1 Communicating Climate Change Adaptation: From Strategy Development to Implementation

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1.1 Introduction

This book displays climate change adaptation measures that were developed and implemented in the Baltic Sea Region. International and European institutions, such as the Intergovernmental Panel on Climate Change (IPCC) as well as the EU Commission (2009) have identified the necessity of actions to go beyond strategies and called for the implementation of adaptation measures (IPCC, 2007; COM, 2009). Examples that demonstrate the need for the implementation of climate change adaptation measures to be politically pushed towards the local level are the resolution on resilient cities adopted by the Congress of Local and Regional Authorities of the Council of Europe (2012), the position paper on climate change by the Association of Finnish Local and Regional Authorities (Suomen Kuntaliitto, 2010) or the recently published policy document on climate change adaptation by the German Association of Cities (2012). The latter paper lists a number of adaptation measures cities shall take into consideration for future land-use planning.

Consistent with these calls for action, the **Climate Change: Impacts, Costs and Adaptation in the Baltic Sea Region (BaltCICA)** project particularly focused on the implementation of adaptation measures, which are summarised in this book. Representatives of regional and local authorities, municipalities, research institutes of various disciplines and universities from eight countries[1] participated in the project. The BaltCICA project was the third consecutive project on climate change adaptation in the Baltic Sea Region conducted under the Geological Survey of Finland. The first of these projects, SEAREG,[2] focused on awareness raising and structuring of the science-stakeholder dialogue. The second project, ASTRA,[3] identified climate change impacts on regional development and formulated adaptation strategies. The BaltCICA project drew on the experiences of these projects and contributed to the implementation of adaptation measures. It produced new knowledge relating to climate change impacts, costs and benefits and governance of adaptation. It reduced uncertainty in decision-making in relation to adaptation by

[1]Denmark, Estonia, Finland, Germany, Latvia, Lithuania, Norway and Sweden
[2]Sea level change affecting the spatial development in the Baltic Sea Region (2002–2005), www.gtk.fi/slr
[3]Developing Policies & Adaptation Strategies to Climate Change in the Baltic Sea Region (2005–2007), www.astra-project.org

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strengthening science-decision maker links and it increased participation of stakeholders and citizens in decision-making on adaptation measures.

Thirteen case studies dealt with a broad range of thematic areas, especially focusing on land-use planning and urban development for adaptation. Interdisciplinary work enabled a multi-faceted approach to these topics. This included modelling of climate change impacts on groundwater and flood-prone areas; the participatory development of adaptation measures with the cooperation of citizens, authorities, scientists and representatives of economic sectors; as well as the assessment of adaptation options with respect to costs, benefits and less tangible criteria such as environmental impacts or aesthetics. These methods were closely interlinked in order to foster climate change adaptation at the local level.

The methodologies to identify and implement adaptation measures were developed on a local level and communicated among project partners via study visits and workshops. These workshops enabled other project partners to both learn about new methodologies and to further develop them according to specific local needs in their respective case studies.

Scenario workshops were designed and employed for direct science-stakeholder cooperation. This methodology was adapted to local circumstances of each case study and applied to identify needs and viabilities of decision-making processes towards implementing adaptation measures. Adapting or changing current land-use plans and underlying regulations, is often a lengthy process. Therefore concrete adaptation actions have been employed in only some of the case study areas, meanwhile in several other municipalities decisions are currently being taken or are high on the political agenda. In any case, the BaltCICA project has had a notable impact in the case studies on developing methodologies on how to take the step ahead from formulating climate change adaptation strategies towards specific adaptation measures.

The project partners have communicated their activities and results beyond the Baltic Sea Region and Europe. In the course of these dissemination activities several new project ideas were born. Some international activities therefore round the book up with examples on how climate change adaptation is perceived and dealt with in areas outside of the Baltic Sea Region.

1.2 Structuring the communication processes

The identification of adaptation necessities and potentials requires interdisciplinary cooperation, not only between scientific disciplines but especially between scientists and stakeholders (including decision makers) (e.g. Adger et al., 2009; Dessai & Hulme, 2004). Therefore the communication process plays a key role. Only if decision makers, scientists and involved citizens agree on local necessities of adaptation options is it possible to develop reasonable and cost-effective options that can be implemented. For decision makers it is usually not practicable to develop measures against impacts that might potentially occur in 100 years. In the daily business of decision makers, the focus is often on current and near future land use patterns. Therefore it is necessary to understand motivations and interests of decision makers in order to find entry points in planning that may respect developments that lie in the farther future. It was shown during the project work that adaptation concepts that can be embedded into current political demands and interests raise the interest and thus also the acceptability among decision makers.

The communication with stakeholders during the BaltCICA project and its predecessors showed that overall ‘tool boxes’ are difficult to deploy or can even be counterproductive, as every municipality has its own history and special characters. An overall adaptation concept is often received sceptically, so that general concepts, for example, on how to start and endorse communication processes are helpful. But finally each approach for every respective case study has to be completely adapted to the special requirements of each respective case study.

It also turned out that preferred adaptation options are in fact those of no-regret character, that is, those that also offer protection to current hazard patterns. It proved useful to start off with current extreme events (including historical records) rather than using those of potential flood events that might occur in the future. The potential impacts of current extreme events revealed recent developments of local vulnerability patterns. Often it turned out that assets had been constructed in unsuitable, that is, currently hazard prone areas. In the communication process land use developments and future options were then combined with potential changes in sea level and hydro-meteorological phenomena.

The combination of current and potential future land use patterns, climate variables and extreme events then lead to an integrated understanding of present as well as emerging risk patterns. In some case studies adaptation measures were designed to avoid or withstand current impacts, with an outlook on enhancing these measures along with ongoing climate change. In these cases adaptation measures are currently being put into practice. In other cases even more radical approaches of retreat were discussed, which would be implemented and aligned to the life cycles of buildings and infrastructure, and the development of climate impacts.

The examples displayed in this book show that whatever option on climate change adaptation might seem to be important from a scientific perspective, the structure of the communication process with stakeholders is the decisive factor to implement cost effective as well as politically and socially acceptable implementation measures.

1.3 Climate change induced physical impacts on the Baltic Sea Region

Impacts of climate change occur and are perceived differently throughout the Baltic Sea Region. Depending on local circumstances, climate change adaptation processes are in various stages and address different challenges. This section gives an overview on climate change impacts in the Baltic Sea Region, as based on current scientific knowledge. Local impacts are, where necessary, further described and analysed in the respective case studies.

1.3.1 Air Surface Temperature (AST)

Long-term observations of the Baltic Sea Basin mean AST indicates both decadal and seasonal trends. Annual temperature anomaly estimates show stronger fluctuations for the northern areas (north of 60°N) for the investigation period 1961–2001 (Jones & Moberg, 2003; HELCOM, 2007). Negative AST anomalies until the 1920s were followed by a first warming phase ending in the 1930s (0.274 K/decade). After a period of cooling (−0.156 K/decade) the annual AST anomalies increased steadily since the 1970s, exceeding any previously observed rates in the early 1990s (1977–2001: 0.364 K/decade) (Jones & Moberg, 2003).

For the Baltic Sea Region south of 60°N the AST development is not dramatic. Up until the 1970s, no significant AST trends can be observed. Nevertheless, an even more distinctive AST increase since 1985 (1977–2001: 0.425 K/decade) (Jones & Moberg, 2003), was recorded and was strongest south and east of Tallinn and St Petersburg due to changing patterns of the atmospheric circulation (HELCOM, 2007). The annual linear AST trends for the investigation period 1871–2004 show an overall increase of 0.07 K/decade for latitudes <60°N and of 0.10 K/decade for latitudes >60°N (Heino et al., 2008). With an annual warming trend of 0.08 K/decade, the Baltic Sea ASTs increase faster than global temperatures (0.05 K/decade) (HELCOM, 2007).

For the southern area seasonal trends are significant in spring, autumn and winter, with the highest increase (0.11 K/decade) for spring temperatures (HELCOM, 2007; Heino et al., 2008). In the northern Baltic Sea Basin the most distinct warming trend is also recorded in spring (0.15 K/decade), whereas the development of winter temperatures is insignificant (Heino et al., 2008). Among other consequences, this resulted in a significantly prolonged growing season in the Baltic Sea Region.

Despite certain caveats and uncertainties, all existing projections indicate that atmospheric temperatures in the Baltic Sea Basin may continue to warm during the next decades. Simulations based on the IPCC A2 and B2 emissions scenarios of future AST in 2071–2100 show changes relative to the reference period 1961–90 between 2.8–4.8 K for the Baltic Sea Region (Meier, 2006). There are seasonal differences, indicating a stronger increase in wintertime AST as compared to summertime AST, which are especially high in the northern and eastern sub-regions of the Baltic Sea (Räisänen et al., 2004; HELCOM, 2007). Meier (2006) found the largest monthly mean AST change of 6 K in February (2071–2100). Moreover, the southern parts of the Baltic Sea Region may experience a more pronounced warming in summer than the northern parts (HELCOM, 2007).

1.3.2 Sea Surface Temperature (SST)

As the Baltic Sea is a relatively small and shallow semi-enclosed sea characterized by a low and strongly varying salinity of its surface waters (approximately 20 practical salinity units (PSU) in the Kattegat and 1–2 PSU in the Bothnian Bay and Gulf of Finland) (HELCOM, 2012), changes in SST occur comparatively fast. This holds true for both seasonal and long-term responses of sea temperatures to solar radiation and air temperatures.

Depending on the investigation period, analyses of SST data lead to different results. A reason for that is the long-term variability in the thermal development of the Baltic Sea. For example, the past 100 years were characterized by warming phases in 1920–40 and since the 1970s. These warming phases were interrupted by colder periods, whereby the SST increase rates of 0.65 K/decade since 1985 are unprecedented (Siegel, Gerth & Tschersich, 2008). The warmest years are observed since 1999 when there was a temperature rise of 0.8 K/year (Siegel, Gerth & Tschersich, 2006; HELCOM, 2007), showing strong seasonal and regional variations. The rise of temperatures in summer and autumn mainly determined the positive trend in SST for the Baltic Sea (Siegel, Gerth & Tschersich, 2008). On the other hand, analyses of modelled mean water temperatures for 1970 and 2002, averaged over all depths of the Baltic Sea, showed no trend at all (Heino et al., 2008).

Current simulations of the SST in the Baltic Sea Basin project a positive warming trend for the next decades. Regional coupled atmosphere-ocean models forced by the B2 and A2 emissions scenarios project an increase in annual mean SST between 2 to 4 Kelvin in the period 2071–2100 compared to 1961–1990, which would be most pronounced in the southern and central Baltic Sea (HELCOM, 2007). In comparison, Neumann and Friedland (2011), based their projections on the IPCC B1 and A1B emissions scenarios, assumed an increase in the order of 2–3.5 K until the end of the 21st century.

1.3.3 Precipitation

Compared to other parameters, precipitation varies greatly in time and space. Due to this and the poor data coverage as well as differing measurement techniques, it is difficult to establish long-term trends for the Baltic Sea Basin. Long-term observations indicate seasonally varying precipitation patterns. For each season, both increasing and decreasing trends can be found for the period 1976–2000 compared to the period 1951–75 (HELCOM, 2007). Nevertheless, an annual increase in precipitation is observed for the period mentioned which however, varies strongly across regions (Heino et al., 2008).

Modelling the development of precipitation under climate change appears to be rather difficult, as the RCM results are still biased, often overestimating winter precipitation (Graham et al., 2008). The general winter precipitation trends may be intensified due to an increasing number and intensity of low-pressure systems from the Atlantic. Changes in summer precipitation may vary regionally with an increase in the northern parts of the Baltic Sea and a decrease in southern parts (HELCOM, 2007; Graham et al., 2008; Neumann & Friedland, 2011). Consequently, precipitation patterns may both shift seasonally and change geographically.

1.3.4 Sea level

Over long-term timescales, the Baltic Sea Region has been subject to dynamic processes, affecting sea level. One of the most important factors is the isostatic effect, due to post-glacial rebound of Fennoscandia, which results in an uplift of the Scandinavian plate with simultaneous lowering of the southern Baltic coast (Heino et al., 2008). Secondarily, since the end of the 19th century there is an eustatic sea-level rise (SLR) of about 1 mm/year (Ekman, 1999). A different factor that is affecting the mean sea level is the salinity gradient (see section on ‘salinity’) together with a mean west wind component in the Baltic Sea Basin which all cause an increase in the mean sea surface height ‘from the Kattegat to the Gulf of Finland and the Bay of Bothnia by about 25 and 32 cm, respectively’ as observed in the 20th century (Meier, Broman & Kjellström, 2004). All these factors have to be considered when discussing changes in sea levels along the Baltic coast. Except for the southern Baltic Sea (SLR 1.7 mm/year), post-glacial rebound combined with eustatic SLR results in decreasing sea levels (Ekman, 1996; Heino et al., 2008; Scotto, Barbosa & Alonso, 2009). In the Gulf of Finland, there is a slight net sea level decrease (1–2 mm/year) (Ekman, 1996). The strongest decrease rates can be found in the Gulf of Bothnia (8–9 mm/year) during the 20th century (Ekman, 1996; Heino et al., 2008). Based on observations from the late 19th century Johansson, Boman, Kahma and Launiainen (2004) found a considerable slow-down of sea level decrease or even slight sea level rise in recent decades. For example in Kokkola on the west coast of Finland, the recent SLR led to a less effective post-glacial rebound of the order of 4–5 mm/year compared to a long-term trend in land uplift of 7–8 mm/year (Schmidt-Thomé, Klein & Satkunas, 2010). Additionally, Johansson, Boman, Kahma and Launiainen (2001) found a significant increasing trend in the maximum values in the Baltic Sea nodal area which is at a range of 10 centimetres over half a century (1950–2000) which is more likely to be triggered by larger-scale changes in hydrological and weather conditions than by local storms.

Due to the previously mentioned reasons, an overall assessment of the development of future SLR for the entire Baltic Sea Region is hardly possible. But, it can be expected that some regions that are currently experiencing decreasing sea levels may be confronted with a SLR at the end of the 21st century as well (Fenger, Buch & Jacobsen, 2001).

1.3.5 Salinity

The Baltic Sea is characterized by a decreasing salinity gradient from southwestern to north/northeastern areas determined by the following factors: river runoff, net precipitation and water exchange with the North Sea (Meier, Broman & Kjellström, 2004; Meier, 2006; HELCOM, 2012). The development of salinity during the 20th century is statistically insignificant and no long-term trend can be found (Winsor, Rodhe & Omstedt, 2001; Heino et al., 2008). But because of variations in freshwater inflow and the zonal wind velocity, decadal effects in salinity can be detected (HELCOM, 2007).

Projections of the future development of salinity vary greatly. Nevertheless, it is likely that the salinity of the Baltic Sea might decrease until the end of the 21st century (HELCOM, 2007). On the basis of simulations using the A1B and B1 emissions scenarios, Neumann and Friedland (2011) report a decrease in sea surface salinity in the range of 1.5–2 g/kg or 8–50 % (Meier, 2006) until the end of the 21st century. Due to increasing rainfalls in the northern parts of the Baltic Sea, the river runoff may increase by up to 15% (Meier, 2006) and may, therefore, influence especially the salinity of the northern and northeastern parts of the Baltic Sea Basin. The decrease in salinity would be more pronounced in the wintertime due to an enhanced river runoff (Neumann & Friedland, 2001).

1.3.6 Sea ice

The development of sea ice in the Baltic Sea is predominantly determined by atmospheric conditions due to the smallness of the basin (Stigebrandt & Gustafsson, 2003). The sea ice concentration ‘increases approximately linearly with decreasing temperatures’ starting at 1°C (Stigebrandt & Gustafsson, 2003). Currently, half of the Baltic Sea is ice-covered in the wintertime (Meier, 2006). The ice extent is mainly forced by the severeness of a winter season. Since the mid 1990s, the ice winters have been average or milder than average (HELCOM, 2007). Within the Baltic Sea Region, the length of the ice season decreased by 14–44 days in the twentieth century (HELCOM, 2007).

As there is a strong relationship between AST and SST, the future ice coverage is highly dependent on climate change induced warming temperatures. Therefore, the development towards more winters with a comparatively small sea ice extent as well as the decreasing length of the ice season are likely to continue in the Baltic Sea Region. Projections suggest a dramatic retreat of ice cover until the end of the 21st century, which would have a great impact on the Baltic winter climate in general (HELCOM, 2007). Simulations (based on A1B and B1) show that the sea may be covered by only one third of the recent coverage at the end of the 21st century (Neumann & Friedland, 2011). On average, large areas would become ice free and the ice season may decrease by one to two months in the northern parts and two to three months in the central parts of the Baltic Sea (HELCOM, 2007).

1.4 Chapter summaries

The chapters in this book are built on adaptation processes with a clear geographic reference, but touching different thematic aspects. They are grouped as far as possible according to common geographic entities as well as thematic preferences. The book starts off with some of the most important aspects of climate change adaptation, the structuring of communication processes and cost evaluations. In the following, applications of these topics are elaborated for planning aspects in urban and metropolitan areas. The management of resources under climate changes is elaborated in the next section, after which climate change impacts and adaptation measures on larger geographical entities comprising entire coastlines and the tourism sector are assessed. The book closes with four examples, reaching from international insurance approaches towards national activities on natural hazard mitigation and agricultural adaptation projects – towards grass-root level adaptation in cooperation with local people, all exemplarily displaying the wide range of ongoing activities.

Chapter 2 introduces two methods for participatory decision-making for climate change adaptation and their application in Kalundborg, Denmark (Bedsted and Gram). Scenario workshops are presented as a way of addressing uncertainties related to climate change and offering stakeholders the possibility of creating their own development visions for an area or a specific thematic issue. The citizen summit in turn allows citizens to discuss and decide on a set of options for the development of their town. The results provide guidance for political decisions. Chapter 3 and Chapter 4 show two assessment methods for specific adaptation options for flood protection. In Chapter 3 Boettle, Rybski and Kropp test, using the example of Kalundborg, the applicability of cost-benefit analysis (CBA) as a supporting tool for decisions about the level and timing of flood protection measures. In this context they show that the results of the CBA (and hence potential decisions based on the CBA) depend strongly on underlying assumptions of discounting rates and climate sensitivity to greenhouse gases. In Chapter 4 the analysis of flood protection options for two case studies in Northern Germany include a wider set of monetary and intangible criteria. Boettle, Schmidt-Thomé and Rybski show that multi-criteria decision analysis (MCDA) can support decision making and increase the acceptance among stakeholders.

The methods of scenario workshops, CBA and MCDA were adjusted to and applied in a range of other case studies of the BaltCICA project. This is reflected in the following chapters.

The role of climate change in an urban context is discussed on the basis of case studies in six chapters. Tuusa et al. (Chapter 5) look at the development process of the climate change adaptation strategy for the Helsinki Metropolitan Area (HSY, 2012) with a special emphasis on interviews of key stakeholders.

Chapter 6 about Riga, Latvia (Kūle et al.) highlights several aspects of flood protection and climate change. On the background of historical flood events and protection measurements it assesses in detail the communication processes and generation of knowledge related to flooding and introduces Multi Criteria Decision Analysis as a potential support tool for strategic flood risk management in Riga.

Chapter 7 by Knieling and Schaerffer takes a look at developments and new plans along the River Elbe and the harbour area in Hamburg, Germany. These developments are critically reflected upon with respect to the aim of absolute flood safety compared to more flexible concepts of flood risk management.

Bergen is among the most active cities with respect to climate change adaptation in Norway (Dannevig, Rauken & Hovelsrud, 2012). Chapter 8 by Langeland, Klausen and Winsvold focuses on the learning processes, knowledge transfer and coordination that take place among the numerous institutions and project addressing climate change.

Though clearly located in an urban context Chapter 9 by Rimkus, Kažys, Stonevičius and Valiuškevičius illustrates the adaptation process based on specific adaptation measures for flood protection along the Smeltalė River in Klaipėda, Lithuania. The chapter includes the modelling of potential climate change impacts on precipitation and flooding, multi-criteria decision analysis for decision support and the participatory development and assessment of a set of adaptation options. In Chapter 10 Ahonen, Valjus and Tiilikainen explain how geological investigations can help to open up the discussion on climate change adaptation on a broader scale. It starts with a thorough geological investigation of the ridge (esker) and popular housing area that separates the two lakes Näsijärvi and Pyhäjärvi in Tampere, Finland. It then describes the most important impacts of climate change to be expected in the investigated area and points out further issues that should be addressed in municipal planning.

Chapter 11 on water supply in the municipality of Hanko, Finland (Luoma, Klein and Backman) describes how potential climate change impacts on water supply can be assessed with the help of groundwater flow models and how they can provide supporting information for groundwater management. Also, Chapter 12 on groundwater availability in Klaipeda, Lithuania (Arustienė, Gregorauskas, Kriukaitė and Satkūnas) describes the assessment of changing climate conditions on groundwater availability, but also addresses groundwater as an important resource for drinking water in Europe. In Chapter 13 Klamt and Schernewski explore the potential for commercial mussel farming in the southern Baltic with the Blue mussel and the Zebra mussel as two suitable species. Mussel farming is not only seen as an economic potential thanks to higher temperatures and less sea ice in winter, but also as an effective measure to reduce eutrophication in the Baltic Sea.

Sea level rise and changes in flood patterns concern not only urban development but are expected to affect the entire coastal zone. These potential changes are assessed by Petersell, Suuroja, All and Shtokalenko (Chapter 14) for the west Estonian coast. They also investigate potential consequences for groundwater quality, loss of forest and arable land and costs for built-up areas. In Chapter 15 Satkūnas, Jarmalavičius, Damušytė and Žilinskas investigate the geomorphological conditions for Karkle beach in Lithuania, potential consequences of climate change and the indirect effects on long-term plans and investments for tourism in this area. Interestingly, not only can the state of the coastal zone, but also the water conditions in the Baltic Sea have effects on the tourism development in the Baltic Sea Region. Mossbauer, Dahlke, Friedland and Schernewski (Chapter 16) model the potential effects of climate change and the Baltic Sea Action Plan on the growth and development on macroalgae accumulations along the German shore and outline the implications for the maintenance of beaches. Two chapters in this book deal specifically with tourism and climate change. Filies and Schumacher (Chapter 17) identify a wide range of direct, indirect and induced impacts of climate change on tourism at the German Baltic Sea coast. Based on their results they challenge the view that the tourism sector could benefit from climate change thanks to higher temperatures and changes in precipitation. Additionally, they compare tourism experts' views on adaptation with adaptation requirements suggested by science. Since tourism also depends highly on the satisfaction of the customers (tourists) it seems to be consequent to take tourists' perceptions and opinions into account in strategic planning. In Chapter 18 Donges, Haller and Schernewski show that visitor questionnaires can provide valuable input for short-term decisions and planning, but have restricted benefits for long-term strategies for climate change adaptation.

The outreach section of this book sets off with Chapter 19 in which Olcina analyses recent modifications to Spain's national, regional and local planning regulation to mitigate the impacts of natural hazards. Meanwhile these policies mainly focus on current hazard patterns; initiatives already go further in order to respect potential climate change impacts too.

In Chapter 20 Sano, Prabhakar, Kartikasari and Irawan describe in detail how Indonesia's agricultural sector is planning to adapt to climate changes in order to safeguard food security. Besides the largely positive activities the chapter also explains the difficulties of applying and implementing climate change adaptation on the local level.

In Chapter 21 Saroar and Routray analyse the often-predicted climate change induced mass emigration scenarios at the grass root level. Vulnerability reductions to hinder prospected emigration patterns are explored.

Prabhakar, Rao, Fukuda and Hayashi (Chapter 22) study risk insurances in the Asia-Pacific region. Focusing on India and Japan they identify a set of potential short-comings in the currently available insurance schemes. These include the affordability of insurance premiums, the access to risk insurances for individuals and the availability of information about risks. They suggest the UNFCCC as a suitable platform to enhance risk insurance as a means of risk reduction and climate change adaptation.

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