreach sessions in schools	No. of schools requesting visits (1 school)	High impact—can relay key messages	Little uptake without direct marketing to teachers	Maybe: requires lots of effort to engage teachers
	Educational materials	Number of USB sticks distributed (150 sent out)	High impact—can relay key messages and boost teacher confidence	Follow up required to know whether teachers have used supplied materials and effect on teacher confidence	Yes: excellent means of disseminating new research

(continued)

Table 1 (continued)

			Lessons Learned		
Activity	What we did	Evidence of success	Pros	Cons	Worth doing?
Student engagement (University)	Uni Student volunteers ran weekly "ask a scientist" sessions	Student feedback	Students responded positively with 30 students volunteering	Limited feedback from students on experience	Maybe—added dimension to exhibition, but needed more feedback
	Lecture Series—both lunchtime and evening	Number of attendees measured	Allows for deeper discussion of topic	Limited to those interested who work or live close to exhibition space	Yes, especially evening talk series
Social media	Twitter access from exhibition	Tweets sent from exhibition (number of tweets sent)	Captures aspects visitors liked about exhibition	Need to ask specific question to tweet answer to, otherwise used as "guest list"	Yes—take time to craft specific questions
	Tweets from researchers in Antarctica	Wide following (80 followers); direct engagement with at least one school	Current information from researchers; view of fieldwork	Takes time to build following; needs follow-on communications to ensure use during next field season	Maybe—takes time to establish. Must embed in wider education work

engagement were quantified to show effective uptake of information; however, we were curious to use an array of methods to explore their ease of use and potential for delivering results.

The most significant and effective means of communicating climate science were the exhibition and contact with teachers via the educational materials. Other modes of engagement were useful, and even fun; however more investment of time would be required for them to produce significant results or evidence of success.

2 Resources for Teachers

> High quality materials … can have significant impact on the quality of teaching and learning. The traditional field trip/visit to an external venue is becoming more challenging as school finances tighten. Outreach services are most welcome in this situation and schools are always interested in what education services can offer in this style of delivery. … The availability of up to date case study material remains key; with schools' keen to use online resources from reputable sources and make links with Universities.
>
> Gabrielle Reddington
>
> Specialist Inspector for Humanities, Durham County Council

Engagement with teachers and schools was a primary goal of *Antarctic Science Today*, with a particular focus on secondary schools (Key Stage 3, 4 and 5) and the changing geography exam specifications. These new exam specifications place a greater emphasis on climate change, with at least one exam board specifically mentioning Antarctica. Antarctica provides an excellent case study for understanding the overarching theme of climate change, as well as specific information for teachers choosing to focus on Cold Environments, which is an optional topic under most exam boards. All materials were mapped to the old and draft new exam curricula for all major exam boards for Key Stages 4 and 5, and to the National Curriculum for Geography for KS3.

A freelance consultant, Science 4 Schools, was hired to liaise with teachers and develop materials appropriate for secondary school teachers and teaching, but rooted in academic research. Through this engagement, *Antarctic Science Today* aimed to:

- Provide teachers with accessible and relevant teaching materials based on current research findings, and linked to the current and draft proposed exam specifications
- Provide modern case studies regarding cold environments and climate change which have particular relevance to the options within the changing curriculum.

The starting point for this task was in essence an attempt to develop the basis for dialogue between climate scientists and geography teachers. A major challenge in terms of communication was that research papers are written primarily for an academic audience and are unlikely to be accessible even where teachers have relevant degree experience or wider interest. Other demands on teachers' time and the limited accessibility of research papers—both in terms of language and physical access—makes keeping up to date with the latest research difficult (MacLeelan 2016; See et al. 2016). To address this, we worked closely with the researchers to help distil key findings and "translate" these into situations and formulations that would better serve classroom practices, while remaining scientifically sound. Our educational resources were developed with the overall goals of:

- boosting teacher confidence by providing excellent information on current climate change science in Antarctica
- igniting student interest in Antarctica and climate change science
- improving teachers' and students' knowledge about the role Antarctica plays in governing the Earth's response to climate change.

Secondary school teachers in County Durham were canvassed via individual meetings and subject network meetings to gain an understanding of the types of materials they require. Information specifically around case studies, photographs, and personal experiences was requested, as was information teachers could use in forming their own lessons. Single activities were not particularly sought, nor were pre-structured lesson plans. Teachers wanted the reassurance that the materials would fit within the exam specifications, and clearly wanted materials to help ease their transition to teaching subject areas being introduced with the new exam specifications.

Based on this feedback, Science 4 Schools developed a series of packs presenting scientific images with explanatory text based on climate change research carried out by scientists in the Department of Geography. Most presentations contained practice exam questions directly related to materials within the presentation. Embedded videos, links to further videos and activities on external websites were also provided. The range of materials is illustrated in Fig. 1.

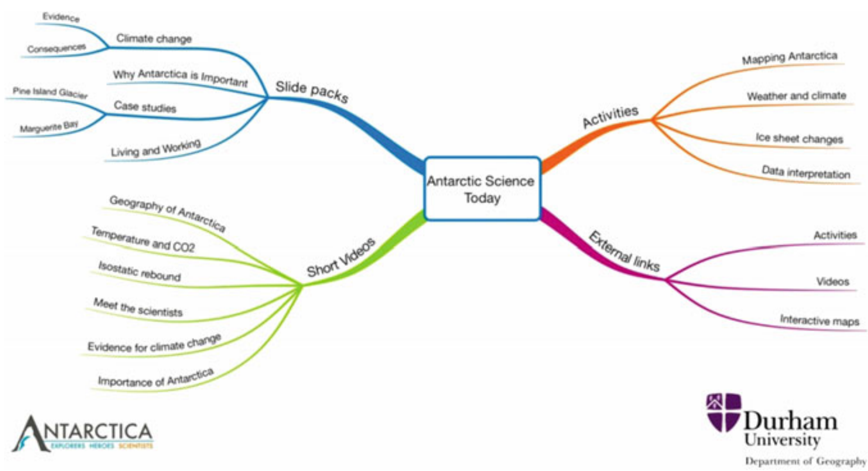


Fig. 1 Outline of the teaching resources developed for Antarctic Science Today

Table 2 Example of the topics covered in one of the resource slide presentations

Evidence and consequences of climate change	Topics covered	Key stage
Part 1 Power point slide pack covering current and historical evidence of climate change from Antarctica	Evidence of current climate change	3, 4, 5
	Evidence from the past	3, 4, 5
	Impacts of global warming	3, 4, 5
	Causes of climate change	4, 5
	One practice exam question	5
	One link to an activity on an external website	3, 4
	Short video on the T and CO_2 relationship	3, 4, 5
Part 2 Power point slide pack covering evidence of climate change from recent research in Antarctica	Evidence of current climate change	3, 4, 5
	Global impacts of climate change	3, 4, 5
	Threats to Antarctica from climate change	4, 5
	Landscapes as means to reconstruct the past	4, 5
	Glacial budget	5
	Glacial processes	5
	Two practice questions on glacial mass balance	5
	Short video describing isostatic rebound	4, 5
	Short video of satellite images showing a glacier moving	4, 5
	Contains links to external videos on sea level rise	3, 4, 5
Part 3 Power point slide pack containing five videos on the Geography of Antarctica, and the evidence of climate change from the three major geographical areas of Antarctica. There is also a short video introducing the scientists	Meet the Scientists	3, 4, 5
	Geography of Antarctica	3, 4, 5
	Evidence of climate change	3, 4, 5
	Consequences of climate change	3, 4, 5

In total, seven Powerpoint slide packs were created, focusing on the evidence and consequences of climate change in Antarctica, why Antarctica is important, two case studies, and living and working in Antarctica. Alongside Durham Research, the British Antarctic Survey provided a large library of photos, maps and other images which were incorporated into the resources.

Interviews with Durham University scientists provided materials for videos supporting these topics. Other videos provided examples of research findings, such as videos of glaciers moving and calving icebergs, or outputs from computer modelling showing past glacial retreat.

The educational resources were provided for free on 8 GB USB memory sticks and the numbers and locations of schools requesting information were recorded providing a database for future evaluation.

Table 2 provides an example outline of the topics covered by one of the presentations, and the targeted Key Stage. When describing the topics covered, we have tried to use similar vocabulary to that used with the current and draft exam specifications.

3 The Exhibition

> Both the exhibition and my studies at Durham Uni have opened my eyes up to the importance of Antarctica for understanding past and future.
>
> Exhibition Visitor

Antarctic Science Today exhibition, Palace Green Library 17 October 2015 to 7 February 2016. © Durham University

Antarctica: Explorers, Heroes, Scientists contained photographs from the Royal Geographical Society (with IBG) popular touring exhibitions; *With Scott to the Pole* and *Antarctic Witness*. The aim in creating the *Antarctic Science Today* exhibition was to deliver a contemporary exhibition incorporating current research on climate change while attracting visitors with the hook of the historical photography.

Antarctic Science Today highlighted the importance of research in Antarctica for understanding climate change, and summarised current research findings from Durham University scientists. Physical artefacts gave visitors a taste of the living accommodation, clothing and food supplies necessary for working in such a challenging environment. Information panels, photographs and a video communicated scientists' studies on how Antarctica's climate has changed in the past, and how it is likely to change in the future. A voting interactive collected visitor responses to a number of key questions linked to the research that was being presented.

Overall, the wider exhibition attracted 4467 ticketed visitors, with further numbers visiting *Antarctic Science Today* and participating through the learning and engagement programme. Outreach from the exhibition reached an additional 7000 people through the *Celebrate Science* event, at which the Culture Durham Learning Team had a stall exploring some of the exhibition's key themes. Repeat visits were encouraged, and previous visitors were able to return to the exhibition with their original ticket.[2]

3.1 Climate Change Science and Museums in Context

The premise and format of the exhibition can be understood in the context of the shift from museums as a window on the past, to places providing spaces for the communication and deliberation of our potential futures (Hebda 2007; Johnson 2012). Cameron (2012, pp. 325–331) identifies nine possible roles for museums and science centres in climate change communication. Our focus—underpinned as it was by commitment to bridge key research findings with public engagement and education—was not that of activist, artist, or lobbyist. Rather, the combination of partners—across research department, university museum and schools—provided a fairly broad and open remit, allowing us to open up a space to communicate the up-to-date science of climate change and provide access to a range of resources on climate change. To a lesser extent, we also provided "a forum for debate and discussion for individuals, communities, organisations locally and globally to express their views on climate change" (Cameron 2012, p. 331).

The wider *Antarctica: Explorers, Heroes, Scientists* exhibition aimed to engage with students and the general public to creatively disseminate research, and engage with learners of all ages to ensure that everyone discovered something new. The collaborative working between Culture Durham and the Department of Geography during this exhibition uses (and has extended) a model for communicating research to non-specialist audiences in an exhibition setting and highlights Durham University's research excellence. This model was developed by the Culture Durham team in 2013 for the award-winning exhibition Lindisfarne Gospels Durham: One Amazing Book, One Incredible Journey. It positions key research at the core of all exhibition and engagement messaging and has subsequently been applied to the ongoing exhibition and engagement programme including an exhibition on Magna

[2]The Antarctic Science Today exhibit was located between the two main galleries in a space free to access so that members of the university or general public using the library, café or learning facilities were able to casually encounter the display.

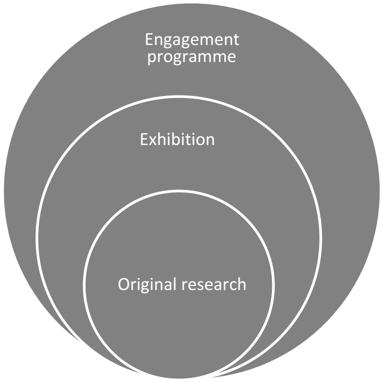


Fig. 2 Durham University model for research-based exhibitions and engagement activity © Durham University, 2013

Carta as well as Antarctica (Hamlett et al. 2015; Swartz et al. 2016). The model is illustrated in Fig. 2.

Our strategy was focused quite conventionally on informational and persuasive practices, albeit with the potential through schools engagement to create resources that might underpin mobilization and deliberation (Johnson 2012; Dulic et al. 2016).[3] What was distinctive was linking research about a specific and largely unknown continent (Antarctica) to wider discourses of climate change.

For *Antarctic Science Today*, the model used trialled a range of engagement practices in order to test effectiveness in demonstrating research impact. The collaboration between cultural practitioners, academic researchers and educators provided unique opportunities in bringing together a range of expertise but was constrained by the longer term remits of individual team members, in particular the exhibitions team for whom this was one of just a succession of varied exhibition projects and who were therefore required to focus on the next project once the exhibition had closed to the public.

3.2 Engagement with the Public and Schools

The creation of the *Antarctic Science Today* exhibition established links with Culture Durham's Learning Team, widening the scope for engagement to primary

[3]The approach that emerged was one rooted in the Culture Durham model but enhanced by engagement with the perspective of teachers and a dialogue with scientists. While there was a clear brief to bring recent research findings to new publics, the model of engagement combined a fairly orthodox "information deficit model" (with its assumptions about transmission of information to rational and passive audience) with what Dulic et al. (2016) see as more dialogical interactive communication model focused on "improving communication between diverse constituents … [and designing] structures to provide a space of discourse" (p. 56).

schools and the general public via school visits, outreach, family activity sessions and public lecture series.

The Learning Team provide engaging, hands-on experiences based around exhibitions, as well as items in their permanent collections. Their involvement allowed the project to reach a much wider audience, and benefit from their experience in running public engagement programmes, their reputation with local schools, and their capacity to host and organise bespoke events for schools.[4]

Antarctic Science Today aimed to engage with the wider public about current climate change science, as evidenced by recent research in Antarctica. The development of educational resources based on research and supporting the exam specifications provides a means of impacting how teachers teach, and students learn. Outreach through venues such as Palace Green Library helps disseminate these research results via their excellent networks with primary and secondary schools. Despite the exhibition and workshops being directly promoted to secondary schools, most secondary schools did not book visits on an individual basis. With the exception of two visits (who brought specially selected students), those that attended came to pre-arranged bespoke events—one to celebrate the exhibition opening with special lectures from BAS researchers, and two aimed at A-level and GCSE students, respectively. Secondary schools were also offered free outreach visits both during and after the exhibition closed.

These events were fully booked—in fact, schools were turned away—and were a huge success. Survey feedback from students and teachers showed appreciation of the first-hand accounts of research in Antarctica, as well as the opportunity to get insight into University life, and thoughtfully engaged with the exhibition and workshops. Since the exhibition closed, a short workshop on Antarctica has been delivered by the Learning Team to an additional 196 students at one school across two consecutive days to complement a science week.[5]

---

[4]An example of this is the *Celebrate Science* event where we showcased some of the exhibition's key themes, and encouraged exhibition visits. An *Antarctica* stall featured activities and demonstrations based on mechanisms of rising sea levels and climate change, including an ice sculpture of a penguin, the melting of which was followed via social media in order to raise awareness of the issues explored by the exhibition. The programme also included a range of other engagement opportunities for different audiences including a series of small scale but well attended public lectures, and a regular Saturday "Ask a Scientist" session run by student volunteers who had drew on their cold environment fieldwork experience to engage with the general public.

[5]Over the course of the exhibition, a total of ten primary schools either visited the exhibition and took part in on-site workshops or were visited through the Learning Team's outreach programme to take part in school based Antarctica workshops. In addition, one group of home schooled children visited the exhibition and took part in on-site workshops and a further primary school booked with the Learning Team after the end of the exhibition to tie in with a 'Great Explorers' topic. In total, 427 primary school age children engaged with the exhibition and/or the formal, curriculum linked learning programme delivered by the Learning Team.

Geography teachers who attended the exhibition, or heard about the exhibition at subject meetings, have requested Continuing Professional Development (CPD) sessions to improve their knowledge of current climate change science, based on the *Antarctic Science Today* materials. The resources developed for *Antarctic Science Today* were used at two training events for primary and secondary school teachers being hosted by Durham County Council. The materials were endorsed in the September 2016 edition of GA, the Geographical Association's magazine which is the key point of reference for all teachers of geography.

An overview of the materials was also presented to visiting teachers from eight different European countries as part of an Erasmus programme focusing on environmental and sustainability issues.

4 Evidence of Engagement and Potential for Impact: What Worked?

> Clear explanation of the importance of research in Antarctica showing that climate change is happening.
>
> Exhibition visitor

Data for evaluation was primarily collected via a visitor questionnaire attached to the exhibition guide leaflet, consisting of a set of questions on group composition, reason for visit and distance travelled, as well as a section designed to monitor how visitors felt their understanding had improved as a result of the visit. A second questionnaire was distributed to the attendees of the talks programme, asking respondents whether they felt that the talks and exhibition enhanced their understanding of the themes. These questionnaire data sets, along with further data captured through a variety of other mechanisms, were collated to measure success against the articulated aims and objectives. These additional mechanisms included interactive exhibits (token voting), ticket sales (giving data on visitor numbers and visitor demographics) and social media interaction and digital engagement.[6]

Visitor comments about both the exhibition and the lecture series were positive in nature and generally encouraged others to visit the exhibition. Comments made via social media, particularly Twitter, also display a good level of satisfaction with the exhibit and its content.

[6]Social media was used in a number of ways to develop feedback from and for the exhibition, including provision of a screen to encourage visitors to tweet their experience of the exhibition using the hashtag #AntarcticaDU. While people did use this facility, it was mainly used as a "guest book". A better approach, and what has successfully worked in other research-based exhibitions, is to ask attendees to respond to a question related to the exhibition.

4.1 Exhibition Impact

Central to the development and delivery of *Antarctic Science Today* was the communication of key thematic messages based on an academic thesis and testing of the responsiveness of visitors to this, including the mechanisms and methods deployed. These two overarching themes were:

1. The early exploration and science of Antarctica, presented via existing Royal Geographical Society exhibitions
2. Modern research into Antarctica and climate change, including rising sea levels, carried out by scientists from Durham University's Geography Department.

Visitor engagement with these questions and themes was tested through paper questionnaires, school workshops, lunchtime and evening talks and a voting interactive, whilst further evidence was seen through social media.

The general visitor questionnaire asked respondents to estimate their understanding of the importance of Antarctica, on a scale of 1–5, both before and after seeing the exhibition. Responses to this question are displayed in Fig. 3, with light grey representing understanding before seeing the exhibition, and dark grey representing understanding afterwards.

In general, visitors' understanding saw a marked increase through viewing of the exhibition, as summarised in the graph above. The vast majority of respondents estimated their post-exhibition understanding at 'level 3' or above, with 89% of all people reporting their understanding to be level 4 or 5, out of a total of 5.

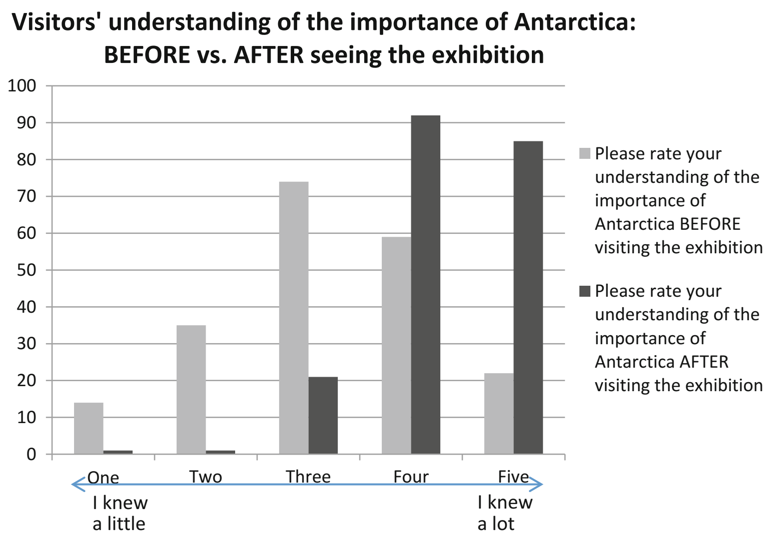


Fig. 3 Visitors' understanding of the importance of Antarctica in climate change research

75% of visitors surveyed through the exhibition guide questionnaire saw an improvement in their understanding of climate change issues in relation to the Antarctic, with around half of the remaining 25% already having declared that they had the maximum 'understanding level' of 5 before they visited the exhibition. Respondents reported an average increase of 1.11 points out of five in their understanding level after having seen the displays

Both the general exhibition questionnaire and the talks programme questionnaire incorporated a question on whether the visitor felt that their understanding of Antarctic issues had 'changed' as a result of seeing the exhibition.

Over half of all visitors who attended the exhibition felt that it had changed their understanding of why research in Antarctica is important. 70% of those who responded to the talks questionnaire and had also attended the exhibition felt that it had at least partly changed their understanding. A number of people who specified that their understanding had not changed as a result of the exhibition expressed that they had already fully understood the implications of Antarctic research prior to the events at Palace Green.

For questions requiring a written response, 'Wordles'—an online-generated graphic representations of word frequency—effectively highlight the main responses. In Fig. 4, the size of the words are proportional to the number of times they appear in a selection of text. The wordle below reflects the question '*How has the exhibition changed your understanding of why research in Antarctica is important?*'

The most prominent words and phrases include 'research', 'understanding', 'climate change', 'global warming', 'importance' and 'future', illustrating the ideas that had impacted most strikingly on the respondents.

A second wordle (Fig. 5) was generated from the responses to the key question, "If you could tell a friend one thing about '*Antarctic Science Today*', what would it be?". The resultant graphic illustrates the aspects of the exhibition that impacted most significantly on respondents. This question was chosen as the central 'impact'

Fig. 4 Wordle based on question "How has the exhibition changed your understanding of why research in Antarctica is important?"

Fig. 5 Wordle based on question "If you could tell a friend one thing about 'Antarctic Science Today', what would it be?"

question for the exhibition, aligning with the final portion of the exhibition based on the research of Durham University geographers.

Whilst some visitors had answered the question in a broader manner, words and phrases such as 'research', 'interesting', 'climate change' and 'important' again feature prominently. This suggests that the visitors in question were successfully engaged by the material, showing an awareness of the key themes that were incorporated in the '*Antarctic Science Today*' section of the exhibition.

4.2 Voting Activity

A total of 22,859 votes were cast in the voting interactive used during the exhibition, through which visitors selected yes or no responses to four questions on the subject of climate change. At the beginning of the exhibition's run, a box of tokens was made available adjacent to the voting slots. This gave all those visiting *Antarctic Science Today* the opportunity to place a vote. However, some visitors were found to be making more than one vote for each question, in some cases placing a great number of votes at once, skewing the results. After this came to light, four tokens were instead handed out to each visitor upon purchase of a ticket.

Despite this initial bias, it appears that for the most part visitors voted in accordance with the instructions given. In all cases, visitors overwhelmingly responded 'yes' to the questions asked, perhaps at least in part a reflection of the educational impact of the exhibition itself. However, nearly a quarter of voters did **not** think that climate change would have an impact on their own lives (see Fig. 6).

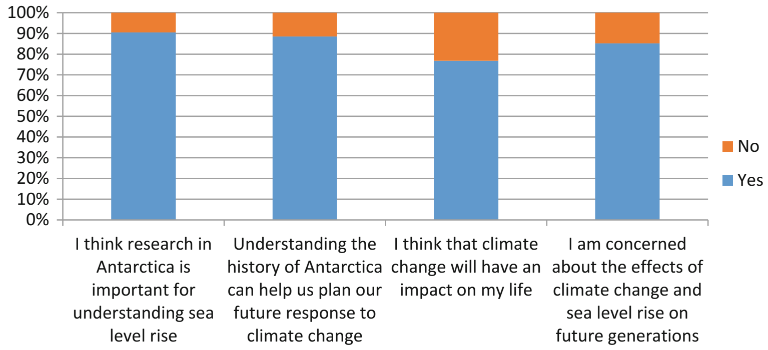


Fig. 6 Results of exhibition voting interactive exhibit

4.3 Evidence from the Teaching Resources

Assessing the impact of teaching resources, such as those developed for *Antarctic Science Today* is difficult. Changes in overall exam results are not an appropriate measure, as exams test a breadth of student knowledge, making it difficult to attribute any improvement in scores to the materials we developed. Focussing instead on teacher confidence regarding climate change science, as well as student engagement with the materials, may provide a more reliable measure of impact. Information useful to gather includes:

- teachers' baseline knowledge of Antarctica, the role of Antarctica in the Earth's climate, and climate change science
- teachers' confidence teaching climate change science
- teachers' confidence teaching about cold environments
- teachers' assessment of student interest in the provided materials—does having specific case studies or results from recent field work make students more interested in the subject?

Teachers have asked for training and materials to help them teach climate change science, especially in relation to the changing exam specifications. Following the exhibition resources have been sent to almost 150 schools throughout the UK. This dissemination has built on existing school-university networks, teachers' conferences and a recommendation in the Autumn edition of the Geographical Association Magazine. A baseline survey has been administered with scope to ask further questions once teachers begin to use the resources.

Initial survey results are few, but by the end of the 2015–16 academic school year, 85% of respondents felt the educational resources will help them teach about cold environments and glaciation. Respondents have also suggested that the materials will be useful not only in class, but also for their background knowledge.

Further surveys are planned over the course of the upcoming academic year to gauge whether teachers:

- found the materials useful in planning lessons
- felt more confident about the subject
- thought the students engaged with the materials.

5 Reflections and the Way Forward

Antarctic Science Today provides many opportunities to understand the benefits of using museums to communicate climate change research to non-specialist audiences, and the advantages of providing educational materials and outreach opportunities for primary and secondary schools. The project did face some limitations outlined in Table 3 below.

Linking the current research taking place in Antarctica to the wider *Antarctica: Explorers, Heroes, Scientists* exhibition including the touring elements from RGS

Table 3 Limitations and solutions associated with *Antarctic Science Today*

Limitation	Consequence	Learning/solution
Fixed timescale of exhibition	Limitation of audience numbers Restricted opportunity for ongoing support from exhibitions team	Team to consider production of a touring exhibition to broaden audience base and impact
Provision of resources in a web-based format	Files too large to be hosted easily on website USB sticks useful but limit distribution—not linked to website, not found by casual internet search	Consider specific website to host research-related teaching materials Consider specific mention of how to order USB stick on website
Lecture series in one location	Limitation to audience numbers Attracts people who are already engaged in the subject matter	Offer lecture series or recorded lectures/podcasts as optional programme alongside touring exhibition and further dissemination of learning resources
Lack of engagement with climate change activists	Limitation to dissemination of key messages using existing channels to people who are engaged with environmental issues; did not link with other activities around Paris talks	Build on links within environmental activist networks to promote exhibition and/or resources
Secondary schools' difficulty in attending activities off school campus	Secondary school visits limited to bespoke events that showcase wider University	Plan in wider University visits to engage schools. Schools need to be able to justify full-day visit

(with IBG) widened the appeal and reach of the exhibition, attracting many more visitors than may otherwise have been expected. A further step, currently being considered by the team is the creation of a touring exhibition linked to a learning and engagement package that would further broaden reach and impact.

Using a specialist Learning Team to develop primary workshop activities, and Science 4 Schools in this case to develop secondary school materials, allowed educational specialists to liaise with teachers and develop appropriate materials, while freeing the scientists to continue their research. During *Antarctic Science Today*, these three parties worked exceptionally well together, with the scientists identifying the recent research that would be appropriate for educational materials, Science 4 Schools and the Learning Team translating the research for public consumption. The link with the Learning Team resulted in a wider reach to schools and the general public than would have happened without their involvement.

Social media is a valuable tool but time is needed to build following, and in future, tweeting prior to fieldwork would help build that following. A designated person to access the Twitter account to re-post tweets and add photographs is useful, although some knowledge of the subject area and topic is necessary to ensure photographs match the content. A more established agreement with organisations such as BAS and RGS for future expeditions could help boost the number of retweets, and therefore viewers.

Antarctic Science Today demonstrates a successful example of how collaboration between different parts of a University can achieve the goals of engagement, impact, widening participation and development of student experience. This model of integrated project-based collaboration offers a good example of future ways of working in a University environment.

6 Conclusions

In this paper we have outlined the development of partnership between climate science researchers, and cultural and education professionals to curate an exhibition and develop educational resources for schools. We have succeeded in meeting the general aim of raising awareness and supporting better understanding of the importance of Antarctica and Antarctic Science in relation to climate change. *Antarctic Science Today* was successful in terms of public engagement and while we had limited resources for evaluation the co-development of exhibition materials (video, interpretation and so on) with the production of educational resources was extremely effective and quite efficient. The education resources have been distributed to teachers in well over 100 schools across the UK and initial feedback has been positive. The challenge will be to track use of the materials in the classroom and provide further rounds of support and feedback.

Antarctic Science Today was not conceived to address the role of scientists as agents of public engagement within the context of universities. That said, our practice and experience highlights the successful elements of institutional partnership, academic engagement and professional practice needed to develop a research-led exhibition and outreach programme on climate science and Antarctica. If Kahan's (2014) demand for "an approach to science communication that is genuinely *evidence*-based from beginning to end" (p. 204) is to be taken seriously then it would be necessary to extend our approach in terms of a deep analysis of the development and reception of a climate change communication strategy. Much of the literature on climate change communication focuses on analysis of media and other analogues for a general but divided public discourse (Leal Filho 2009; Crow and Boykoff 2014; Hansen and Cox 2015). While this can provide much in terms of techniques for critical communication we would argue that best practice requires a structured and staged dialogue between research scientists and wider constituencies. This is demanding in terms of time and resources, but a renewed concern with research impact presents a genuine (but not simple) opportunity to build a deeper understanding of how this can work. In light of the resources and relationships being mobilised under the strategic (re)orientation of universities to include research impact, there is an opportunity to design evidence-based approaches into the conception, completion and communication of research projects (as many are already doing).

As an ideal, this requires an evidence-based approach to the complete (if complex) life cycle of climate science research. This would begin with the development of research proposals that engage social scientists, publics, artists, climate activists, policy makers, business and so on in the deliberative definition of research problems as well as the design of research projects (solutions to questions). It would end with the critical and medium-term investigation of the social and scientific changes brought about by the research. There is in short, scope for an alliance between climate scientists, communication researchers and the broader base of professional support in universities to create practical partnerships around real world science that improve climate change communication and have research impact.

The particular learning taken from *Antarctic Science Today* reflects the environment in which the project took place; the realities of university impact partnerships which rely on collaboration between researchers working on long term projects and a short term project based engagement professionals. Our experience suggests that the tension between the two can be overcome when a project has clear communication goals and wider objectives. We would, however, highlight the importance of a collaboration based on a broad partnership with the capacity to put in time and resources both before and after the main period of engagement. This challenges some existing working practices but once addressed the organisation can continue to build on effective climate change communication models to broaden reach and impact in the long term.

References

Bentley MJ, Cofaigh CÓ, Anderson, JB, Conway H, Davies B, Graham AGC, Hillenbrand C-D, Hodgson DA, Jamieson SSR, Larter RD, Mackintosh A, Smith JA, Verleyen E, Ackert RP, Bart PJ, Berg S, Brunstein D, Canals M, Colhoun EA, Crosta X, Dickens WA, Domack E, Dowdeswell JA, Dunbar R, Ehrmann W, Evans J, Favier V, Fink D, Fogwill CJ, Glasser NF, Gohl K, Golledge NR, Goodwin I, Gore DB, Greenwood SL, Hall BL, Hall K, Hedding DW, Hein AS, Hocking EP, Jakobsson M, Johnson JS, Jomelli V, Jones RS, Klages JP, Kristoffersen Y, Kuhn G, Leventer A, Licht K, Lilly K, Lindow J, Livingstone SJ, Massé G, McGlone MS, McKay RM, Melles M, Miura H, Mulvaney R, Nel W, Nitsche FO, O'Brien PE, Post AL, Roberts SJ, Saunders KM, Selkirk PM, Simms AR, Spiegel C, Stolldorf TD, Sugden DE, van der Putten N, van Ommen T, Verfaillie D, Vyverman W, Wagner B, White DA, Witus AE, Zwartz D (2009) A community-based geological reconstruction of Antarctic Ice Sheet deglaciation since the Last Glacial Maximum. Quat Sci Rev 100:1–9

Cameron F (2012) Climate change, agencies and the museum and science centre sector. Mus Manage Curatorship 27(4):317–339

Crow D, Boykoff M (eds) (2014) Culture, politics and climate change: how information shapes our common future. Routledge, London

Dulic A, Angel J, Sheppard S (2016) Designing futures: inquiry in climate change communication. Futures 81:54–67

Hamlett E, Norton C, Bailey-Ross C (2015) Magna carta and the changing face of revolt: evaluation report. Palace Green Library, Durham University, Durham

Hansen A, Cox R (eds) (2015) The routledge handbook of environment and communication. Routledge, London

Hebda R (2007) Museums. Climate change and sustainability, museum management and curatorship 22(4):329–336

Johnson BB (2012) Climate change communication: a provocative inquiry into motives, meanings, and means. Risk Anal 32(6):973–991

Kahan D (2014) Making climate-science communication *Evidence*-based: all the way down. In: Crow D, Boykoff M (eds) Culture, politics and climate change: how information shapes our common future. Routledge, London, pp 203–220

Leal Filho W (2009) Communicating climate change: challenges ahead and action needed. Int J Clim Change Strat Manage 1(1):6–18

MacLellan P (2016) Why don't teachers use education research in teaching? Blog entry for Royal Society of Chemistry. http://www.rsc.org/blogs/eic/2016/08/why-dont-teachers-use-education-research-teaching. Accessed 10 Dec 2016

Miles BWJ, Stokes CR, Jamieson SSR (2016) Pan–ice-sheet glacier terminus change in East Antarctica reveals sensitivity of Wilkes Land to sea-ice changes. Sci Adv 2:e1501350

See BH, Gorard S, Siddiqui N (2016) Teachers' use of research evidence in practice: a pilot study of feedback to enhance learning. Educ Res 58(1):56–72

Shepherd AA, Ivins ER, Geruo A, Barletta VB, Bentley MJ, Bettadpur S, Briggs KH, Bromwich DH, Forsberg R, Galin N, Horwath M, Jacobs S, Joughin I, King MA, Lenaerts JTM, Li J, Ligtenberg SRM, Luckman A, Luthcke SB, McMillan M, Meister R, Milne G, Mouginot J, Muir A, Nicolas JP, Paden J, Payne AJ, Pritchard H, Rignot E, Rott H, Sørensen LS, Scambos TA, Scheuchl B, Schrama EJO, Smith B, Sundal AV, van Angelen JH, van de Berg WJ, van den Broeke MR, Vaughan DG, Velicogna I, Wahr J, Whitehouse PL, Wingham DJ, Yi D, Young D, Zwally HJ (2012) A reconciled estimate of ice-sheet mass balance. Science 338:1183–1189

Swartz M, Biddlecombe-Brown J, McCarrison K, Price S, Rossi A, Holden A (2016) Antarctic Science Today: an evaluation. Palace Green Library, Durham University, Durham

Whitehouse PL, Bentley MJ, Milne GA, King MA, Thomas ID (2012) A new glacial isostatic adjustment model for Antarctica: calibrated and tested using observations of relative sea-level change and present-day uplift rates. Geophys J Int 190:1464–1482

Communicating Climate Change in the Greater Manchester Region: A Whole Systems Approach to Change

Judith Emanuel and Carolyn Kagan

1 Introduction

This paper aims to share the knowledge and experience of communicating about climate change gained by Steady State Manchester (SSM) in order to identify strategies that might be used by others. We will do this through analysis of our communication strategy using an ecological public health framework and case studies which illustrate aspects of our work. Our motivation for doing this arises from our public health practice and commitment to bridging the public health and climate change fields.

Johnson (2013) makes the point that climate change campaigns can learn from the hard, costly, time consuming lessons have been learned in public health campaigns, We have worked as public health practitioners and researchers and are aware that Public Health thinking appears to be largely absent amongst key climate change communicators in the Manchester region. We aim to raise public health thinking up the climate change agenda through our critical analysis of our climate change communication strategies.

SSM is a small group of research activists established in November 2012, working at the regional level in north west England (Burton 2016). We are a collective (currently 9 people) with a network of 31 members and many more supporters. Funding is minimal, mainly from membership fees, and there are no paid staff.

SSM understands climate change to be the most serious crisis facing the world, but in line with mainstream approaches to sustainability since the Bruntdland Commission (WECD 1987) understands climate change as part of a wider system which recognises the interconnectedness of economic, social and environmental

J. Emanuel (✉) · C. Kagan
Steady State Manchester, 37, Chandos Road South, Manchester M21 0TH, UK
e-mail: steadystatemanchester@gmail.com

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_26

factors (Meadows et al. 1972). We add cultural factors. At the core of this system is the economy and as the IPCC note (IPCC 2014: 8), economic growth makes the biggest contribution to climate change and environmental degradation. Thus our focus is on envisioning and promoting a viable economy as a vehicle for climate change adaptation and further mitigation; an economy no longer reliant on economic growth and extraction from the natural world. What we call a viable economy is one in which people live *in a world that is viable, rather than one that risks tipping into decline or crisis: that means an economy that is resilient and dynamic, providing enough for all, while supporting social well-being. And it must be ecologically viable, not causing further damage to the earth's fragile systems without which life is not possible*. (Burton et al. 2014: 2)

Communication about climate change, then, is inseparable from communication about a viable economy. Figure 1 shows the way that the economy is embedded in culture and society, which can only exist within the ecosystems of the natural world.

Our communication aim is two fold. Firstly, to engage with decision-makers and the wider public in Greater Manchester and more widely, to raise awareness, and promote the idea of a viable economy in order to encourage a groundswell for change. Secondly, to advocate and support developments that demonstrate elements of a viable future, helping in the transition to a viable economy and thereby growing a shared understanding of what is needed in the way of change.

Our activities focus on the regional level. We realise that whilst Government has an important part to play in leading and legislating on climate change, we can exert relatively little influence at this level. Indeed, it is becoming increasingly clear that

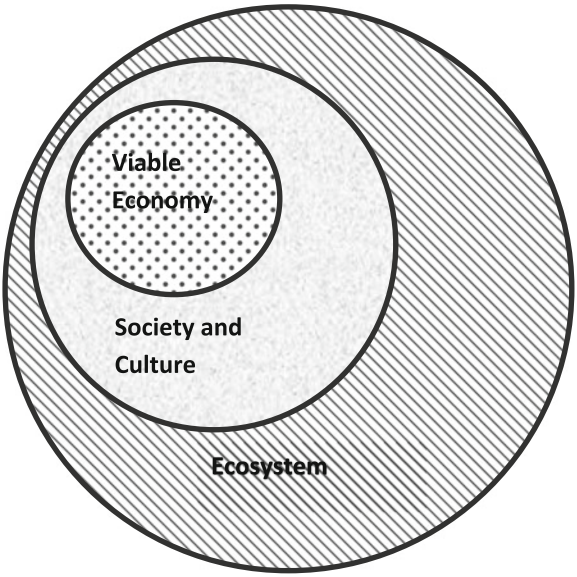


Fig. 1 A Viable economy, society and culture embedded in the ecosystems of the natural world

in many ways, fundamental change is needed at more local levels. As Stears (2016) recognises:

> The old mechanisms of change don't work anymore because in other urgent moments in our past we have looked to the established authorities of Westminster and Whitehall and we have asked for change to emanate from there. …Everything we know about what is going on in our country today, tells us that fundamental change is not going to begin from those places…The primary mechanism for change is working out who out there is rooted in the community, who actually can start this process going now, be it a process of … community economic regeneration… or a newly elected mayor trying to think about pushing the boundaries of the authority that he or she has within that situation. (Stears 2016)

We are all local to the Greater Manchester region, so it is there that we seek to push the boundaries and catalyse change. Furthermore, there is growing recognition of the importance of cities and city regions, for economic and social development, largely due to their being large centres of population under local administrations (Simon 2016). Our work is concerned with identifying who we can best work with, who is or may become allies to our agenda, and endeavour to provide them with any support we can to get viable economy (and steady state) ideas taken on board for a future where everyone in our region can live well, with greater equity and within planetary resources.

2 The Challenge

Our challenge, then, is to communicate the need for and promote social, economic and individual transformations that enable essential climate change adaptation and mitigation. Communication is an essential factor in achieving this, but we do not believe it can be effective if isolated from other crucial factors which contribute to a momentum for change, and, importantly, create the conditions for messages to be heard and acted upon.

We recognise that communication of climate change is notoriously difficult at all levels (Futerra 2005; Markowitz et al. 2014; Shome and Marx 2009). At the time of writing (2016) most people—and certainly decision makers—have had access to information. The enormity of the problem, however, invariably comes across as overwhelming, unpalatable and complex, and people may often feel powerless and unable to act. Furthermore, whilst the *fact* of climate change has been communicated, the *urgency* of adaptation and further mitigation has not. Many listeners, whether they be lay people, professionals, or politicians, do not see it as a priority in relation to competing issues in their lives. Consequently communications are not absorbed, or worse still make people defensive and/or can reinforce denial! The social consensus—or social norm—is to ignore the urgency and importance of climate change and to support the notion of endless economic growth, irrespective of the damage that growth will wreak on the environment.

The good news is that norms do change. Naomi Klein, for example, argues that those of us determined to successfully address climate change can learn from the campaign to abolish slavery in the US in the 19th century (Klein 2015) and the role that the abolitionist movement played in breaking the control that slave owners had over the state. The lesson is that it is necessary to create a mass movement in favour of a different way of living, culturally, socially and economically.

Public health shows us other examples of norms shifting. A recent UK example is reducing smoking. Non-smoking rates almost doubled—from 48% in 1948 to 81% in 2014 (ONS 2016). Over the years there were mass communication campaigns about the dangers of smoking, and these played a part. However, a range of economic, fiscal, political and legal measures, designed a society which supported the non-smoking messages, offering alternatives to people, aids to help them quit smoking and making it easier for them to do so.

We are inspired by public health approaches, and we are seeking to explore the extent to which public health approaches are useful in this very different sphere, in attempts to effect change at a regional level. In the following discussion we use an ecological public health model through which to view our communication and change strategies.

3 Ecological Public Health Framework

Public health focuses on whole populations. It is concerned with challenging or altering mass behaviour, society wide processes and collective experience. It recognises that individuals operate within social frameworks, mediated by groups, which can be lost in more individualistic approaches. We try to integrate these lessons into our approach to communication about climate change. The task is greater than awareness raising or behaviour change. Like the relatively new branch of public health, ecological public health, we see the communication task as *altering accepted reality and common sense,*—changing culture not just behaviour, where culture is *a bundle of tensions and possibilities* (Rayner and Lang 2012: 326, 276).

Some of the key features of an ecological public health approach, shared by SSM are:

- A need to *design* a world where ecological choices are easier choices through a range of whole system measures. This recognises that individuals and groups are located within a wider web of influences, which dramatically affects the amount of control they have to make changes. The design aspect of behaviour change in public health is, perhaps the disciplines most important contribution to transformational change strategies, and there is an urgent need for sustainable frameworks for living to be articulated, designed and championed.
- An holistic or *whole system* perspective that recognises the interconnectedness of economic, social and environmental well-being and does not focus only on internal attitude change.

- A recognition that communication has a symbiotic relationship with a wealth of services and policies, qualities of which contribute to cultural and other norm and system change. This explains the many other factors in addition to communication, including practical measures which can be taken, which create momentum for change and importantly *create the conditions for messages to be heard and acted upon.*
- The encouragement to *embrace complexity*, by analysing and confronting it. A recognition that a long term strategic approach to facilitate journeys, rather than singular acts of change is needed. There are no quick fixes and soft policy options on their own will fail and may even be part of the problem, obfuscating the task (p. 319).
- An understanding of the array of components that will lead to sustainability or lack of sustainability, including: a focus on the interrelationship and dependence of human health (and in our case social and economic justice) on the eco-system (see, for example, Raworth 2012); the need to *integrate* the different dimensions (in our case social, economic, environmental and cultural) in order to recognise and manage conflicts arising from an emphasis on any one of them; an understanding that we live in a constantly changing world and that there are a number of different transitions for change—cultural transformation is one of them, alongside, economic, demographic, urban, energy, ecological, democratic transformations.
- Build knowledge through continual intellectual engagements. This requires more than evidence, including the pursuit of social values, highlighting the role of interest groups and debates, and not just limiting dialogue to restricted scientific circles. Wider thinking about the nature of life, good societies, order and change is needed: in other words, encourage *reflective thinking*.
- Adopt an overtly interdisciplinary and multi actor perspective. Action is required on multiple fronts and change requires the *building of a movement.* Communications thereby serve to facilitate multi level action by state, private spheres, commerce and civil society, building collaborations to drive innovation, grounded in citizen perspectives and adopting co-design, co-creation and co-production approaches (Durose and Richardson 2016) to mitigation activities
- The importance of locating our communications within—people's existing value sets and priorities, starting from what is important to different audiences (Johnson 2013).

The need in climate communication is, therefore, for an ecological public health imagination, which stresses the need for critical thinking and imagining wholesale change and for using opportunities when they emerge. The fire at Kings Cross tube station in 1987 is a public health example of using opportunities when they emerge. It was caused by a discarded cigarette or match. This led to an outcry and inquiry, making the case for changing social norms. The idea that smoking bans impinged on individual liberty, was no longer accepted by the majority of people and a cultural shift was possible, leading eventually to legislation banning smoking in public places.[1]

Altering accepted reality and common sense, changing culture not just behaviour, is, undoubtedly a complex and long term process. Our work acknowledges this complexity and that whilst the work is urgent it is also long term. Our own communication strategy is consistent with an ecological public health perspective.

4 Steady State Manchester and Communicating Climate Change

> How do you change a worldview, an unquestioned ideology? (Klein 2015)

It is clear to SSM that our communication approach has to contribute to the necessary cultural transformation of Naomi Klein's question. Not only must we stimulate the momentum for the necessary change, but we must link our communication with factors which will enable messages to be heard and acted upon.

Everything we do in one way or another is about communication. We agreed an approach to communication in 2014 which aimed to both widen the base of who we engage with and maximise the impact of our communication activities. Essentially we are endeavouring to change a worldview, an unquestioned ideology about economic growth and the exploitation of environmental resources. We seek to enable people to discuss, challenge and develop their ideas and thinking; to help others see that their interests coincide with climate change and a viable economic future; to offer hope and possibilities for living better within planetary boundaries; to share practical ways of doing things differently; to provide critiques of current practices but at the same time offer alternatives. Our communications are directed at decision makers (politicians and those with power to effect change), civil society organisations, academics and the general public, thereby seeking to influence both individuals and organisations.

We communicate in a variety of ways, framing the issues differently and using different channels for different audiences and different purposes, depending on whether we are seeking to introduce new ideas or challenge existing ones; changing how people think and act; helping others see how their interests connect with climate change; offering possibilities for hope and providing solutions not just problems; or sharing practical ways to do things differently.

[1]A fire at London's Kings Cross underground station in 1987 killed 57 people. Smoking had been banned on the trains in 1984 and was then extended to the whole of the Underground system in 1987. The 2006 Health Act banned smoking in public places.

We publish and disseminate reports, articles, working papers and pamphlets. These introduce new ideas and give examples of practical action for change, are available in hard copy, on our website and distributed in meetings or at events.

We use social media to promote the idea of a viable economy and its link with climate change. We maintain a website where we have posted over 220 blog posts and make our publications available. These cover a range of topics relevant to social, economic, environmental and cultural issues. They are designed to introduce new ideas, help others think differently, challenge received wisdom and offer detailed analyses of published research for others to use in their related campaigns. We have, a Facebook page and at the time of writing have made 3920 tweets with 1179 Twitter followers and have 345 subscribers on our mailing list, who receive regular email bulletins. In total we have 2473 followers on social media so our reach is substantial. The majority of people who look at the website are based in the UK; but there is also a significant global following. Through our website we make connections with other organisations and relevant events.

We organise workshops, events and a monthly café conversation,[2] both by ourselves and in partnership with others on a range of issues. These introduce new ideas and enable participants to see that their interests connect with those of the viable economy and climate change; and stimulate people to take action on climate change. We have produced films; go out to organisations to give talks, and present at conferences, locally and internationally.

We work in partnership with a range of organisations and arrange meetings and discussions with politicians and decision makers to discuss issues of concern, introduce new ideas and connect different interests to those of a viable economy.

We contribute to a range of campaigns mounted by other organisations with overlapping agendas. We seek relationships with those activists, academics, environmentalists, think tanks and influencers who share some common concerns in order to support a growing movement towards transformational change.

Underpinning the strategy is recognition that we are a learning organisation (Argyris 1999) with a need to develop our own understanding and skills of influential engagement with others. We hold regular meetings where we continuously review the ever changing context in which we work to form coalitions with others, share information and experiences and draw out the implications of these for our own understanding and activities.

Our strategy is influenced by Freirean methods (Freire 1972) which integrate learning, developing understanding and action. From this perspective, communication is a dialogic process whereby the taken-for-granted can be problemmatised, and as awareness grows, shared solutions and possible actions are articulated.

[2]Informal themed conversations, loosely modelled on the World Café process (Brown and Isaacs 2005).

Such an approach involves experts and lay people learning together, making sense of their world and thereby acting on it, changing it and being changed by it. It is an educational method which has an important contribution to make in transforming culture, as well as the other dimensions of life that need to change if climate change is to be addressed. It involves everyone potentially becoming a critical thinker, where the division between theory and practice (or knowledge and skill) dissolves (SSM 2015).

We create opportunities to network and engage others and to help others connect with each other. When writing a blog about an event, for example, we might interview people who were there to incorporate their perspective or ask a participant to write the blog for us.

We advocate support and promote developments that demonstrate the application of ideas in order to generate shared understanding. As concrete alternatives take shape, we expect they will become more persuasive, more definite and more sophisticated.

The intention of our strategy is to make our communication accessible in terms of language, to build from where people are and create a vision for action by

- Challenging feeling overwhelmed—communicate effective and credible solutions that can cumulate and scale up.
- Talking in relation to people's experience. Focus on the effects of climate change on people's lives, for example that people will need to pay more for dirty fossil fuel and alternatives.
- Appealing to communal values for example health, community development, and having a clean and safe environment.
- Amplifying the voices of affected communities: hear the voices of those directly impacted by climate change and from those implementing solutions at the community level—this will help to highlight how climate solutions can be empowering and could serve to overcome structural barriers.
- Empower people to send their own messages: give people the chance to communicate their own desire for climate solutions.
- Create a vision for action: Where possible, make it easy to understand what needs to happen; something simple that can capture people's imagination and is physical and concrete. An example would be a world powered by 100% renewable energy.
- Incorporate questions at the end of written communications in order to stimulate readers to comment and open up dialogue.

We will give some examples of different communication to illustrate different communication approaches via three examples, each of which involve different methods, messages, partners and audiences. We will critically evaluate some of the communication challenges and the extent to which we may be contributing to cultural transformation in Greater Manchester.

4.1 *Fossil Fuel Divestment: In Which We Carry Out Detailed Research and Use This to Influence the Local State via Political Decision Makers and Catalyse Other Campaigns*

Since its inception, SSM has attempted to influence local politicians. We obtained information about the City Council's banking strategy and investments from a sympathetic local politician responsible for Finance. It became clear that there were substantial investments held in the local government pension fund covering the City and the nine other local authorities in the region.

One channel of influence is via the local Overview and Scrutiny Committees.[3] We participated in the Finance Committee, initially writing to ask them about their ethical investment strategy. We were able to follow this up by attending a meeting to speak to our letter and make suggestions for more ethical choices. A formal response was received to our letter in two parts (a) banking and (b) investments. We attended subsequent meetings, including one to which the Pension Fund senior managers had been invited (a year later).

In between meetings, we wrote blog posts summarising the discussion. In anticipation of the argument that the Pension Fund managers had a duty to get the best financial return from their investments, we prepared a well-researched report focusing on fossil fuels and ethical investments. Our report presented information from a variety of sources, including up to date legal advice on the broad fiduciary duty of trustees, beyond ensuring maximum financial returns and we discussed this at the meeting the Pension Fund attended (see https://steadystatemanchester.net/2015/03/13/greater-manchester-pension-fund-some-positive-moves-but-more-ambition-needed/ for a detailed report of meeting, a link to our report as well as links to the previous discussions on this issue). We were able to question the restrictive interpretation of the duties of the Fund's Trustees, and drew attention to examples of decisions taken by other large local government pension funds about positive investment decisions in favour of renewable energy—all pointing to a broader understanding of ethical investment decisions. The council requested that the Pension Fund review their responsible investment strategy, which at that time did not include environmental and social issues and focused on maximising financial returns. This they did.

About the same time, a Fossil Free Greater Manchester campaign focussing on fossil divestment by the Pension Fund, was initiated by local environmental activists, including prominent members of Friends of the Earth, part of the national coalition of groups campaigning for a Fossil Free UK.[4] SSM became part of this

---

[3]Scrutiny Committees are made up of elected members who act as 'critical friends' to local decision makers. They are able to consider any matters of relevance to residents and make recommendations to decision makers. Their meetings are made public through minutes and videos. Residents may request to speak to matters under consideration.

[4]See http://gofossilfree.org/uk/.

campaign and helped it get off to a flying start as necessary background research had been done. We have worked together on a multi-pronged communication campaign for fossil fuel divestment from the Pension Fund, including direct action, letter writing, open letters to the Pension Fund, report writing, and presenting examples of divestment by other pension funds. We have used multiple message frames, tapping into different fields of meaning for different people at different times (Goffman 1974). Our frames began with ethical investment and went on to include financial risk, and environmental risk and/or benefit. The metaphor of dinosaurs (to evoke a lack of forward thinking), used in a direct action campaign, attracted media attention.

4.2 Promotion of a Sharing Economy Platform in Which We Build a Coalition of Different Stakeholders to Persuade Experimentation with a Scheme for Utilising Excess Assets for Community Good

In common with others, we have identified the nature of the finance and money system in promoting excessive exploitation of material resources and the deleterious consequences of the growth economy and material throughput for social and economic equity (SSM 2012, 2014). A steady state economy implies a more redistributive economy and society serving both climate change mitigation and adaptation. One way to connect redistribution with the reduction of material throughput is to make use of and share out the under-utilised, wasted resources of the hyper-abundant city economy.

We drew on our networks to identify people who had either worked on alternative financial institutions or were interested in exploring, in a practical way, the development of the sharing economy. We formed a steering committee for the project. This was a communication challenge: stimulating interest, identifying the points at which the proposed project idea fitted with each person's existing interests, and persuading them of the advantages of becoming involved, even before there was any practical realisation of initial ideas. Our steering committee was made up of a range of different stakeholders, including: the director of a third sector support organisation in the city, the person responsible for implementing a successful timebanking project in the city, the local credit union, a commercial ethical investment manager, a local politician with an interest in the sharing economy, a researcher from a local economic think tank who had been involved in research on the Brixton and Bristol Pounds, an academic with an interest in alternative finance and members of SSM. The group decided to explore setting up a viable, non-monetary exchange project thorough which spare local resources would be linked with people participating in and contributing to their local communities, supported by an online platform. A small grant application was made to support some development work, which entailed concisely describing the project, in writing. The major communication challenge then become one of stimulating interest and persuading organisations with surplus resources as well as community organisations of the potential benefits of such a scheme, and to illustrate how the proposed scheme built on their strengths and enhanced their local profiles (see for a rationale for such a project, https://steadystatemanchester.net/?s=sharing+platform).

To do this we established meetings with key people in relevant local organisations, and then introduced the project, framing the benefits that involvement might bring, in a variety of ways, fitting the message to the audience. This included stressing the benefits in terms of corporate social responsibility; community service and low cost access to goods and services.

At the time of writing, interest in the idea is growing. In one locality a similar project is about to begin, as a result of our input although utilising a commercial platform, and there is a possibility that a pilot project in another locality will start.

The task of awareness raising, encouraging others to think differently and persuading other potential partners continues and we continue to play a part in communicating the possibilities of a sharing economy that contributes to better use of spare resources and decreases the need for endless consumption and the ways in which this contributes to climate change adaptations and mitigation.

4.3 Café Conversation: In Which People Come Together to Explore Tactics for Climate Change Communication Through a Dialogic Approach

Our monthly Café Conversations are carefully planned. We publicise them on the SSM website, to the SSM mailing list and social media. We prepare an introduction or set of provocations at the start of the event along with some focused questions for groups to consider. At the event itself, groups either move around in World Café style (Brown and Isaacs 2005) between tables, or they consider each of the questions with the same group of people. The process involves participants collectively identifying the most important, inspirational or innovative points to emerge from their discussions. These ideas are then 'harvested' and shared with all participants. A closing summary of the overall set of discussions is made by the event facilitator and next steps identified as relevant, encouraging participants and others to suggest topics for further conversations. Feedback from participants has been very positive.

One café conversation held in October 2016 gives a taste of what they are like in practice. The theme for the event was '*Climate change is an emergency: what do we know about the best way of influencing decision makers*?'

We were keen to involve agencies in Greater Manchester which have a key role communicating about climate change and through their networks we were successful in attracting 25 people, one third of whom were attending a Café Conversation for the first time.

Two brief provocations from SSM collective members outlined the scale of the emergency. These suggested that (a) the problem of creating momentum for the necessary change may not only be a communication issue; and (b) that we can learn a lot from public health and other campaigns.

Participants energetically engaged with these provocations and stimuli and identified a wide range of scenarios, positive and negative that we can learn more from, including a range of possibilities for influencing decision makers to address climate change. These included:

- tactics used by successful lobbyists including the oil, gas and fracking industries;
- making the change an easier choice through a combination of contextual changes;
- developing a greater understanding of legislation-driven change has been achieved;
- understanding and seeing the humanity in others and appealing to what is important to them;
- the younger generation can be very influential;
- the potential of local authorities for leading change;
- the importance of engaging the media in addressing misinformation and supporting both climate change mitigation and adaptation;
- understanding that some changes are controversial
- realising that social pressure can catalyse action
- the importance of having a vision of what living well with adaptation and within planetary resources might look like—and involving a wide range of people in creating the visions.

Further dissemination of the conversation was done through a blog post (Emanuel 2016). This café conversation was successful in terms of helping people make connections between the environment and the economy, introducing new ideas and stimulating shared learning.

5 Conclusion

This chapter has outlined the work of SSM in communicating climate change with reference to three illustrative case studies of our work. We have introduced an ecological public health framework and suggested it is a useful framework for guiding climate change communication. Communicating climate change and ecological public health are concerned with '*altering accepted reality and commonsense*'. The framework as a whole can be adopted by others but it should be borne in mind that the potential for success is context specific. Our criteria for success lie not only in the number of people we reach, but also in the interest shown and adoption of ideas in other people's work. As (Blackman 2006) rightly points out, demonstrating the impact for any long term approaches embracing complexity, is a challenge in itself.

Indeed, as we have suggested, the task of communicating climate change at a City Regional level is complex and multi-faceted. We have argued that lessons can be learnt from public health in relation to cultural and behaviour change and that ecological public health offers us a some pointers to effective communication strategies. In SSM we follow the ecological public health framework in our varied communications, arguing for a viable economy approach to climate change: one that takes a whole systems approach and that understands the interconnections between the economy, the environment, culture and society. Our communication strategy sets out to communicate climate change in its totality; mitigating the effects of climate change and adapting to the changes in climate that are already with us.

We realise that many climate decisions must be taken at national and international levels. Nevertheless, the regional level is a useful level at which to pursue policies and practices that support a viable economic future within planetary boundaries. We have given some examples of complex communication approaches, and the importance of critical, continual reflection on their impact, in order to adapt and modify them. We have outlined, above, some of the lessons from ecological public health communication that we endeavour to take on board. Other lessons, from our own experiences include:

- Understanding the complexity of the context in which climate change is taking places and messages about it are either not heard or acted upon.
- Importantly, a regional communication strategy must take into account that there are few opportunities in the national and international landscape to progress an agenda of hope, but at a regional level this is possible.
- There are no easy, short term results to be gained. Climate change communication, and the necessary policy and practice change is a long term task.
- Struggle to get the messages across, and most importantly heard and acted upon, is inevitable.
- Communication about climate change, its mitigation and adaptation is part of a wider transformational change project that is needed to design a society which truly addresses climate change. Thereafter communication is needed to promote this design.
- It is important to seek out opportunities to enable people to make sense of what is happening in their lives in order to enable these cultural shifts.
- Communication in narrow channels will be ineffective, and part of the communication about climate change lies in forging alliances with others and becoming part of a social movement for change.

Indeed, along with Lang and Rayner (2012) we suggest the need to "*be noisy and build alliances…to be change agents building and supporting movements*" and not assume that change will come from our communications alone.

References

Argyris C (1999) On organisational learning, 2nd edn. Blackwell, Oxford
Blackman T (2006) Placing health, neighbourhood renewal, health improvement and complexity. Policy Press, Bristol, England
Brown J, Isaacs D (2005) The world café: shaping our futures thought conversations that matter. Berret-Koehler, Oakland, CA. http://www.theworldcafe.com. Accessed 27 Oct 2016
Burton MH (2016) Intervening at the regional level: building momentum for another possible regional economy: opportunities and traps. Paper presented at 5th international degrowth conference, Budapest. http://www.academia.edu/28426063/Intervening_at_the_regional_level. Accessed 14 Nov 2016
Burton M, Irvine B, Emanuel J, Barnes M (2014) The viable economy Steady State Manchester, Manchester. www.steadystatemanchester.net. Accessed 22 Nov 2016
Durose C, Richardson L (2016) Designing public policy for co-production: theory, practice and change. Policy Press/University of Chicago Press, Bristol
Emanuel J (2016) Lively café conversation. Steady State Manchester, Manchester. https://steadystatemanchester.net/2016/10/28/lively-cafe-conversation/. Accessed 1 Dec 2016
Freire P (1972) Pedagogy of the oppressed. Penguin, Harmondsworth, England
Futerra (2005) The rules of the game: principles of climate change communications. Futerra Sustainability Communications Ltd, London http://www.stuffit.org/carbon/pdf-research/behaviourchange/ccc-rulesofthegame.pdf. Accessed 14 November 2016
Goffman E (1974) Frame analysis. Harper and Row, New York. http://is.muni.cz/el/1423/podzim2013/SOC571E/um/E.Goffman-FrameAnalysis.pdf . Accessed 28 Nov 2016
IPCC (2014) Summary for policymakers. In climate change, mitigation of climate change. Contribution of working group to the fifth assessment report of the intergovernmental panel on climate change. Cambridge University Press, Cambridge. http://report.mitigation2014.org/spm/ipcc_wg3_ar5_summary-for-policymakers_approved.pdf. Accessed 21 Nov 2016
Johnson S (2013) Communicating sustainability: lessons from public health. https://greenallianceblog.org.uk/2013/04/02/communicating-sustainability-lessons-from-public-health/. Accessed 12 Nov 2016
Klein N (2015) This changes everything: capitalism versus the climate. Penguin, London
Lang T, Rayner G (2012) Ecological public health: the 21st century's big idea? Br Med J 345: e5466. www.bmj.com/content/345/bmj.e5466. Accessed 15 Oct 2016
Markowitz E, Hodge C, Harp G (2014) Connecting on climate: a guide to effective climate change communication. Center for Research on Environmental Decisions and eco America, Washington DC
Meadows D, Meadows D, Randers J, Behrens III W (1972) The limits to growth. Club of Rome: Universe Books. Available at http://www.donellameadows.org/wp-content/userfiles/Limits-to-Growth-digital-scan-version.pdf. Accessed 21 Nov 2016
ONS (2016) Adult smoking habits in Great Britain: 2014. Office National Statistics, London. http://www.ons.gov.uk/peoplepopulationandcommunity/healthandsocialcare/healthandlifeexpectancies/bulletins/adultsmokinghabitsingreatbritain/2014. Accessed 30 Nov 2016
Rayner G, Lang T (2012) Ecological public health: reshaping the conditions for good health. Routledge, Abingdon, England
Raworth K (2012) A safe and just space for humanity: can we live within the doughnut? Oxfam Discussion Papers. https://www.oxfam.org/sites/www.oxfam.org/files/file_attachments/dp-a-safe-and-just-space-for-humanity-130212-en_5.pdf. Accessed 17 Nov 2016
Shome D, Marx S (2009) The psychology of climate change communication: a guide for scientists, journalists, educators, political aides and the interested public. Center for Research on Environmental Decisions, New York. https://www.cred.columbia.edu/guide. Accessed 2 Nov 2016

Simon D (ed) (2016) Rethinking sustainable cities: accessible, green and fair. Policy Press, Bristol. Open access: https://oapen.org/search?identifier=613676. Accessed on 29 Sept 2016

SSM (2012) In place of growth. Steady State Manchester, Manchester. https://steadystatemanchester.files.wordpress.com/2012/11/inplaceofgrowth_ipog_-content_final.pdf. Accessed 28 Nov 2016

SSM (2014) The viable economy. Steady State Manchester, Manchester. https://steadystatemanchester.files.wordpress.com/2014/11/the-viable-economy-master-document-v4-final.pdf. Accessed 8 Dec 2016

SSM (2015) How can education help to shape a steady state culture? A discussion paper. https://steadystatemanchester.net/2015/11/18/how-can-education-help-to-shape-a-steady-state-culture-a-discussion-paper/. Accessed 11 Nov 2016

Stears M (2016) Speech at New Economics Foundation's relaunch event, London, October 2016. http://neweconomics.org/building-an-economy-where-people-really-take-control/. Accessed 12 Nov 2016

WCED (1987) Our common future. World commission on environment and development. Oxford University Press, Oxford

Author Biographies

Judith Emanuel has a BA (Hons) in Social Anthropology from Sussex University, England and an M.Sc. in Community Medicine from Manchester University, England. She has retired from a Public Health career within the UK National Health Service, in Zambia and at Manchester and Salford Universities with a focus on community and organisational development. She is now an activist in Steady State Manchester and her local community.

Professor Carolyn Kagan holds an Emerita Chair in Community Social Psychology at Manchester Metropolitan University, where she was the Director of the Research Institute for Health and Social Change, and a member of Steady State Manchester. Throughout her career she has worked on action research projects in community settings, in pursuit of greater social justice, health and wellbeing, with those marginalised by the social system. Much of Carolyn's work is action oriented, addressing sustainable communities, and complexity in community and human service systems. Her work is collaborative and interdisciplinary and she has promoted a situational model of communication that has self awareness and reflexivity at its core. She is founding editor of the journal Community, Work and Family and a co-author of the groundbreaking text, Critical Community Psychology.

Erratum to: Climate Change Communication in Nepal

Anup K. C.

Erratum to:
Chapter "Climate Change Communication in Nepal" in: W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*, Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_2

The original version of the book was inadvertently published without changing the author name from "K. C. Anup" to "Anup K. C." in the chapter "Climate Change Communication in Nepal", which has been now changed.

The updated online version of this chapter can be found at
https://doi.org/10.1007/978-3-319-70066-3_2

W. Leal Filho et al. (eds.), *Handbook of Climate Change Communication: Vol. 2*,
Climate Change Management, https://doi.org/10.1007/978-3-319-70066-3_27