Springer Climate

Silvia Serrao-Neumann
Anne Coudrain
Liese Coulter *Editors*

Communicating Climate Change Information for Decision-Making

Springer

Springer Climate

Series editor

Prof. John Dodson, Institute of Earth Environment, Chinese Academy of Sciences, Xi'an 710061 Shaanxi, China

Springer Climate is an interdisciplinary book series dedicated to climate research. This includes climatology, climate change impacts, climate change management, climate change policy, regional climate studies, climate monitoring and modeling, palaeoclimatology etc. The series publishes high quality research for scientists, researchers, students and policy makers. An author/editor questionnaire, instructions for authors and a book proposal form can be obtained from the Publisher, Dr. Michael Leuchner (michael.leuchner@springer.com).

More information about this series at http://www.springer.com/series/11741

Silvia Serrao-Neumann · Anne Coudrain
Liese Coulter
Editors

Communicating Climate Change Information for Decision-Making

Springer

Editors
Silvia Serrao-Neumann
Faculty of Arts and Social Sciences
The University of Waikato
Hamilton
New Zealand

and

Cities Research Institute
Griffith University
Brisbane, QLD
Australia

Anne Coudrain
Unité de recherche ESPACE-DEV
IRD, Universités UM UR UG UA,
Maison Teledetect
Montpellier
France

Liese Coulter
Cities Research Institute
Griffith University
Brisbane, QLD
Australia

ISSN 2352-0698 ISSN 2352-0701 (electronic)
Springer Climate
ISBN 978-3-319-74668-5 ISBN 978-3-319-74669-2 (eBook)
https://doi.org/10.1007/978-3-319-74669-2

Library of Congress Control Number: 2018930125

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

As we embarked upon the preparation of this edited book, many events unfolded with implications for global climate change response. In particular, 2015 was considered a tipping year for humanity to tackle climate change. There were many initiatives converging to make the Paris Climate Agreement accepted. In the end, all the countries that signed the Agreement realized that if they were to go ahead and follow their individual modernization plans, this planet simply would not have been big enough. And then it came 2017, with spiraling international insurgence of conservative and protectionist aspirations. One could ask whether 2017 is the reverse tipping point year. Or is it a year that illustrates how climate change entangled itself in the period of Great Regression in which we live?

In his preface for the book entitled "The Great Regression", Geiselberger[1] asks: "How have we ended up in this situation? Where will we be in five, ten or twenty years' time? How can we stop the global regression and achieve a turnaround?" The reality is that despite the amount of information on climate change, there continues to be a denial of accepting it, and some now frame this denial not in terms of whether climate change is real, but in their ability to adjust economic development in the short term. For example, in one of his earlier tweets, President Trump said that "The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive."[2] This statement raises doubts as to whether the origin of the current USA decision to withdraw from the Paris Agreement lies in the lack of conviction that climate change exists, and recasts the focus of policies on domestic as opposed to global benefits.

[1] Geiselberger, H (2017) Preface. In *The Great Regression*, Ed. Geiselberger H, Wiley, pp. 7–15. http://www.thegreatregression.eu/preface-of-the-editor/.

[2] Trump, D [realDonaldTrump]. (11:15 AM—6 Nov 2012) The concept of global warming was created by and for the Chinese in order to make U.S. manufacturing non-competitive. [Tweet]. https://twitter.com/realDonaldTrump/status/265895292191248385.

It is a situation well illustrated by Latour[3] in the metaphor of the Titanic: "enlightened people can see the iceberg heading straight for the prow, know that shipwreck is inevitable, grab the lifeboats, and ask the orchestra to play enough lullabies so that they can make a clean getaway under the cover of night before the alarming list of the vessel alerts the other classes! (…) if they want to survive in comfort, they shouldn't seem to be pretending that they share their space with the rest of the world." Hence, efforts to develop and communicate climate change information to guide decisions and support proactive adaptation and mitigation strategies cannot ignore the concerns of parties which deny the information for their own short-term, self-interested benefits.

Deliberately declining to accept information about climate change clearly appears to be an expression of selfishness and self-centered interest for organizations, countries, sectors, and communities. It is a question of extracting oneself from the burden of solidarity in the face of a future that is frightening: not enough resources to maintain the resource-intensive lifestyles promoted by the developed world throughout the twentieth century for all in the twenty-first century and beyond. However, projections suggest that world population could peak by the middle of this century, reaching around 8.6 billion people and then declining to 6.9 billion by the end of the century.[4] Nonetheless, total world population size trajectories between now and the end of the twenty-first century depend on educational and health investments, especially for women—as explicitly highlighted by the solidarity sustainable development goal adopted by the United Nations in 2015.

As argued by Pottier[5] (2016), there are different reasons as to why mainstream economic discourse sets itself apart from reality and largely minimizes the severity of climate change impacts. Economists are well aware that models based on a conception of human being as *Homo economicus* and on a society that can be stabilized by markets are false, yet they continue to use them in the absence of a better economic paradigm. The cost-benefit analysis of climate change is proving to be a triple trap as it gives an innocuous image of climate change, masks uncertainties through the illusion of knowledge, and drives the assessment of climate change in endless controversies, in which the economist holds the upper hand.

While on June 1 2017, President Trump acknowledged that the USA was pulling out from the Paris Agreement, during the G20 Summit held in Hamburg on July 7–8 of the same year the other 19 parties (European Union plus 18 countries) reaffirmed their commitment to the Agreement. This reaffirmation was supported by a number of American States (despite the lack of commitment to the Agreement from their Federal Government) and major corporations, including oil companies. These latest developments do not make it useless to continue to produce and

[3]Latour, B (2017) L'Europe refuge in L'âge de la régression, dirigé par Heinrich Geiselberger, Ed. Premier Parallèle, Paris, pp. 115–126.

[4]KC S, Lutz W (2017) The human core of the shared socioeconomic pathways: Population scenarios by age, sex and level of education for all countries to 2100. Global Environmental Change 42:181–192. https://doi.org/10.1016/j.gloenvcha.2014.06.004.

[5]Pottier A (2016) Comment les économistes réchauffent la planète. Anthropocène Seuil, France.

communicate climate change information. More than ever, these changes reinforce the need for credible information and examples of how such information can liberate us from the traps of economic and short-sited discourses and project us into a future of solidarity and respect for one another.

Montpellier, France — Anne Coudrain
Brisbane, Australia — Silvia Serrao-Neumann
Brisbane, Australia — Liese Coulter
August 2017

Contents

Part I Developing Climate Change Information

1 Science and Knowledge Production for Climate Change Adaptation: Challenges and Opportunities 3
Silvia Serrao-Neumann and Anne Coudrain

2 Science and Evidence-Based Climate Change Policy: Collaborative Approaches to Improve the Science–Policy Interface 13
Edward A. Morgan and Gabriela Marques Di Giulio

3 Conceptual Analysis of Climate Change in the Light of Society-Environment Relationships: Observatories Closer to Both Systems and Societies 29
Mireille Fargette, Maud Loireau, Nabil Ben Khatra, Habiba Khiari and Thérèse Libourel

4 Rethinking IPCC Expertise from a Multi-actor Perspective 49
Maud H. Devès, Michel Lang, Paul-Henri Bourrelier and François Valérian

5 Computational Constraint Models for Decision Support and Holistic Solution Design 65
Carmen Gervet

Part II Communicating Climate Change Information

6 Uncertainty and Future Planning: The Use of Scenario Planning for Climate Change Adaptation Planning and Decision 79
Silvia Serrao-Neumann and Darryl Low Choy

7 Future Climate Narratives: Combining Personal and Professional Knowledge to Adapt to Climate Change 91
Liese Coulter

8 Integrating Research and Practice in Emerging Climate Services—Lessons from Other Transdisciplinary Dialogues 105
Susanne Schuck-Zöller, Carina Brinkmann and Simone Rödder

9 Communicating Climate Information: Traveling Through the Decision-Making Process 119
Ghislain Dubois, Femke Stoverinck and Bas Amelung

10 Transforming Climate Change Policymaking: From Informing to Empowering the Local Community 139
Michael Howes

11 Resilience and Vulnerability Assessment as the Basis for Adaptation Dialogue in Information-Poor Environments: A Cambodian Example 149
Chris Jacobson, Stacy Crevello, Chanseng Nguon and Chanthan Chea

Part III Applying Climate Change Information: Case Studies

12 Scalable Interactive Platform for Geographic Evaluation of Sea-Level Rise Impact Combining High-Performance Computing and WebGIS Client 163
Agnès Tellez-Arenas, Robin Quique, Faïza Boulahya, Gonéri Le Cozannet, François Paris, Sylvestre Le Roy, Fabrice Dupros and François Robida

13 Coral Reef Monitoring Coping with Climate Change, Toward a Socio-ecological System Perspective 177
Gilbert David and Jean-Pascal Quod

14 The Experience of the Brazilian Climate and Health Observatory: Seeking Interaction Between Organizations and Civil Society 191
Renata Gracie, Diego Ricardo Xavier, Sandra de Souza Hacon, Vanderlei Matos, Heglaucio da Silva Barros, Maria de Fátima de Pina and Christovam Barcellos

Part IV Conclusion

15 Informing Decisions with Climate Change Information 207
Liese Coulter and Anne Coudrain

Index 217

Editors and Contributors

About the Editors

Silvia Serrao-Neumann is a Senior Lecturer at The University of Waikato, New Zealand, and Adjunct Research Fellow at the Cities Research Institute, Griffith University, Australia. Her research focuses on climate change adaptation from multiple perspectives, including: catchment scale landscape planning for water-sensitive city regions; cross-border planning and collaboration; disaster recovery under a stakeholder-focused collaborative panning approach; natural resource management; and action/intervention research applied to planning for climate change adaptation.

Anne Coudrain is an Engineer in water sciences (Ph.D.—Paris School of Mines) and a Doctor of Sciences and Auditor of the "Institut des Hautes Etudes pour la Science et la Technologie." She is currently Honorary Research Director at the research unit ESPACE-DEV in the science societies field on climate change. Beginning her career in 1980 at the National Mining Industry Company in Mauritania, she researched the safety analysis of underground nuclear waste repositories, and the relationships between hydrosphere and climate, before becoming involved in managing research for development.

Liese Coulter is a Lecturer in Science, Technology, and Society at Griffith University. Her research focuses on how climate knowledge is used to envision, communicate, and manage environmental and social issues associated with climate change. Previously, Liese was Communication Manager for the CSIRO Climate Change Adaptation Flagship, and the National Climate Change Adaptation Research Facility (NCCARF).

Contributors

Bas Amelung Chair Group Environmental Systems Analysis, Wageningen University, Wageningen, The Netherlands

Christovam Barcellos Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Nabil Ben Khatra Observatoire du Sahara et du Sahel—OSS, Tunis, Tunisia

Faïza Boulahya BRGM Bureau de recherches géologiques et minières, Orléans, France

Paul-Henri Bourrelier Association Française de Prévention des Catastrophes Naturelles (AFPCN), Scientific Committee, Paris, France

Carina Brinkmann Climate Service Center Germany, Helmholtz-Zentrum Geesthacht, Hamburg, Germany

Chanthan Chea United Nations Food and Agriculture Organisation, Phnom Penh, Cambodia

Anne Coudrain Unité de recherche ESPACE-DEV, IRD, Universités UM UR UG UA, Maison Teledetect, Montpellier, France

Liese Coulter Cities Research Institute, Griffith University, Brisbane, QLD, Australia

Gonéri Le Cozannet BRGM Bureau de recherches géologiques et minières, Orléans, France

Stacy Crevello United Nations Food and Agriculture Organisation, Phnom Penh, Cambodia

Heglaucio da Silva Barros Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Maria de Fátima de Pina Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Sandra de Souza Hacon National School of Public Health (ENSP/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Gabriela Marques Di Giulio Departamento de Saúde Ambiental, Faculdade de Saúde Pública, São Paulo, SP, Brazil

Gilbert David IRD, UMR ESPACE-DEV, Maison de la télédétection, Montpellier, France

Maud H. Devès Institut de Physique du Globe de Paris, CNRS UMR 7154 & Centre de recherche Psychanalyse Médecine et Société, CNRS EA 3522, Université Paris Diderot - Sorbonne Paris Cité, Paris, France; Association Française de Prévention des Catastrophes Naturelles (AFPCN), Scientific Committee, Paris, France

Ghislain Dubois TEC Conseil, Marseille, France

Fabrice Dupros BRGM Bureau de recherches géologiques et minières, Orléans, France

Mireille Fargette IRD, UMR ESPACE-DEV, Montpellier, France

Carmen Gervet Research Unit ESPACE-DEV, University of Montpellier, Montpellier, France

Renata Gracie Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Michael Howes Griffith University, Gold Coast, Australia

Chris Jacobson Sustainability Research Centre, University of the Sunshine Coast, Sippy Downs, Australia

Habiba Khiari Observatoire du Sahara et du Sahel—OSS, Tunis, Tunisia

Michel Lang Unité de recherche Hydrologie-Hydraulique, Irstea, Centre de Lyon-Villeurbanne, Villeurbanne, France; Association Française de Prévention des Catastrophes Naturelles (AFPCN), Scientific Committee, Paris, France

Thérèse Libourel Université Montpellier, UMR ESPACE-DEV, Montpellier, France

Maud Loireau IRD, UMR ESPACE-DEV, Montpellier, France

Darryl Low Choy Cities Research Institute, Griffith University, Brisbane, QLD, Australia

Vanderlei Matos Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Edward A. Morgan Cities Research Institute, Griffith University, Brisbane, QLD, Australia; Climate Change Response Program, Griffith University, Gold Coast, Australia

Chanseng Nguon University of Battambang, Battambang, Cambodia

François Paris BRGM Bureau de recherches géologiques et minières, Orléans, France

Robin Quique BRGM Bureau de recherches géologiques et minières, Orléans, France

Jean-Pascal Quod ARVAM/PARETO, Technopole de la Réunion, Sainte-Clotilde La Réunion, France

François Robida BRGM Bureau de recherches géologiques et minières, Orléans, France

Simone Rödder Institute of Sociology, Department of Social Sciences, Faculty of Business, Economics and Social Sciences, University of Hamburg, Hamburg, Germany

Sylvestre Le Roy BRGM Bureau de recherches géologiques et minières, Orléans, France

Susanne Schuck-Zöller Climate Service Center Germany, Helmholtz-Zentrum Geesthacht, Hamburg, Germany

Silvia Serrao-Neumann Faculty of Arts and Social Sciences, The University of Waikato, Hamilton, New Zealand; Cities Research Institute, Griffith University, Brisbane, QLD, Australia

Femke Stoverinck Chair Group Environmental Systems Analysis, Wageningen University, Wageningen, The Netherlands

Agnès Tellez-Arenas BRGM Bureau de recherches géologiques et minières, Orléans, France

François Valérian Conseil Général de l'Economie, CNAM, LabEx ReFi, Paris, France; Association Française de Prévention des Catastrophes Naturelles (AFPCN), Scientific Committee, Paris, France

Diego Ricardo Xavier Institute of Health Communication and Information, Oswaldo Cruz Foundation, (ICICT/Fiocruz), Manguinhos, Rio de Janeiro, RJ, Brazil

Part I
Developing Climate Change Information

Chapter 1
Science and Knowledge Production for Climate Change Adaptation: Challenges and Opportunities

Silvia Serrao-Neumann and Anne Coudrain

After more than two decades of consistent messages emanating from the scientific community that the climate is changing, there is now recognized urgency for both climate change mitigation and adaptation. Addressing climate change is not a straightforward task with the International Panel on Climate Change calling for substantial and widespread transformational change (IPCC 2014). To enable such transformational change there needs to be significant advances in scientific, political, and social practice (Gillard et al. 2016). At the center of advancements lies the role of interdisciplinary research, including interactions between scientists and citizens or representatives of entities at risk (cities, ocean, biodiversity, climate).

One could argue that the climate change challenge offers one of the greatest opportunities for interdisciplinary research and inherent knowledge production to establish itself as an instrumental and fundamental form of research. Its role might not only apply to how it can generate new and more accurate science but also how it can contribute to the application of scientific, and other forms of, knowledge in providing much-needed responses to complex challenges such as climate change threats (Robertson et al. 2017; Obermeister 2017). In fact, embarking upon interdisciplinary research to address climate change threats is seen as researchers' responsibility to increase the usability and applicability of scientific knowledge outside the academic realm (Moser 2010).

S. Serrao-Neumann (✉)
Faculty of Arts and Social Sciences, The University of Waikato,
Private Bag 3105, Hamilton 3240, New Zealand
e-mail: s.neumann@waikato.ac.nz

S. Serrao-Neumann
Cities Research Institute, Griffith University, Brisbane, QLD, Australia

A. Coudrain
Unité de recherche ESPACE-DEV, IRD, Universités UM UR UG UA,
Maison Teledetect, 500 Rue Jean Francois Breton, 34093 Montpellier 5, France

S. Serrao-Neumann et al. (eds.), *Communicating Climate Change Information for Decision-Making*, Springer Climate, https://doi.org/10.1007/978-3-319-74669-2_1

To maximize the applicability and usability of scientific knowledge for addressing climate change, partnerships need to be established between end users (policy makers, decision-makers, practitioners) and scientists (Mastrandrea et al. 2010; Dilling and Lemos 2011). It is a critical time for researchers to make their research and inherent scientific outputs more readily available to end users. Equally important, however, is how these outputs are communicated. Proactive action to deal with climate change cannot only be expected from decision-makers, it has also to start with climate change knowledge production and communication. Thus, researchers must also seek to transform how they produce and communicate climate change information.

This book explores many challenges and opportunities inherent in science and knowledge production and application for climate change adaptation and mitigation. In particular, it builds on the assumption that there is significant progress in knowledge generation about climate change, but such progress is largely represented by individual, or more aligned disciplines. Additionally, despite the availability of such knowledge, there has been relatively slow progress toward addressing climate change challenges at the political and policy implementation levels. Hence, the book offers a reflection and some insights as to how to increase the application of existing and new generated knowledge about climate change in practice.

To this end, the book compiles thirteen chapters to provide a snapshot of how climate change information is generated, communicated, and applied. Contributions come from different projects, continents, and countries, therefore providing a rich suite of both quantitative and qualitative perspectives.

1.1 Two Evolving Fields: Interdisciplinary Research and Climate Change Science

Addressing the challenges posed by climate change requires knowledge, but knowledge generation and applicability are not divested of power relations (Hagemeier-Klose et al. 2014; Klenk and Meehan 2015). There are power relations that assume some forms of climate knowledge are more relevant than others. For example, there are uneven grounds and acceptability concerning knowledge production involving natural, technological, and social sciences (Holm et al. 2013), and prioritization of scientific knowledge over other forms of knowledge such as indigenous knowledge (Obermeister 2017; Kagle and Baptiste 2017). There are power relations that influence the type and extent of scientific knowledge used in decision-making. In particular, proactive decision-making has been hindered by an assumption that available climate change knowledge is too uncertain to be taken into consideration (Quay 2010). There are also power relations in framing policy-relevant knowledge. For instance, while the International Panel on Climate Change (IPCC) consolidated the need for climate change-related research

undertaken through interdisciplinary approaches, it placed substantial focus on earth system science research in the first assessment reports and is now shifting its focus to solutions to climate change impacts such as development pathways (Spencer and Lane 2017).

Discussions about the need for knowledge integration emerged in the early 1970s. Erich Jantsch's work is often identified to be a seminal piece in the field, calling for a systems approach to science, education, and innovation to understand the society—environment interface (Jantsch 1972). While more than forty years old, Jantsch's call is more contemporary than ever when climate change and the role of anthropogenic activity in it are at stake. Hence, there is a need for shared understanding to take place to enable the decoding of society–environment system complexity (Stock and Burton 2011).

The manner through which knowledge integration occurs ranges from being multidisciplinary, interdisciplinary, or transdisciplinary. Definitions and interpretations of those terms vary widely and continue to evolve as multidisciplinarity, interdisciplinarity, and transdisciplinarity are pursued and implemented in research, education, and practice (Stock and Burton 2011).

The top two forms of research seeking knowledge integration comprise interdisciplinarity and transdisciplinarity. The first focuses on addressing 'real problems' through bridging disciplinary viewpoints and collaboration from the outset of research problem framing, data collection and analysis. The second expands the collaborative effort to reach out to include nonacademic participants—that is, policy makers, practitioners, community members (Stock and Burton 2011).

However, as an evolving endeavor, knowledge integration through interdisciplinary and/or transdisciplinary research is confronted with several challenges. Perhaps, the most recurrent is the difficulty in breaking down discipline silos concerning disciplinary languages and terminologies and methodologies. Extrinsic to knowledge integration, epistemological challenges are barriers related to how it is supported, or not, within research institutions, academic peers, and funding opportunities (Milman et al. 2017). Hence, knowledge integration for the purpose of improving the understanding of complex problems to enable the generation of solutions is not straightforward (Stock and Burton 2011).

There has been a significant increase in climate change-related research across both natural and social sciences over the last decade, especially within natural sciences. Scholars point to the role of IPCC's assessment reports in influencing not only the amount but also the type of climate change-related research since its inception in the early 1990s (Vasileiadou et al. 2011). Notably, with time, this research has also become more interdisciplinary and transdisciplinary, requiring an application context for its broader evolution (Hellsten and Leydesdorff 2016). There is also reference to the IPCC's role in placing climate change at the center of policy agendas (Vasileiadou et al. 2011). In particular, more recent assessment reports highlighted the need for seeking adaptation in addition to mitigation and called for institutional and technological change as well as alternative adaptation pathways to enable system transition (Rothman et al. 2014).

Despite the amount of climate change information available, uptake by decision-makers has been patchy. Several reasons have been identified to explain the relative low usability and applicability of climate science in decision-making processes. These include institutional and organizational factors and intrinsic individual accounts of climate change such as beliefs and values. It also includes aspects relating to the knowledge generation process with calls for greater interaction between knowledge producers and knowledge users to shift from useful information to usable information (Lemos et al. 2012). To overcome this situation, new models of knowledge production underpinned by transdisciplinarity are being advocated such as the Mode 2 model and postnormal science. In particular, these models treat knowledge as complex in nature which in turn shapes how it is organized and coproduced as well as communicated, disseminated, and used. They also accept that science uncertainty is unavoidable hence the need to engage with stakeholders from the problem definition stage through to data collection and analyses and the development of usable information (Kirchhoff et al. 2013).

As the climate change science and interdisciplinary and transdisciplinary forms of research continue to evolve, there is no simple answer to address the pressing challenges being brought in by climate change. We have no alternative but to continue to 'learning-by-doing' and 'doing-by-learning' (Loorbach and Rotmans 2006). This entails making use of the best available information to address climate change, striving for knowledge integration as much as possible, and learning from successes and failures to guide transformational change. It also includes creating more opportunities for interdisciplinary and transdisciplinary climate change-related research now within institutional structures. Indeed, some call for radical inter- and transdisciplinary research environments to enable progress toward addressing climate change challenges (Holm et al. 2013). Others highlight the role of approaches which are in essence based on exploring current and future uncertainties in knowledge to anticipate future changes (Klenk and Meehan 2015). 'Learning-by-doing' and 'doing-by-learning' are critical to operationalize much-needed transformational change because society is still learning, and will continue for quite some time, how to do both developing and applying climate change information.

While some climate change impacts may already be unfolding, there is indication that impacts will become more intense and more frequent in the future. It is imperative thus that action is taken now to avoid future unwanted outcomes rather than waiting for the ideal suite of knowledge and solutions to emerge. Addressing climate change demands a degree of pro-action now to effectively manage future impacts. Many may argue that it is difficult to forecast future climate change impacts without uncertainty, but it is this uncertainty that places future, strategic, and long-term thinking at the forefront of climate change adaptation and mitigation. In particular, future thinking is a transdisciplinary field of enquiry that combines a variety of methods to explore plausible futures and, therefore, deals with situations underpinned by uncertainties and low levels of controllability such as climate change impacts (Bengston et al. 2012). It ranges from predictive/empirical approaches informed by natural and technological sciences through to participatory and holistic

approaches supported by social sciences (Gidley 2013). It is therefore a strategy that can integrate multiple knowledge perspectives for devising multiple futures.

Preparing and planning for multiple plausible futures are perhaps the best, if not the only, alternative we have to deal with climate change impacts. Several approaches to develop pathways to navigate plausible futures are being developed in research and practice, including adaptive pathways and adaptation tipping points (Bishop et al. 2007; Haasnoot et al. 2013). Scholars point to the benefit in adopting future thinking to deliver holistic solutions and to encourage decision-makers to consider the big picture relating to multiple disciplinary perspectives, creative problem-solving, and account for longer temporal scales associated with the efficiency and robustness of decisions taken at present (Bengston et al. 2012).

In returning to the question of transformational change, it is important to stress the role of transdisciplinarity and future thinking in enabling climate change adaptation and mitigation. Transformational change however needs to be guided by a vision of the future (van der Helm 2009) or take the very long term into account. It is equally important to accept that we are dealing with dynamic changes that will continue to challenge how knowledge is developed and communicated (van der Leeuw et al. 2011). These challenges are here to stay, and the earlier we start to come to terms with them the better is the chance that we can learn from the past to anticipate the future.

1.2 Chapters Overview

This book is divided into three main parts of investigating aspects of how climate change information is being generated, communicated, and applied. *Part* I provides a snapshot on how climate change information is bridging natural/technological sciences and social sciences. It touches on aspects of evidence for policy implementation and participatory approaches to knowledge generation.

Morgan and *Di Giulio* investigate the relationship between science and policy to best guide research design to support decision-making and increase the usability of research outputs by end users. The authors draw on their research carried out in Queensland, Australia, and São Paulo, Brazil, to reflect on how more collaborative approaches can tackle the challenges put forward by uncertainty, complexity, and politics in decision-making involving climate change impacts.

Fargette, Loireau, Ben Khatra, Khiari, and *Libourel* explore the connection between geographical imprints and society–environmental relationships and global climate systemic functioning. They apply a conceptual systemic framework to investigate how scientific observatories enable the generation of sound information while enhancing arenas for democratic discussions and decision-making.

Devès, *Lang*, *Bourrelier,* and *Valérian* reflect on the IPCC's process of generating assessment reports in light of new demands placed on the types of expertise required by those reports. Using the example provided by the French Association for Disaster Risk Reduction, the authors discuss whether the IPCC needs to review

its organization to ultimately provide support for effective implementation of climate change adaptation and mitigation programs that need to be integrated and operational across a range of spatial and temporal scales and stakeholder spectrum.

Gervet describes how computation constraint models can aid decision-making and design of holistic solutions. She focuses on techno-economic issues involved in the implementation of renewable energy parks in Egypt to describe how a computational model was used as a communication and simulation tool between involved parties to evaluate the impact and effectiveness of their energy management-related choices.

Part II offers examples of how climate change information can be communicated to inform decision-making with present and future implications. It covers aspects of stakeholder engagement to deal with uncertainty in climate change science, communication of climate change information within personal circles, and bridging research, practice, and decision-making.

Serrao-Neumann and *Low Choy* report on the suitability of scenario planning as a tool to inform decision-making and policy implementation in light of high uncertainty and low controllability. The authors use examples from Australia to discuss the intricacies of using scenario planning at multiple scales, including institutional and community scales.

Coulter notes on the difficulties of imagining and talking about a future that will be affected by climate change impacts. Focusing on Australian and Canadian examples, she highlights how challenges in communicating about climate change are not confined to circles of people who do not have access or lack of deep knowledge about climate change, but exceed knowledge to include emotional spheres of personal relationships.

Schuck-Zöller, Brinkamm, and *Rödder* analyze the role of interdisciplinary research in integrating research and practice. Drawing on the example of the Climate Services initiative, they argue for the integration between researchers and practitioners to solve real-world problems and propose a list of criteria to guide best practice in transdisciplinary dialogues.

Dubois, Stoverinck, and *Amelung* discuss how visualization can help users to understand complex and uncertain climate science. Based on the analyses of European examples, the authors offer important considerations to avoid confusion and improve understanding of uncertainty when using common visual tools to communicate climate change, including maps and their need for consistency and norms.

Howes outlines how policy-making processes to be effective need to enhance community empowerment. Analyzing three case studies from Australia, the USA, and the UK, he proposes a three-step approach to policy-making to inform, engage, and support democratic community-based adaptation.

Jacobson, Crevello, Chanseng, and *Chanthan* tackle the confronting issue of adaptation in information-poor situations. Using examples from rural Cambodia focused on using vulnerability and resilience assessments for policy dialogue, the authors offer much-needed engagement strategies to enable less resourced actors to also plan for their adaptation and transformation.

Part III provides a view on case studies which are applying climate change information. Selected cases offer examples of application and usability of complex climate change information through Web-based platforms, citizen science projects, and virtual laboratories.

Tellez-Arenas, Quique, Boulahya, Le Cozannet, Paris, Le Roy, Dupros, and *Robida* discuss the challenges in using large, complex, and heterogeneous datasets for informing climate change adaptation in coastal areas. The authors address the interoperability challenges of Web services that integrate multifaceted datasets and propose a flexible architecture to improve both analyses of complex scenarios by experts and their communication to the general public.

David and *Quod* propose an important innovation in monitoring programs for coral reef health by integrating ecological and social systems. The authors outline how financial and human resource barriers to carrying out monitoring activities can be overcome through engaging citizen scientists. They also discuss the dilemmas in choosing the focus of monitoring programs in terms of their applicability at large scales, their genericity, or local management application.

Gracie, Silva, Hacon, Matos, Barros, de Pina, and *Barcellos* report on the development of a virtual laboratory to inform climate adaptation in the human health sector. The authors focus on the Brazilian Climate and Health Observatory to investigate how a 'one-stop shop' for accessing information concerning health-related effects of environmental and climate change can facilitate its application by citizens, government agencies, and researchers.

Coulter and *Coudrain* conclude the book by providing an overall assessment on how climate change information is being developed, communicated, and applied in the context of developed and developing countries. Drawing on the various contributions gathered in this book, the authors discuss how climate change information is promoting informed action to manage climate change mitigation, adaptation, and management.

Overall, the contributions collated in this book offer a snapshot of contemporary developments in the generation, communication, and application of climate change information worldwide. They provide important insights for researchers and practitioners pursuing the implementation of transdisciplinarity and climate change adaptation and mitigation. The book targets researchers, practitioners, and citizens with an interest in climate change and cutting-edge forms of knowledge generation in many fields of enquiry, including natural sciences through to technologies and social sciences. Hence, it contributes to the continuous evolution of research and practice of both climate change science and transdisciplinarity.

Acknowledgements The preparation of this book was inspired by two sessions on *Information for Decision-making* (4418a—how to engage in future thinking or plan for the long term, and 4418b—improve availability, access and use of information) held at the *Our Common Future under Climate Change* Conference, Paris, July 2015 (http://www.commonfuture-paris2015.org/). We thank all the authors for their contributions and willingness to provide valuable insights into advancing climate change adaptation and mitigation.

References

Bengston DN, Kubik GH, Bishop PC (2012) Strengthening environmental foresight: potential contributions of futures research. Ecol Soc 17(2):10

Bishop P, Hines A, Collins T (2007) The current state of scenario development: an overview of techniques. Foresight 9:5–25

Dilling L, Lemos MC (2011) Creating usable science: opportunities and constraints for climate knowledge use and their implications for science policy. Glob Environ Change 21:680–689

Gidley JM (2013) Global knowledge futures: articulating the emergence of a new meta-level field. Integral Rev 9:145–172

Gillard R, Gouldson A, Paavola J, Van Alstine J (2016) Transformational responses to climate change: beyond a systems perspective of social change in mitigation and adaptation. Wiley Interdisc Rev Climate Change 7:251–265

Haasnoot M, Kwakkel JH, Walker WE, ter Maat J (2013) Dynamic adaptive policy pathways: a method for crafting robust decisions for a deeply uncertain world. Glob Environ Change 23:485–498

Hagemeier-Klose M, Beichler SA, Davidse BJ, Deppisch S (2014) The dynamic knowledge loop: inter- and transdisciplinary cooperation and adaptation of climate change knowledge. Int J Disaster Risk Sci 5:21–32

Hellsten I, Leydesdorff L (2016) The construction of interdisciplinarity: the development of the knowledge base and programmatic focus of the Journal Climatic Change, 1977–2013. J Assoc Inform Sci Technol 67:2181–2193

Holm P, Goodsite ME, Cloetingh S, Agnoletti M, Moldan B, Lang DJ, Leemans R, Moeller JO, Buendía MP, Pohl W, Scholz RW, Sors A, Vanheusden B, Yusoff K, Zondervan R (2013) Collaboration between the natural, social and human sciences in Global Change Research. Environ Sci Policy 28:25–35

IPCC (2014) Climate change 2014: impacts, adaptation, and vulnerability—summary for policymakers. In: Working group II contribution to the IPCC 5th assessment report—changes to the underlying scientific/technical assessment. IPCC

Jantsch E (1972) Toward interdisciplinarity and transdisciplinarity in education and innovation. In: Apostel L, Berger G, Michaud G, (eds) Interdisciplinarity: problems of teaching and research in universities. Paris: Organization for Economic Cooperation and Development (OECD) and Center for Educational Research and Innovation (CERI)

Kagle M, Baptiste A (2017) A framework for collaborative climate change research. J Environ Stud Sci 7:301–309

Kirchhoff CJ, Carmen Lemos M, Dessai S (2013) Actionable knowledge for environmental decision making: broadening the usability of climate science. Annu Rev Environ Resour 38:393–414

Klenk N, Meehan K (2015) Climate change and transdisciplinary science: problematizing the integration imperative. Environ Sci Policy 54:160–167

Lemos MC, Kirchhoff CJ, Ramprasad V (2012) Narrowing the climate information usability gap. Nat Climate Change 2:789–794

Loorbach D, Rotmans J (2006) Managing transitions for sustainable development. In: Olshoorn X, Wieczorek A (eds) Understanding industrial transformation, views from different disciplines. Springer, Dordrecht

Mastrandrea M, Heller N, Root T, Schneider S (2010) Bridging the gap: linking climate-impacts research with adaptation planning and management. Clim Change 100(1):87–101

Milman A, Marston JM, Godsey SE, Bolson J, Jones HP, Weiler CS (2017) Scholarly motivations to conduct interdisciplinary climate change research. J Environ Stud Sci 7:239–250

Moser SC (2010) Now more than ever: the need for more societally relevant research on vulnerability and adaptation to climate change. Appl Geogr 30:464–474