

CLIMATE CHANGE ADAPTATION MANUAL

Lessons learned from European
and other industrialised countries



Edited by Andrea Prutsch,
Torsten Grothmann,
Sabine McCallum, Inke Schauser
and Rob Swart

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Success in the international negotiations on mitigating climate change seems further away than ever. The importance and urgency of adaptation is becoming more and more apparent. It is now one of the main imperatives of international research and action. However, past and present research on adaptation is mostly not directly applicable to adaptation policy or practice, leaving a disconcerting gap between scientific results and practical advice for decision makers and planners. This book seeks to address this problem. It bridges the gap and provides readers with practical and readily applicable information on climate change adaptation.

Following a context-setting introduction, the book is organised into four main sections. Each reflects an essential component of the adaptation process. Whereas most books in the field focus on adaptation in developing countries, this volume provides an examination of policy and practice in industrialised countries, predominantly in Europe. It offers novel inter-disciplinary insight into cutting-edge knowledge and lessons learned.

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CONTENTS

<i>List of figures</i>	<i>xii</i>
<i>List of tables</i>	<i>xiv</i>
<i>List of contributors</i>	<i>xvi</i>
<i>Foreword</i>	<i>xx</i>
<i>Acknowledgements</i>	<i>xxv</i>

PART I	
Introduction and overview	1
1 Guiding principles for good adaptation and structure of this book	3
<i>Inke Schauser, Sabine McCallum, Andrea Prutsch, Torsten Grothmann and Rob Swart</i>	
1.1 Why this book?	3
1.2 Structure of the book	5
2 Facing the specific challenges of adaptation	7
<i>Andrea Prutsch, Sabine McCallum, Torsten Grothmann, Inke Schauser and Rob Swart</i>	
2.1 Introduction	7
2.2 Addressing challenges in the guiding principles for good adaptation	11
3 Adaptation research: where do we stand and where should we go?	14
<i>Torsten Grothmann</i>	
3.1 Introduction	14

3.2	Theoretical concepts in IVA research	15
3.3	Some general methodological considerations	17
3.4	Final remarks	21
4	Adaptation policy initiatives in Europe	24
	<i>Sabine McCallum and Stéphane Isoard</i>	
4.1	Introduction	24
4.2	EU-level efforts	26
4.3	National efforts	31
4.4	Transnational, regional, and local efforts	33
4.5	Conclusion	35

PART II

Phases of adaptation processes and guiding principles for good adaptation **39**

5	Explore potential climate change impacts and vulnerabilities and identify priority concerns	41
	<i>Inke Schauser, Andrea Prutsch, Torsten Grothmann, Sabine McCallum and Rob Swart</i>	
	Explanation of the guiding principle	41
	Chapter overview	43
5.1	Regional vulnerability assessment in the Alps	43
	<i>Marc Zebisch, Stefan Schneiderbauer and Lydia Pedoth</i>	
5.2	Practical guidance for vulnerability assessments at the regional and local scale (BalticClimate)	50
	<i>Mattias Hjerpe and Julie Wilk</i>	
5.3	An ad-hoc prioritisation methodology applied in the Swiss national adaptation strategy	57
	<i>Roland Hohmann, Thomas Probst, Pamela Köllner-Heck, Hugo Aschwanden and Bruno Schädler</i>	
5.4	Lessons learned for the assessment of climate change impacts and vulnerabilities	62
	<i>Inke Schauser</i>	
6	Initiate adaptation, ensure commitment and management	67
	<i>Andrea Prutsch, Sabine McCallum, Torsten Grothmann, Inke Schauser and Rob Swart</i>	
	Explanation of the guiding principle	67
	Chapter overview	68
6.1	The role of governments in adaptation: A comparison across Europe	68
	<i>Reinhard Steurer and Anja Bauer</i>	

6.2	Building commitment for adaptation: The right place at the right time?	74
	<i>Julian Wright</i>	
6.3	Initiating and sustaining adaptation in the private sector	78
	<i>Magnus Benzie and Oskar Wallgren</i>	
6.4	Lessons learned for the management and governance of adaptation	84
	<i>Andrea Prutsch</i>	
7	Build knowledge and awareness	89
	<i>Torsten Grothmann, Andrea Prutsch, Inke Schauser, Sabine McCallum and Rob Swart</i>	
	Explanation of the guiding principle	89
	Chapter overview	90
7.1	The European Climate Adaptation Platform (Climate-ADAPT)	91
	<i>André Jol and Stéphane Isoard</i>	
7.2	Awareness of climate change adaptation in Denmark: How to address a target group	97
	<i>Louise Grøndahl</i>	
7.3	Making climate change scenarios useful for regional adaptation plans in France	102
	<i>Christian Pagé</i>	
7.4	Adaptation communication with business actors and the general public at the metropolitan level: Experiences from northwestern Germany	107
	<i>Claudia Körner and Andreas Lieberum</i>	
7.5	Lessons learned for the communication of impacts, vulnerabilities and adaptation options	114
	<i>Torsten Grothmann</i>	
8	Identify and cooperate with relevant stakeholders	119
	<i>Torsten Grothmann, Andrea Prutsch, Inke Schauser, Sabine McCallum and Rob Swart</i>	
	Explanation of the guiding principle	119
	Chapter overview	120
8.1	Lessons learned from stakeholder involvement in the development of the Austrian National Adaptation Strategy	121
	<i>Andrea Prutsch and Therese Stickler</i>	
8.2	Stakeholder involvement for developing adaptation innovations in rural areas: Examples from Berlin-Brandenburg	128
	<i>Andrea Knierim</i>	
8.3	Ancona is getting ready! How the city of Ancona is building resilience using a participatory process	136
	<i>Marco Cardinaletti</i>	

8.4	Lessons learned for stakeholder engagement <i>Torsten Grothmann</i>	145
9	Explore a wide spectrum of adaptation options <i>Inke Schauser, Andrea Prutsch, Torsten Grothmann, Sabine McCallum and Rob Swart</i>	153
	Explanation of the guiding principle	153
	Chapter overview	154
9.1	Identifying and sorting adaptation options <i>Inke Schauser and Andreas Vetter</i>	154
9.2	Adaptation: What could it look like? Examples from the <i>Adaptation Inspiration Book</i> <i>Marjolein Pijnappels</i>	159
9.3	Identifying adaptation options: Practical experience from the application of the Adaptation Wizard <i>Megan Gawith, Roger Street and Kay Johnstone</i>	164
9.4	Lessons learned for the identification of adaptation options <i>Inke Schauser</i>	170
10	Prioritise adaptation options <i>Rob Swart, Andrea Prutsch, Torsten Grothmann, Inke Schauser and Sabine McCallum</i>	174
	Explanation of the guiding principle	174
	Chapter overview	175
10.1	Economic appraisal <i>Paul Watkiss and Alistair Hunt</i>	176
10.2	Prioritisation of adaptation options for the Netherlands: A Multi-Criteria Analysis <i>Ekko C. van Ierland, Karianne De Bruin and Rob B. Dellink</i>	186
10.3	Prioritising actions using adaptation tipping points and adaptation pathways <i>Marjolijn Haasnoot, Jaap Kwadijk and Nathalie Asselman</i>	190
10.4	Lessons learned for the prioritisation of adaptation options <i>Rob Swart</i>	196
11	Work with uncertainties <i>Torsten Grothmann, Andrea Prutsch, Inke Schauser, Sabine McCallum and Rob Swart</i>	201
	Explanation of the guiding principle	201
	Chapter overview	202
11.1	An adaptive approach to conservation management in Bosherston Lakes SAC <i>Clive Walmsley and Tristan Hatton-Ellis</i>	202

11.2	Robust decision-making? Managing uncertainties in adapting water resource systems to a changing climate in England and Wales	208
	<i>Suraje Dessai and Geoff Darch</i>	
11.3	How to communicate climate change uncertainties: recommendations from psychological research	213
	<i>Torsten Grothmann</i>	
11.4	Lessons learned for decision-making under uncertainty	219
	<i>Torsten Grothmann</i>	
12	Avoid maladaptation	224
	<i>Rob Swart, Andrea Prutsch, Torsten Grothmann, Inke Schauser and Sabine McCallum</i>	
	Explanation of the guiding principle	224
	Chapter overview	225
12.1	A white decay of winter tourism in Europe?	226
	<i>Carmen de Jong</i>	
12.2	Combining climate change mitigation and adaptation: Green roofs in Basel, Switzerland	233
	<i>Aleksandra Kazmierczak</i>	
12.3	Climate change opportunities and sustainability	237
	<i>Rob Swart and Marjolein Pijnappels</i>	
12.4	Lessons learned for the avoidance of maladaptation	242
	<i>Rob Swart</i>	
13	Modify existing and develop new policies, structures and processes	246
	<i>Andrea Prutsch, Sabine McCallum, Torsten Grothmann, Inke Schauser and Rob Swart</i>	
	Explanation of the guiding principle	246
	Chapter overview	247
13.1	Climate-proofing: A step-wise approach for mainstreaming adaptation applied to EU policies	248
	<i>Sabine McCallum and Thomas Dworak</i>	
13.2	Assessing the climate change fitness of policies: The case of spatial planning in the Alpine space	256
	<i>Marco Pütz and Sylvia Kruse</i>	
13.3	The world's second northernmost capital region adapts to climate change: The Helsinki metropolitan adaptation strategy	261
	<i>Lasse Peltonen, Leena Kopperoinen and Susanna Kankaanpää</i>	
13.4	Lessons learned for mainstreaming adaptation	266
	<i>Sabine McCallum and Andrea Prutsch</i>	

14	Monitor and evaluate systematically	272
	<i>Andrea Prutsch, Sabine McCallum, Torsten Grothmann, Inke Schauser and Rob Swart</i>	
	Explanation of the guiding principle	272
	Chapter overview	273
14.1	Asking the right questions: Monitoring and evaluating adaptation	273
	<i>Patrick Pringle</i>	
14.2	Adaptation indicators: A basis for monitoring implementation and effectiveness	281
	<i>Jelle van Minnen, Mike Harley, Kaj van de Sandt and Willem Ligtoet</i>	
14.3	The French approach to monitoring an adaptation plan	288
	<i>Bertrand Reyset</i>	
14.4	Lessons learned for the monitoring and evaluation of adaptation	293
	<i>Andrea Prutsch</i>	

PART III

State of art outside Europe 297

15	Adaptation experiences in other industrialised countries and in developing countries	299
	<i>Rob Swart</i>	
15.1	The state of the art in adaptation science, policy and practice in the United States	301
	<i>Richard H. Moss, Thomas J. Wilbanks and Sherry B. Wright</i>	
15.2	Doing it right: Getting science into Australian adaptation policy	308
	<i>Rohan Nelson and Mark Howden</i>	
15.3	Wise adaptation to climate change: Japan	314
	<i>Makoto Tamura, Kazuya Yasuhara, Nobuo Shirai and Mitsuru Tanaka</i>	
15.4	Principles for adaptation decision-making in developing countries	320
	<i>Kelly Levin</i>	
15.5	Context-specific and yet transferable? A reflection on knowledge-sharing in the field of adaptation to climate change	326
	<i>Britta Horstmann</i>	
15.6	Lessons learned and differences between Europe and other regions	332
	<i>Rob Swart</i>	

PART IV**Lessons learned 339**

16	Lessons learned from practical cases of adaptation to climate change in industrialised countries	341
	<i>Rob Swart, Torsten Grothmann, Sabine McCallum, Andrea Prutsch and Inke Schauser</i>	
16.1	How to prepare the ground for adaptation	342
16.2	How to plan for adaptation	344
16.3	How to implement adaptation and review success	346
	<i>Index</i>	348

FIGURES

5.1.1	Framework of the vulnerability assessment	44
5.2.1	A chart illustrating the three blocks and the specific exercises in the vulnerability approach	51
5.2.2	Factors affecting the ability to adapt in a Finnish region	54
5.3.1	Assessment of the topics in the water management sector	59
7.2.1	Group work at the <i>Tour de klimatilpasning</i>	101
7.3.1	Change in precipitation and temperature for the Bouches-du-Rhône <i>département</i> in winter	104
7.4.1	Example screenshot from scrap-paper animation clip	111
7.4.2	User interface for <i>nordwest2050</i> online climate game	112
8.3.1	Geographical context of the city of Ancona	137
9.2.1	Children planting trees in the waterboxes in Viladecans	163
9.3.1	The Adaptation Wizard	165
10.3.1	Example of an Adaptation Pathways map	193
10.3.2	The River Rhine and its main tributaries in the Netherlands	194
10.3.3	Adaptation Pathways map for the River Rhine	194
11.1.1	Submerged beds of <i>Chara hispida</i> in Bosherton Lakes	203
11.1.2	Water lilies at Bosherton Lakes	204
11.1.3	Assessment of the risk of tidal overtopping of the dam	205
11.1.4	Schematic diagram of the adaptive management cycle adopted for the Bosherton Lakes SAC	206
12.1.1	Problems with maintenance of artificial snow cover at the end of the season, Val Thorens, 2011	229
12.1.2	Attempts to adapt to climate change by means of artificial snow production	231
12.1.3	The carrying capacity of a ski resort after three main phases of development	232

12.2.1	The green roof of the Basel Exhibition Hall	237
12.3.1	Taking climate change into account in spatial planning and water management projects	239
13.3.1	The process of preparing the Helsinki Metropolitan Area Climate Change Adaptation Strategy	263
14.1.1	Internal and shared learning through monitoring and evaluation	276
14.1.2	A question-based approach to adaptation M&E	280
14.2.1	EEA conceptual framework for adaptation indicators	283
14.2.2	Monitoring framework in ASC adaptation assessment toolkit	284
14.2.3	Dutch adaptive capacity wheel and scoring scheme	285
14.3.1	Interlinkage of the national adaptation process with regional and local processes	289
14.3.2	Monitoring and evaluation framework of the French NAP	291
15.2.1	Participatory development of adaptation policy	313
15.3.1	Dual approach for climate change adaptation	315
15.3.2	Research map of climate change issues in Japan	316
15.3.3	Guidance for local governments in the initiation of adaptation planning and implementation	318
15.5.1	Characteristics of adaptation processes relevant for transferability	327

TABLES

1.1	Phases of adaptation processes and guiding principles for good adaptation	5
5.1.1	Five-step regional vulnerability assessment	45
5.1.2	Results of the vulnerability assessment for the agricultural sector per impact	49
5.3.1	Assessment of topics in the water management sector that could potentially be affected by climate change	60
6.1.1	Overview of governance challenges and governance approaches	72
6.2.1	Summary of some of the key steps in the establishment of the adaptation response in England and the UK	77
6.3.1	Strengths and weaknesses of the ARP and CDP schemes for initiating adaptation in the private sector	83
7.4.1	Communication principles in <i>nordwest2050</i>	109
8.1.1	Overview of involvement formats in Austria	122
8.2.1	Types of actors in INKA BB	130
8.2.2	Overview of the agricultural stakeholders involved in INKA BB	131
8.3.1	Direct/indirect influence matrix for the Ancona Local Adaptation Board	140
8.3.2	Overview of stakeholder involvement instruments used by the Ancona LAB	141
8.3.3	Advantages and disadvantages of stakeholder involvement tools	142
9.3.1	Excerpt of adaptation options to address priority risks	167
9.3.2	Excerpt of potential adaptation options to address risks to new homes and existing stock	169
10.1.1	Methodologies for assessing the costs and benefits of adaptation	178
10.1.2	Coverage of studies for European adaptation costs and benefits	180

10.1.3	Traditional and new decision support tools for evaluating adaptation options	182
10.2.1	Ranking of high-priority options	188
13.1.1	EU legislation in which mainstreaming is taking/has already taken place	250
14.2.1	Recommendations to support the future development and use of adaptation indicators	287
15.2.1	Criteria used for selecting policy processes in Australian adaptation research	311
16.1.1	Phases of adaptation processes and guiding principles for good adaptation	342

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FOREWORD

European Commission – DG Climate Action

Climate change is a reality, and its impact is increasingly felt in Europe and around the world. Our first priority remains reducing greenhouse gas emissions to keep global warming below 2°C and avert dangerous climate change. Far-reaching EU legislation on mitigation measures is already in place for this.

However, irrespective of the success of mitigation efforts, climate impacts will increase in the coming decades because of the delayed effect of past and current greenhouse gas emissions. This is why, alongside our mitigation measures, we need policies focused on adaptation. Action taken now will avoid increased costs and losses later.

Adaptation efforts are already underway across the EU at various governance levels and in different sectors. Several EU Member States have adopted a national adaptation strategy, and more are being prepared. Some of these strategies have been followed up by action plans, and there has been some progress in integrating adaptation measures into sectoral policies. Beyond the national level, many transnational cooperation projects on adaptation have been initiated over the last years which receive financing by EU-funds such as the LIFE+ and INTERREG programmes. At the local level, a significant share of adaptation activities takes place at city level. There are already many examples of cities in Europe that have adopted adaptation strategies or action plans or are in the process of developing them.

With the EU Adaptation Strategy adopted in the spring of 2013 we aim to raise the profile of adaptation to climate change and step up action on adaptation across the EU, complementing and supporting the Member States' activities.

The strategy particularly also supports action by promoting greater coordination and information-sharing between Member States, and by ensuring that adaptation considerations are addressed in all relevant EU policies.

Targeted information is crucial for decisions on adaptation and – this being still a fairly new policy field – not always easy to come by. Sharing knowledge and experience in adaptation policy and practice thus plays an important role in facilitating mutual learning from practical examples and supporting effective adaptation action.

This *Climate Change Adaptation Manual* presents a variety of adaptation approaches and practical experiences across Europe and provides a comprehensive overview of the state of the art in other continents. It structures the cases along generic guiding principles for good practice in adaptation, addresses challenges in adaptation processes and how to overcome them, and highlights lessons learned.

I am confident that this book will be useful to adaptation practitioners and of interest to all concerned with adaptation.

Humberto Delgado Rosa

Director of Directorate C

(Mainstreaming Adaptation and Low Carbon Technology),

DG Climate Action, European Commission

Organisation for Economic Co-operation and Development (OECD)

Adaptation to climate change is inevitable. However, successful adaptation will depend on the effectiveness of the actions taken by governments, businesses, civil society and households in response to a changing climate. Supporting this process in a fair, effective and efficient way is a central policy question for OECD members and partner countries.

During the past decade, there has been a progression from research on the potential impacts of climate impacts to the development of strategies to prepare for these changes. Since 2005, 18 OECD countries have produced national strategies that help to plan, co-ordinate and communicate national action on adaptation. The key challenge now is to move from planning to implementation. Our research has identified three priorities for successfully making this transition.

The first priority is to embed adaptation across the public sector as a whole, securing strong engagement beyond environment ministries. The cross-cutting nature of adaptation requires working across traditional sectoral and policy boundaries, often to address existing inefficiencies. For example, improved management of flood risk may require reforms to land-use planning, design standards, insurance markets and innovation policy.

It is also essential to support the private sector's response to climate change. There is currently high awareness of climate change impacts, but sparse action to manage the resulting risks. There is a pressing need to make the business case for targeted action in this area. An integral part of this will be to strengthen links between researchers and end-users to ensure that relevant tools and data are being produced. Regulatory frameworks governing private infrastructure

also need to be fit for purpose, removing barriers to cost-effective action on adaptation.

The third priority is to integrate robust monitoring and evaluation from the outset of programme and policy design. By doing so, this will help to ensure that interventions are delivering their expected results and to learn lessons to inform the design of future interventions. It can also help to ensure accountability for mainstreamed approaches to adaptation.

This manual is very timely in offering practical guidance on these key issues. It makes an important contribution in supporting the implementation of high-quality adaptation strategies and measures.

Michael Mullan

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Environment Directorate,
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European Environment Agency

Climate change is now a major part of planning for the future. Around the world, the extent and speed of change is becoming ever more evident according to the IPCC Fifth Assessment Report ‘*Climate Change 2013: The Physical Science Basis*’ and, as reported in the EEA’s 2012 ‘*Climate change, impacts and vulnerability in Europe*’, climate change is already causing a wide range of impacts on society and the environment in Europe. While reducing greenhouse gas emissions, there is also a need for society to adapt. Otherwise, damage costs will continue to rise.

EEA’s 2013 report on *Adaptation in Europe* shows that 16 European member countries have already developed national adaptation strategies (nine more than in 2008), and that 12 more are in the process of doing so. As the first comprehensive overview on adaptation in Europe, the report also highlights a wealth of regional, transnational and local responses, tailor-made to address specific conditions and needs as well as social and economic contexts. There is no ‘one-size-fits-all’ approach to adaptation.

National adaptation strategies to date address primarily the water, agriculture and forestry, biodiversity, and human health sectors. Examples of implemented actions show that adaptation of both natural and human systems is already taking place across Europe. At EU level, instruments for implementing adaptation policy include mechanisms such as cohesion, agriculture and infrastructure funds, as well as support under the LIFE+ programme. These are critical in helping to integrate adaptation into EU policy – a process known as ‘mainstreaming’ of adaptation.

Research has a key role to play in strengthening the knowledge base on climate change adaptation in Europe. National and EU-funded research has improved the understanding of past and current changes in the climate system, scenarios for future climate change and the impacts and vulnerabilities/risks. There are, nevertheless, some areas that require more information and assessments. These

include the costs and benefits of adaptation actions and the monitoring and evaluation of adaptation, for example through the development of indicators. In addition, research can help improve the process of planning, implementing and reviewing adaptation policies by further examining the factors for successful adaptation and good practices as well as highlighting remaining knowledge gaps.

In that context, national adaptation portals as well as the European Climate Adaptation Platform (Climate-ADAPT, <http://climate-adapt.eea.europa.eu>) are important tools for sharing with stakeholders at all levels of governance practical experiences in developing and implementing actions and the results of research (i.e. EU research, INTERREG and ESPON projects) on climate change risks, adaptation practices, national initiatives or decision-support tools.

Policy makers face the challenge of designing and implementing adaptation approaches that are: *coherent* across sectoral domains and levels of governance; *flexible* so that strategies and plans can be progressively adjusted to new conditions as they unfold and are updated with new information from monitoring, evaluation and learning; and *participatory* as involvement of stakeholders (policymakers, NGOs, businesses, citizens) is important in creating a sense of ‘ownership’ in adaptation policy. These challenges bring opportunities for research to further support the implementation phase of the European Strategy on Adaptation to Climate Change.

The strategy includes a guidance document for development of national adaptation strategies and this *Climate Change Adaptation Manual* provides a wealth of information that complements the approaches presented in the guidance document.

The origin of the *Climate Change Adaptation Manual* was, at least in part, earlier EEA work on guiding principles for good practice in adaptation. EEA is convinced that this publication strengthens the knowledge on adaptation to climate change and that it will support, for a wide range of stakeholders, related policy developments and their implementation.

Dr. Hans Bruyninckx

Executive Director of the European Environment Agency (EEA)

Science

The IPCC in its 5th Assessment report reconfirms most findings of earlier assessments of the risks of climate change. It specifically notes a broadening evidence basis that brings the already observed impacts of climate change to the fore and deepens our understanding of what the future impacts may be.

The stagnant pace of the international negotiations on curbing the increase of greenhouse gas emissions suggests that the options to avoid dangerous impacts of climate change are dwindling. So adaptation is not only unavoidable; indeed, it is also urgent. Since the 2009 Copenhagen UNFCCC Conference of Parties, there is global agreement that climate change is real and that, if major damage is to be

avoided, global mean temperature rise should be limited to at most 2°C as compared to pre-industrial levels. However, both the current observed warming, and the future warming to which we are increasingly becoming committed due to past emissions, are at odds with this long-term goal. At the same time, in most regions there is still much uncertainty as to how climate change will manifest itself locally and what the effects will be, in particular with respect to rainfall and crucial extreme events.

Yet despite the remaining uncertainty, it is clear that we must act now to develop policies and allocate resources. This does not only apply to national governments, but also to municipalities, water managers, farmers and firms. But how? And when? What are the options? How should we prioritise them? And which instruments do we have at our disposal to implement them? And when implemented, how do we know that they will be effective?

Because the emphasis at national and international levels has been on mitigation for a long time, actual experiences in adaptation that give answers to these questions are as yet very scarce. Therefore, the publication of this manual is very timely.

Although Europe has, like other regions, started to adapt late to the prospect of climate change, more than half of the EU Member States have now adopted national adaptation strategies, and in 2013 a European adaptation strategy was released. At the same time, cities, river basin management institutions, and energy and agricultural organisations have started to consider boosting their climate resilience. Europe is, therefore, leading the way in experimenting with climate change adaptation, and it is thus appropriate that the examples in this manual originate from that continent.

The manual organises its guidance around ten principles for adaptation that are broadly applicable in any region. Thus, although adaptation can be highly localised in its character, it is possible to transfer knowledge about adaptation from one context to another; and the manual makes abundantly clear that meaningful adaptation is possible, now, regardless of current uncertainty.

In the coming years, more experiences will be developed with actual adaptation to climate change in Europe and elsewhere. Research and practice will further increase our understanding of what works and what does not, and in which circumstances. Through the work of UNEP PROVIA (Programme of Research on Vulnerability, Impacts and Adaptation) and many other initiatives, research results and practical experiences can be shared around the world to help reduce the number of people and assets at risk. This manual is critical reading for all who want to engage in reducing vulnerability to climate change, from practitioners to policy makers and researchers.

Professor Martin Parry

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The idea of developing this book was triggered by the publication of ‘Guiding principles for adaptation to climate change in Europe’ in 2010. We are grateful to the European Environment Agency (EEA), in particular to André Jol and Stéphane Isoard, for giving us the opportunity to develop those guiding principles under the work programme of the European Topic Centre on Air and Climate Change (ETC/ACC). We acknowledge the feedback from 252 experts on earlier versions of the guiding principles responding to an internet survey, overall agreeing that they integrate the most important aspects of good practice in adaptation.

We are thankful to the publishers at Earthscan, now Routledge, for enabling us to compile this book based on the earlier ETC/ACC publication and we also recognise the dedicated team at Routledge, in particular our main contact Helen Bell, for support throughout the production of the manual. Extended thanks also go to all contributing authors, who agreed to enrich this book with a wide variety of case studies reflecting their experiences with adaptation policy and practice around the world. We very much appreciated the high quality and timely input which indeed substantially helped to finalise the manuscript.

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PART I

Introduction and overview

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1

GUIDING PRINCIPLES FOR GOOD ADAPTATION AND STRUCTURE OF THIS BOOK

*Inke Schauser, Sabine McCallum, Andrea Prutsch,
Torsten Grothmann and Rob Swart*

1.1 Why this book?

Climate change is already affecting our environment, our economy, and our way of living: evidence from all continents and most oceans shows that many natural and social systems are being affected by regional climate change (Parry et al. 2007). A series of extreme weather events in the last decade, such as the heat wave in Europe in 2003, flooding of the rivers Elbe and Danube in 2002 and 2013, and the drought and associated forest fires in 2010 in Russia, have also shaped public awareness of climate change. These events have all highlighted the need for Europe to adapt itself to the realities of climate change, especially considering that the frequency and magnitude of extreme events such as these are projected to increase in the coming years (IPCC 2012).

Adaptation is necessary to minimise negative impacts resulting from current and expected climate change, and in order to maximise our ability to benefit from any opportunities that climate change may bring. The question is, how to adapt? Simple advice, such as ‘save energy’ or ‘use more renewable energy’, is suitable and effective when it comes to preventing climate change. However, when it comes to adapting to climate change, there is no equivalent simple advice. Nevertheless, some common recommendations and guiding principles do exist, and they are equally valid in different countries, for different economic sectors, and for different climatic threats.

Adaptation to climate change is already taking place in Europe and across the world. In fact, adaptation to changing conditions is not a new phenomenon. Both traditional and industrialised societies have adapted their environments to alleviate risks associated with climate variability throughout human history, a process known as autonomous adaptation. It is to be expected that some autonomous adaptation by economies and societies will continue to take place even without any policy

intervention. Autonomous responses to a changing environment by individuals, groups or organisations will take place whenever actors perceive that people or assets are at risk, or where they perceive that action will provide economic and societal benefits.

However, autonomous adaptation on its own will not be fully adequate for coping with climate change (EEA 2013). The complexity of climate change, and the range and magnitude of risks we might face, may overwhelm a process of autonomous adaption. Instead, it will be necessary to implement planned adaptation, which proactively addresses potential risks and opportunities. Planned adaptation will help policy makers and societies to take decisions that will remain both robust (to cover all possible climate change scenarios) and flexible (so the measures can be changed if conditions change) to cope with an uncertain future.

Adapting to climate change is a critical challenge for the future. However, it must be remembered that climate change is only one of many stresses that influence decision making, which is also affected by short-term political or economic challenges, among other things. Climate change must therefore be considered alongside – and not separate from – environmental, social and economic issues affecting human and natural systems. Thus, adaptation requires a balanced approach that addresses both climate and non-climate risks (e.g. globalisation, demographic change).

In many cases, adaptation options do not solely target adaptation to climate change, but also aim at other societal or policy objectives. Planning for adaptation provides the opportunity for actors from different sectors to cooperatively address future risks and opportunities, while acknowledging the different backgrounds and values of all involved. Engaging stakeholders, and in particular stakeholders affected by climate change, offers an opportunity to identify innovative solutions to climate change that also have legitimacy and broad support.

The past decade has seen a great accumulation of knowledge on climate change adaptation, both in terms of the policy responses, and in terms of practical, on-the-ground measures. This manual brings together in one volume a variety of adaptation approaches and a broad spectrum of lessons learned in climate adaptation policy and practice up to now. It provides adaptation planners and decision makers with scientifically based information that is also practical and user-friendly. It elaborates on key aspects of successful adaptation by giving examples of adaptation policy and practice that have already been implemented in Europe. Experience from previous adaptation actions can also be very relevant in other regions outside Europe.

The title ‘Adaptation Manual’ is not intended to imply that this volume provides readers with detailed step-by-step instructions on how to plan for adaptation. Instead, ‘manual’ should be understood in a broader sense. This work shows different approaches for each adaptation phase, building on generic guiding principles, and highlighting lessons learned to support sharing of existing knowledge and experiences.

TABLE 1.1 Phases of adaptation processes and guiding principles for good adaptation

<i>Prepare the ground for adaptation</i>
Explore potential climate change impacts and vulnerabilities and identify priority concerns (cf. Chapter 5)
Initiate adaptation, ensure commitment and management (cf. Chapter 6)
Build knowledge and awareness (cf. Chapter 7)
Identify and cooperate with relevant stakeholders (cf. Chapter 8)
 <i>Plan for adaptation</i>
Explore a wide spectrum of adaptation options (cf. Chapter 9)
Prioritise adaptation options (cf. Chapter 10)
Work with uncertainties (cf. Chapter 11)
 <i>Implement adaptation and review results</i>
Avoid maladaptation (cf. Chapter 12)
Modify existing and develop new policies, structures and processes (cf. Chapter 13)
Monitor and evaluate systematically (cf. Chapter 14)

1.2 Structure of the book

This manual is divided into four parts. Part I provides an overview of the general challenges of adaptation, and the state of current adaptation research and action.

Part II is the core component of the book. It presents the ten guiding principles for good adaptation that were developed for the EEA by the editors of this book (Prutsch et al. 2010) (cf. Table 1.1). These ten principles cover the different interlinked phases of adaptation, from preparing the ground, to the selection and planning of measures, to the implementation of these measures and the monitoring and assessment of their progress. In every chapter, the guiding principle is first explained and updated based on new scientific literature. The principle is then illustrated by three to four cases representing experiences from adaptation policy and practice in several European countries. These cases reflect adaptation experiences from various regions, sectors and levels of decision making. They have been chosen to illustrate how specific guiding principles can be realised in practice and not every case can illustrate all ten guiding principles. Finally, the lessons learned from the cases are identified for each chapter and guiding principle.

It must be remembered that the guiding principles are not organised in order of importance. The guiding principles are strongly interlinked and mutually influenced. Together, they give a common basis for cooperative adaptation activities across sectors and for all decision-making levels. While developed with a focus on Europe, the guiding principles are also relevant elsewhere in the world.

In Part III, the focus of the manual is broadened, turning to the state of adaptation policy and practice in the US, Australia, Japan and developing

countries. These contributions reflect on the relevance of the guiding principles for countries outside Europe. Part IV, the final chapter of the manual, summarises the main lessons learned from the various practical experiences presented in this book.

With this manual, we aim to provide readers with inter-disciplinary insights into cutting-edge knowledge and on climate change adaptation, including knowledge from adaptation research, policy and practice. We believe that learning from past experience and basing future decisions on what works will increase long-term adaptive capacity and resilience. Thus, we hope that the lessons learned in this volume will add to the discussion on how to reach good practice in adaptation and encourage taking further proactive steps towards a climate-resilient society.

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2

FACING THE SPECIFIC CHALLENGES OF ADAPTATION

*Andrea Prutsch, Sabine McCallum,
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2.1 Introduction

Despite similarities to other planning processes, adaptation to climate change is characterised by several challenges that set it apart from other planning processes and must be acknowledged and proactively addressed. The analysis of these challenges and consideration of how they could be overcome led to the ten guiding principles for good adaptation presented in Chapter 1 and elaborated in Chapters 5 to 14.

Adaptation is complex due to the fact that climate change affects all regions, most sectors, all levels of decision making and many actors from various backgrounds differently (Grothmann 2011). This diversity and the long-term and large-scale nature of the risks involved imply that current practice in planning will be insufficient for comprehensive adaptation. Planning for adaptation also involves dealing with imperfect knowledge and uncertainties; this can conflict with the expectation that decision making should be based on agreed-upon “hard” evidence and robust information. In addition, non-climatic factors such as social and economic issues must be taken into account in comprehensive adaptation decision making.

In this chapter, we present a concise summary of the main challenges that can occur in adaptation processes.

2.1.1 Adaptation faces regional disparities

Climate impacts emerge at the regional and local levels in manifold ways. Due to the diversity of bio-physical and socio-economic situations in different regions, the impacts of climate change will differ from region to region. For example, the European Alps are characterised by small-scale climatic conditions, which in turn

result in various climate change impacts reflecting the scattered natural landscapes. The impacts of climate change also vary according to the degree of socio-economic development and the adaptive capacity of the area.

2.1.2 Adaptation affects sectors differently, and there are cross-sectoral effects

Climate change affects most sectors; thus, adaptation is a multi-sectoral issue (Burton et al. 2006, Agrawala & Frankhauser 2008). The sectors involved might follow different objectives, and a certain adaptation measure in one sector could create negative side-effects for another sector. In addition, actors from a variety of sectors will be involved in adaptation, representing diverse values and interests; some of these might be controversial and generate resistance (de Bruin et al. 2009). The improved horizontal integration of adaptation policies across sectors within and beyond the environmental domain will be needed. Additionally, horizontal integration will also require mechanisms that facilitate the interactions between state, business and civil society actors.

2.1.3 Adaptation concerns various levels of decision making

The “sphere of competence of authorities in charge of environmental protection [...] does not always match with the boundaries of the affected environment” (Liberatore 1997: 116). This applies to the authorities responsible for adaptation, as adaptation pressures and responses cut vertically across different levels of decision and policy making, from the EU level to national, regional and local levels (Klein et al. 2007). These different levels and actors interact with each other within hierarchical structures (Adger et al. 2005). The need for appropriate adaptation extends beyond the local and regional scales (Adger et al. 2005, Paavola & Adger 2006, Swart et al. 2009) and cannot be the sole responsibility of any single institution.

2.1.4 Adaptation affects many stakeholders with possibly conflicting interests

Climate change will (and already does) affect a range of actors and stakeholders (e.g. public authorities, businesses, NGOs, scientific organisations) in different ways; this makes adaptation imperative for most actors. Multi-actor collaboration can be challenged by questions regarding, e.g. roles, power, authority and responsibility, as well as by the multiple and possibly conflicting interests of actors collaborating on adaptation measures (Lebel et al. 2010). Thus, new mechanisms are often needed to facilitate cooperation between stakeholders from different fields and with different competencies and levels of experience.

2.1.5 Adaptation despite imperfect information and uncertainties

The uncertainty of future climate change and its impacts is often perceived to be the most significant challenge facing adaptation, since changes in the future climate cannot be accurately projected. This is due to uncertainties with regard to changes in greenhouse gas emissions and related economic and social developments (e.g. human behaviour, demographic and technological developments), incomplete scientific knowledge of the climate system (e.g. tipping points) and insufficient long-term data for many of the impact indicators on appropriate spatial and temporal scales. Uncertainties in projected global climate change impacts can often increase when downscaled to the regional level, and it is not clear as yet whether more reliable high-resolution projections can ever be developed.

Nevertheless, climate change projections provide clear trends and sufficient concerns to justify adaptation actions (Adger et al. 2007). In addition, it must be acknowledged that climate change impacts can already be seen, e.g. glaciers melting and permafrost thawing (cf. the Europe-wide summary in EEA 2012). Further changes can be expected due to greenhouse gas emissions in the past and to lagging progress in climate mitigation policy. Thus, the uncertainties associated with climate change projections should not be an excuse for inaction or a reason to delay adaptation. Relying entirely on reactive adaptation is undesirable, since the costs of impact damages and thus reactive adaptation are expected to be much higher than the costs of proactive adaptation and residual damages (Frankhauser et al. 1999, Stern 2006). Furthermore, a wait-and-see attitude would have serious drawbacks in the case of irreversible climate change consequences (Smith 1997). Finally, and perhaps most importantly, as several cases in this manual illustrate, there are many opportunities for actions that will decrease vulnerability that would make sense even if climate change does not materialise as projected.

2.1.6 Long-term global projections versus information needs for short-term decision making

In the long term and at the global level, the results from climate change models provide a reasonably clear picture, as the patterns of change are very similar for all models (Hallegatte 2009), in particular for temperature projections but also for precipitation in various regions (including the Mediterranean). However, this information does not necessarily meet the requirements of most decision-makers and planners for shorter planning horizons, nor is it always provided at the appropriate scale to fine-tune adaptation measures for site-specific conditions in a proactive manner (Frankhauser 2009).

Reacting to changes in the short term will result in poor adaptation because climate change by its nature is a long-term problem, and the worst effects may only become visible after decades have passed. In addition, certain adaptation options have long lead times and might only be fully effective in the long term

(e.g. the introduction of new trees in forest management, the development of new crop types). Thus, timing and the sequence of response actions are important (Frankhauser 2009, Horstmann 2008); the most appropriate solutions may transcend traditional ways of thinking and current practices in decision making.

2.1.7 Adaptation embedded within a broader context

Addressing climate change is only one of many stresses that influence decision making (Scheraga & Grambsch 1998). In many situations, short-term political or economic challenges will have a greater influence on decisions than climate change. Thus, in the case of adaptation, non-climatic developments (e.g. globalisation, demographic developments) must also be considered. For example, the level of heat-related fatalities also depends on age distribution and the quality of public health care. Thus, other processes must be taken into account as well when planning for adaptation.

In addition to the consideration of economic and demographic changes, the achievement of ecological and social justice presents a further challenge for adaptation. This issue relates to disparities in climate change impacts between different regions, sectors, actors, population groups and species. In Europe, mountain regions, coastal areas, flood-prone river systems, urban areas, the Mediterranean and the Arctic are likely to be more severely affected than other regions (EEA 2010). In addition, climate change is expected to have negative consequences for biodiversity, whereas agriculture may benefit, at least in the short term and in regions that are disadvantaged by cold temperatures at present. The elderly, ill and very young are more vulnerable to heat events than average, healthy, middle-aged people. The challenge is to reach ecological and social (including intergenerational) balance – also in terms of the costs of climate change and adaptation – in order to prevent social conflicts or ecological damage. In this context, Paavola and Adger (2006: 607) propose that “adopting the principles of avoiding dangerous climate change, forward-looking responsibility, putting the most vulnerable first and equal participation of all would be a step towards fairer adaptation”.

2.1.8 Identifying and overcoming potential barriers

Multiple types of barriers may hinder successful adaptation action. These include financial (e.g. lack of financial resources for adaptation), cognitive (e.g. lack of motivation for adaptation), behavioural (e.g. lack of leadership qualities in critical positions), social (e.g. lack of political action) and cultural (e.g. cultural traditions that restrict cooperation between different stakeholders) barriers (Adger et al. 2007, Lorenzoni et al. 2007, Hulme et al. 2007, EEA 2009, Burch 2010, Grothmann 2011). Further barriers can arise from hindering regulations, opposing political interests, impeding organisational or managerial structures or the lack of technology (Grothmann 2011, Grothmann et al. 2009, Clar et al. 2013). Missing information regarding climate change and its impacts might also

pose a major barrier to adaptation. In addition, the lack of information exchange and communication between sciences and policy as well as limited experience and competence in dealing with climate-related impacts could hinder the adaptation process (Amundsen et al. 2010, Clar et al. 2013, Grothmann & Siebenhüner 2012).

However, it is important to note that even sufficient information and awareness of the need for adaptation do not necessarily lead to action (Baron 2006, Weber 2006). In fact, decisions are influenced by personal experiences, individual perceptions and values, emotions and hidden agendas (Grothmann & Patt 2005, van de Kerkhof 2006). Hence, every decision-making process includes a certain level of “surprise” that is difficult to estimate in advance and thus to influence. Nevertheless, to the extent possible, barriers should be identified and openly confronted so that they can be removed or transcended (Grothmann 2011, Grothmann et al. 2009, Lim et al. 2004, Smith et al. 2009).

2.2 Addressing challenges in the guiding principles for good adaptation

Addressing these various challenges is not an easy task, and because every adaptation case is unique, it is impossible to provide generalisable step-by-step instructions for how to tackle them. Nevertheless, the ten guiding principles for good adaptation presented in Chapter 1 and elaborated in Chapters 5 to 14 attempt to address these challenges by articulating important elements that should be taken into consideration when preparing the ground for adaptation, planning and implementing adaptation and reviewing its success.

Certain guiding principles focus on a particular challenge. For example, the guiding principle “Work with uncertainties” specifically addresses the challenge of realising adaptation despite imperfect information and uncertainties. Other guiding principles tackle a wide range of challenges. For example, the principle “Identify and cooperate with relevant stakeholders” is useful for addressing the challenge entailed by adaptation’s effects on a variety of stakeholders with possibly conflicting interests. However, it also addresses the challenges of dealing with potential cross-sectoral effects, including various levels of decision making, embedding adaptation within a broader context and identifying and overcoming potential barriers.

Future research and practice will determine whether additional challenges of adaptation should be added and new guiding principles developed to address them.

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