

Climate Change in the Baltic Sea Region: A Cross-Country Analysis of Institutional Stakeholder Perceptions

Joanna Piwowarczyk, Anders Hansson,
Mattias Hjerpe, Boris Chubarenko,
Konstantin Karmanov

Abstract Before climate change is considered in long-term coastal management, it is necessary to investigate how institutional stakeholders in coastal management conceptualize climate change, as their awareness will ultimately affect their actions. Using questionnaires in eight Baltic Sea riparian countries, this study examines environmental managers' awareness of climate change. Our results indicate that problems related to global warming are deemed secondary to short-term social and economic issues. Respondents agree that problems caused by global warming will become increasingly important, but pay little attention to adaptation and mitigation strategies. Current environmental problems are expected to continue to be urgent in the future. We conclude that an apparent gap exists between decision making, public concerns, and scientific consensus, resulting in a situation in which the latest evidence rarely influences commonly held opinions.

Keywords Climate change · Baltic Sea region countries · Decision making · Perception · Adaptation

INTRODUCTION

Coastal areas are usually the most productive marine ecosystems and therefore involve many uses and stakeholders. They deliver a wide range of marine ecosystem services—benefits we obtain from the marine environment—that advance societal well-being. Such services may be life-supporting, create economic opportunities, or contribute to cognitive or spiritual development (SEPA 2009), and provision of these services depends on the state of the ecosystem. At the same time, coastal and marine areas are under increasing anthropogenic pressure. About one-third of the EU population lives within 50 km of the coast, and

this proportion is increasing (Curran et al. 2002; EEA 2006). The degradation caused by urban development and other on-land activities makes coastal areas increasingly fragile and vulnerable (SEPA 2009). Of the major anthropogenic pressures, unsustainable management practices, over-harvesting, and climate change are of greatest importance (EEA 2006).

Sufficient scientific evidence indicates that Europe (e.g., EEA 2005, 2008; IPCC 2007a, b) and the Baltic Sea region (BSR; BACC Author Team 2008) will face considerable climate change consequences, although the region will be less affected than Africa or Southeast Asia. Rising mean temperatures and changed precipitation patterns is expected to affect, inter alia, energy demand, agriculture, and flood risk (EEA 2005). Impact scenarios (e.g., Metzger et al. 2008; Reidsma et al. 2009) generally suggest an uneven distribution of impacts across and within EU countries (O'Brien et al. 2004; Folke et al. 2005). Political work is underway to prepare policies and strategies for meeting these challenges and seizing the opportunities they create at the EU (EU Commission 2007, 2009a, b), BSR (EU 2010), and, to a greatly varying extent, at national (Biesbroek et al. 2010) levels.

Although all BSR countries except Russia are EU member states, they are not equally developed, differing significantly in country size, population density, economic development, living standards, governance capacity, and recent history (Table 1).

The warming trend observed in the twenty-first century in the BSR ($0.08\text{ }^{\circ}\text{C decade}^{-1}$) is considerably greater than the 1861–2000 global trend ($0.05\text{ }^{\circ}\text{C decade}^{-1}$) and is expected to continue for the next 100 years (HELCOM 2007). Sea level rise of $\sim 1.7\text{ mm year}^{-1}$ in the southern BSR and -9.4 mm in the Gulf of Bothnia (in the northern Baltic Sea, land uplift still overcompensates for sea level

Table 1 Geographic, economic, and governance characteristics of BSR countries (based on www.cia.gov/library/publications/the-world-factbook/, www.govindicators.org, <http://epp.eurostat.ec.europa.eu>, and <http://hdr.undp.org/en/statistics/>)

	Estonia	Finland	Germany	Latvia	Lithuania	Poland	Russia	Sweden
Area (sq km)	45 228	338 145	357 022	64 589	65 300	312 685	13 400 ^b	450 295
Population (July 2011)	1 282 963	5 259 250	81 471 834	2 204 708	3 535 547	38 441 588	937 800 ^c	9 088 728
GDP per capita (in 2010 USD)	19 100	35 400	35 700	14 700	16 000	18 800	15 900	39 100
Human development index (2011)	0.835	0.882	0.905	0.805	0.810	0.813	0.755	0.904
Political stability (2010)	0.635315	1.381071	0.812112	0.476837	0.664017	0.998996	-0.887010	1.076211
Government effectiveness (2010)	1.221572	2.240691	1.554770	0.697276	0.723395	0.705965	-0.394028	2.016361
Regulatory quality (2010)	1.447284	1.836937	1.575231	0.976836	0.974011	0.973952	-0.394849	1.719856
Carbon dioxide (1000 t; 2008)	15894.54	56600.48	690253.04	8101.50	13484.31	290330.74	No data ^d	49461.98
GHG emissions (1000 t CO ₂ equivalent; 2009)	16 837	66 336	919 698	10 723	21 609	376 659	No data ^d	59 994
GHG emissions, base year 1990 (2009) ^a	41	94	74	40	44	83	No data ^d	83
Share of renewable energy in gross final energy consumption (%; 2009)	22.8	30.3	9.8	34.3	17.0	8.9	No data ^d	47.3

^a Index: 1990 = 100

^b Kaliningrad region only

^c In 2009, Kaliningrad region only

^d No reliable data were found for Kaliningrad region

rise) will also contribute to environmental change in the region (HELCOM 2007). Higher temperatures will likely cause more frequent algal blooms, also influenced by possibly larger nutrient loads to the sea caused by heavier rains (e.g., Meier et al. 2012). Low-lying coastal areas will be even more exposed to erosion during expected mild winters, with strong and frequent storms in the absence of sea-ice cover. Water temperature changes and a potential salinity decrease will probably influence the plankton and zoobenthos composition, possibly reducing stocks of commercial fish such as cod. Hard shoreline protection and beach replenishment are already key issues, often conflicting with requirements to protect fish stocks and likely to become an even greater challenge (HELCOM 2007). In addition, many management decisions made today (e.g., large investments, coastal infrastructure, and hard shoreline protection) will constrain the management options available tomorrow, when climate change effects become more obvious and urgent (Moser and Tribbia 2006). As a result, natural ecosystems may no longer function properly and their vulnerability could increase, threatening more people and more aspects of human life. This is why climate change issues must be included in future planning and long-term coastal management (Naess et al. 2005).

Anthropogenic climate change has prompted two major policy responses: mitigation and adaptation (Stehr and von Storch 2005; Fussler and Klein 2006). Mitigation policy options aim at limiting climate change by reducing greenhouse gas (GHG) emissions and enhancing carbon sinks. Adaptation policies strive to diminish the negative effects of climate change by establishing a broad range of policies and measures targeting the vulnerable systems, for example, changes in human systems in response to actual or expected climate change (McCarthy et al. 2001). Adaptation often includes actions to seize new opportunities that may arise from climate change. Though the need for policy responses to enhance coastal resilience might be obvious to researchers, it is not necessarily obvious to decision makers because scientific knowledge cannot be directly translated or accepted by them. It is difficult for scientific knowledge of climate change effects to reach the level of certainty policy makers require if they are to implement related adaptation and mitigation policies (Bradshaw and Borchers 2000). This level of certainty is correlated with willingness to invest or act to avoid climate change effects. This willingness is due to the perceived risks and severity of climate change consequences (Scheraga and Grambsch 1998). If these risks are assessed as insignificant, especially by decision makers, more severe consequences could result, because societies will not change their everyday habits and no mitigation or adaptation actions will be undertaken (Sundblad et al. 2009).

Table 2 Characteristics of respondents

Country	No. of distributed questionnaires	No. of responses	Response rate (%)	No. of respondents involved in climate change activities	% of respondents involved in climate change activities
Estonia	32	12	38	6	50
Finland	32	15	47	13	87
Germany	75	23	31	12	52
Latvia	78	17	22	6	35
Lithuania	38	32	84	10	31
Poland	92	38	41	2	5
Russia	31	31	100	3	10
Sweden	107	18	17	16	89
Total	485	186	38	68	37

Several recent studies have examined how laypeople perceive the climate change issue (e.g., Lorenzoni and Pidgeon 2006; Leiserowitz 2007; Lorenzoni and Hulme 2009; Upham et al. 2009). Surprisingly, the opinions of institutional stakeholders, that is, government officials carrying out practical climate change mitigation and adaptation work, are less often discussed. To the best of our knowledge, few studies focus on the BSR (e.g., Eisenack et al. 2007); other existing studies focus either on individual countries (e.g., Belle and Bramwell 2005; Sundblad et al. 2009; Bray and Martinez 2011) or on several regions in one country (e.g., Moser and Tribbia 2006; Moser and Luers 2008).

This article aims to address this gap by providing an overview and illustrating how institutional coastal management stakeholders in the BSR perceive climate change, and its impacts and consequences at the local level. It also aims to identify respondents' general priorities as well as their personal knowledge of and confidence in the science of adaptation and mitigation strategies.

MATERIALS AND METHODS

This article draws together a large sample of institutional respondents active in coastal management from across the BSR. We specifically targeted three major groups of coastal stakeholders in eight BSR countries: (1) local and regional policy-making bodies, e.g., counties, communes, or municipalities, (2) statutory bodies and competent authorities, e.g., maritime administration or environmental agencies), and (3) environmental educators. We defined these target groups broadly, to cover a wide range of coastal management activities. All target groups were included in the national surveys conducted, but their relative proportions differed between countries. The final

sample included primarily officials working in regional and local authorities as planners or environmental managers. To capture the large heterogeneity of authorities in the BSR, the aggregate sample contained respondents working in sectoral departments in housing, energy supply, environmental management, spatial and physical planning, transportation, and agriculture. The questionnaire also enabled us to identify respondents who worked directly on issues related to global warming. The aggregate findings, based on the survey responses, fill an important gap in current knowledge of climate change perceptions in the BSR.

To determine target group attitudes, we developed questionnaires and translated them into the national languages of the surveyed countries. In all, 454 questionnaires were distributed in 2009 in the countries listed in Table 2, except Russia; 31 questionnaires were distributed in Russia in February 2010. The overall response rate was 38 %, the highest values occurring in Russia (100 %) and Lithuania (84 %) and the lowest in Latvia (22 %) and Sweden (17 %).

Two types of questionnaires and two survey modes were used, which may partly explain the differences in response rates. The first survey (three overarching and 33 sub-questions), which was adapted slightly for each country, was mailed to respondents in six countries, i.e., Finland, Sweden, Germany, Estonia, Lithuania, and Latvia; the response rate on a pilot mail trial of this survey in Poland was close to zero. The second survey (four overarching and 41 sub-questions) was administered at meetings focusing on environment-related issues held in highly urbanized regions: three meetings in the province of Pomerania in Poland and one meeting in the Kaliningrad region in Russia. The 100 % response rate obtained in Russia is accounted for by the survey administration method: respondents answered the questions together, question by

Table 3 Severity of climate change consequences over time: indicative numbers for BSR countries (no. of replies and %)

Cases	Total BSR (no. of replies)	Total BSR (%)
1 (↑ over time)	131	75
2 (↑ in 20 years; ↓ in 100 years)	11	6
3 (↔ in 20 years; ↑ in 100 years)	4	2
4 (↑ in 20 years; ↔ in 100 years)	13	7
5 (↔ over time)	14	8
6 (↓ over time)	2	1
Total	175	100

↑ increase, ↓ decrease, ↔ no change

question, while sample answers were presented on a screen. We believe that the results were not greatly affected by the method of administration, because the sample answers rarely appeared among the actual responses.

Both the questionnaires included open-ended and multiple-choice questions. The questionnaires used in Poland and Russia did not assess mitigation and adaptation measures, but only respondents in Poland and Russia identified the most important regional problems and assessed future development scenarios.

Survey data were loaded into an Excel spreadsheet to enable descriptive analysis of each survey item. The differences between survey modes and between targeted organizations and agencies in the various countries limited the ability to make direct cross-country comparisons. Instead, we compared what were the most frequently recognized among all response options rather than speculating about to what extent the option was recognized. We have striven to present results for each country and for the total sample in aggregate.

RESULTS

Consequences of Climate Change

Respondents were first asked to evaluate the consequences of climate change today and in the coming 20 and 100 years (Table 3) using a scale ranging from 1 (not serious) to 10 (extremely serious). Eleven of 186 surveys were incomplete. Most respondents (75 %) agreed that climate change would increase in importance over time. Some respondents, however, felt that the current situation was more severe than others believed it would be in 100 years. For example, there were some respondents who assessed the current situation to be between 7 and 10, while a few believed that in 100 years it will be 4 or less. On the other hand, the 8 % of respondents who did not expect the severity to change generally recognized the current situation as precarious. Six percent of respondents suggested that climate change would be an increasingly serious problem in 20 years, but that adaptation or mitigation strategies would improve the situation in 100 years.

Influence on Coastal and Marine Activities

We also asked how climate change would affect respondents' regions (Table 4). Although the overall outlook was pessimistic, a minority of respondents believed that a few sectors would actually benefit from climate change. The largest single fraction (about one quarter) of respondents believed that energy supply would benefit, but also one quarter believed otherwise. Similarly, about one-fourth expected agriculture to benefit (but about half of the respondents expected it to suffer). The least common answer, expressed by about 1 in 10 respondents, was that

Table 4 Climate change consequences for various sectors: indicative numbers for BSR countries (no. of replies and %)

Country/ effect	Agriculture	Forestry	Fishing	Industry	Water supply	Energy supply	Human health	Coastal infrastructure	Weather extremes	Biodiversity
Total BSR (no. of replies)										
Worse	96	90	92	30	92	38	85	102	130	103
Better	46	35	13	22	17	44	15	30	20	17
Unchanged	22	35	46	75	51	62	49	19	11	29
Do not know	21	25	34	41	25	41	36	34	24	36
Total BSR (%)										
Worse	52	49	50	18	50	21	46	55	70	56
Better	25	19	7	13	9	24	8	16	11	9
Unchanged	12	19	25	45	28	34	26	10	6	16
Do not know	11	14	18	24	14	22	19	18	13	19

climate change would positively affect fishing, human health, water supply, and biodiversity.

A high number of responses, ~25 %, were “don’t know,” especially regarding the future impact of climate change on industry and energy supply. Greater confidence (only 13 % “don’t know” responses) was attached to weather extremes, most often identified as negatively affected by temperature rise, eliciting 70 % “worse” or “much worse” responses. Only agriculture received a lower number of “don’t know” answers (11 %), but respondents were much less sure about the future of this sector.

About half of the environment-related activities (i.e., agriculture, forestry, fishing, frequency of extreme weather, and biodiversity) touched on in our surveys received 49–70 % of “worse” and “much worse” answers. Water and energy supply were not considered vulnerable by about one-third of respondents. Only the industrial sector was believed to be exposed to minor risks, and about half of respondents thought that climate change would not affect this sector. For one sector, energy supply, responses were equally distributed among the four possible options regarding risk.

The modes of survey design limit the extent to which inter-country comparisons can be made. Interestingly, however, the two Scandinavian countries included in our study (Finland and Sweden) were the only two in which most respondents believed that any sector (agriculture in both the countries, plus forestry and energy supply in Sweden) would benefit from climate change. However, the percentage of respondents involved in climate change-related activities was the highest in these two countries (Table 2).

Vulnerability Assessment

To assess awareness of coastal ecosystem vulnerability to climate change, we asked respondents to evaluate their personal understanding of climate change causes, effects, and mitigation and adaptation strategies (Fig. 1); however, this question was not included in the Russian and Polish

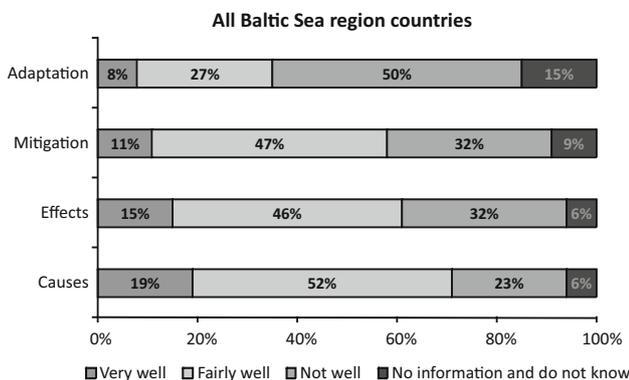


Fig. 1 Vulnerability assessment: how well are respondents informed about climate change causes, effects, mitigation, and adaptation

surveys. BSR respondents considered themselves well informed as to the causes and effects of global warming. They also considered themselves knowledgeable about mitigation policies, but were less familiar with adaptation issues.

Future Scenarios

The survey administered in Poland and Russia did not include the vulnerability assessment. On the other hand, only the surveys administered in these countries evaluated sustainable development scenarios. A choice between four future scenarios was proposed; respondents were asked to choose the scenario that (i) best supported sustainable development in the region and (ii) that they thought would best capture conditions in 2050 (Fig. 2). The scenarios were based on the four SRES socioeconomic scenarios and represent differences in world development patterns, economic growth, population, and technological change. These scenarios have been widely used as a basis for estimating future GHG emissions (Parry et al. 2004).

Most respondents (78 % in Poland and 50 % in Russia) who completed this item identified scenario number 3 (which the scientific community considers the most sustainable) as most sustainable. However, scenario 1 came second, being chosen by 19 % of respondents in Poland and 30 % in Russia, reflecting the prevalence of a neo-classical economic mindset. In Poland, most respondents (56 %) selected scenario number 3 as the most likely to describe 2050 conditions, while the increasing poverty scenario, number 2, ranked second, chosen by 32 %. In Russia, opinions regarding the 2050 scenario were divided nearly equally between all four options. Interestingly, although the survey was administered during the financial crisis starting in 2008, the 2050 predictions were quite optimistic.

Sustainable Development

Open-ended questions asked Polish and Russian respondents to identify activities that could promote sustainable management.

In Poland, better information provision (e.g., promoting environmentally friendly everyday habits) and education (i.e., formal and informal education, including learning by doing) were most frequently suggested. Although most Polish respondents suggested that schoolchildren would be the main target group of these activities, a few emphasized that special programs should also be developed for industry (especially large companies) and local decision makers. Respondents also noted that available scientific knowledge is not easily understandable. They believed that popularized explanations, even at the risk of oversimplification, should be incorporated into political, social, and media

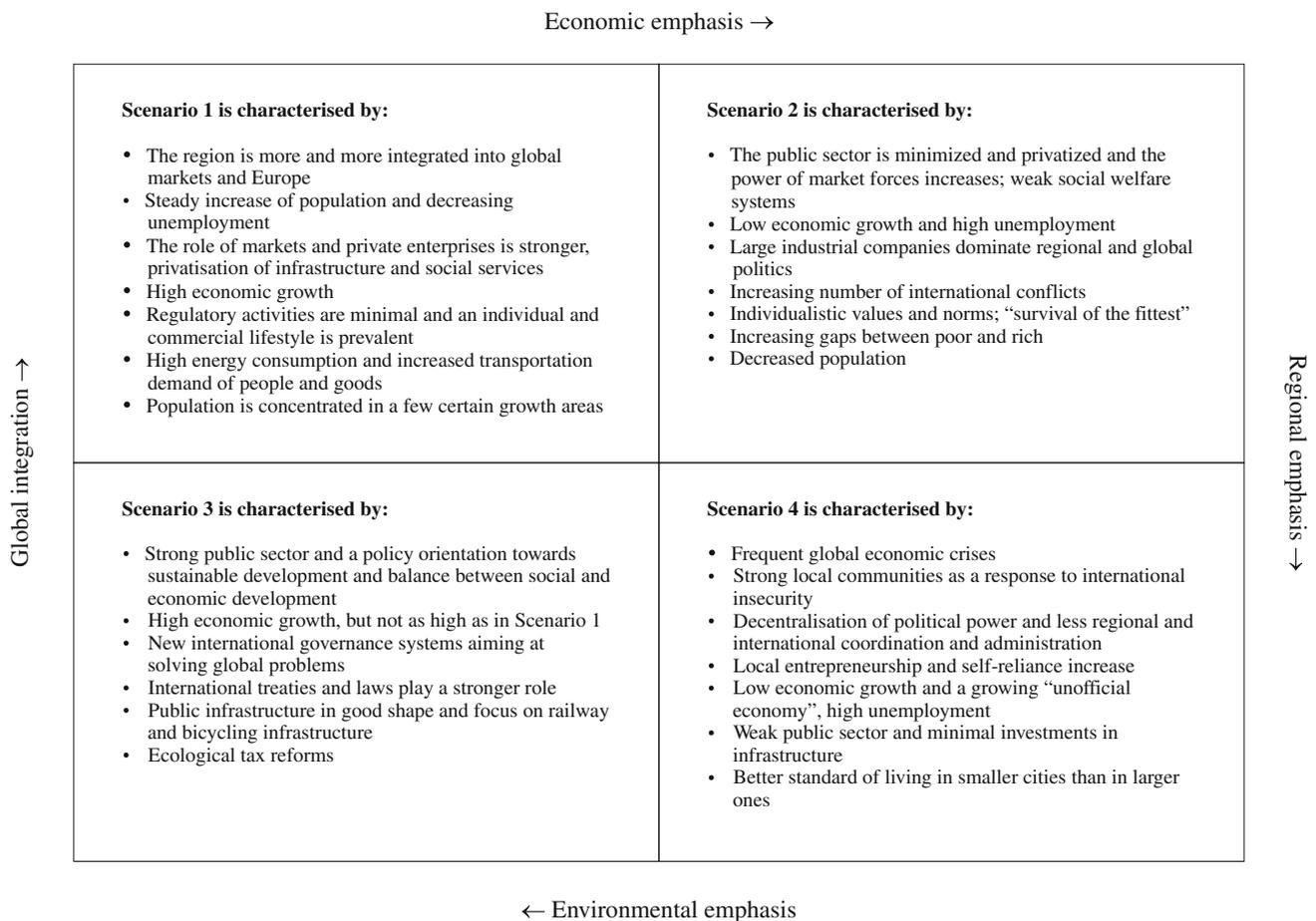


Fig. 2 Future scenarios (adapted from Parry et al. 2004)

discourses. Many respondents suggested that legal and financial incentives would be most effective at changing habits and raising awareness. However, the most common suggested legal measures included revising existing environmental legislation and strictly enforcing it. Such revision should aim to change environmental norms and the level of financial responsibility of abusers. Furthermore, more funding should be made available for promoting and supporting pro-environmental solutions and behaviors. Respondents also emphasized that local and even regional initiatives would be insufficient to resolve climate change challenges and that central planning and policies needed to become more effective. On the other hand, many respondents suggested that policy makers are not taking social needs into consideration, giving the public little confidence in local and governmental agencies. According to these respondents, delegating the choice between sustainable development and economic growth to representatives and experts may result in negative public reactions. Public engagement and increased transparency regarding science and policy should create a better basis for sustainable development.

Russian survey participants primarily represented local municipalities and environmental administrations, which may be why they concentrated on more concrete and hands-on problems with relatively easy-to-implement solutions. They asked for statistically reliable environmental monitoring data, including regional climate change scenarios. They also emphasized the need for systematic approaches to regional development and urban planning. As in Poland, however, common suggestions included changed natural resource management policy and strict implementation of environmental legislation. They called for water quality improvement, developing and modernizing housing and other public utilities, and establishing special protected natural areas. Lack of sufficient funding was also mentioned.

Major Regional Problems

Finally, both Poles and Russians were asked to identify the major regional problems today and in 20 years. Poles most often mentioned organizational problems (including insufficient funding), ineffective legislation, environmental

problems (e.g., eutrophication, habitat destruction, and biodiversity loss), limited environmental awareness, and inappropriate education. Less frequent answers included the financial crisis, unemployment, demographic change, and poor technical infrastructure in the region.

Although Russian respondents were also concerned with legislation and organizational problems, social and economic problems were considered much more serious. Russian respondents often mentioned the global financial crisis, lack of transport infrastructure, economic instability, low living standards, and high unemployment. The pollution of Vistula Lagoon and land areas changing into swamps were the environmental problems mentioned most often.

Polish respondents anticipated that the indicated problems would remain unsolved in 20 years, but almost no one expected new problems to appear in the future. A few answers indicated population decline and increasing anthropogenic pressure, such commercial or industrial development in NATURA 2000 areas.

Russians were more pessimistic than Poles. They anticipated that current problems would become more severe in 20 years and that new problems would arise, such as flooding, depopulation, significant health problems, and decreasing regional investment resulting in increased local poverty.

DISCUSSION

Social and economic conditions vary between BSR countries, but despite these differences, attitudes toward climate change differed only slightly. Notably, respondents from more economically developed countries were not more concerned with environmental issues or global warming. Climate change was not a priority for Polish and Russian respondents, nor did previous research find it to be a priority among Latvian, Finnish, Estonian, Lithuanian, Polish, and German respondents (Eisenack et al. 2007).

Direct involvement in climate change issues did not seem to significantly influence respondents' optimism or pessimism regarding the future effects of global warming. However, the highest number of such involved respondents was in Sweden, and the Swedish respondents as a cohort expected climate change to be relatively beneficial.

Generally, respondents from all countries agreed on the vulnerability assessment. Respondents commonly claimed to have good knowledge of climate change causes and effects, but were less familiar with mitigation and adaptation strategies. The actual average self-rated understanding might be worse as the response rate was generally low (qualified and issue-informed respondents are usually willing to complete questionnaires and share their views;

Moser and Tribbia 2006). Our findings support the finding of Eisenack et al. (2007) that local institutions are more aware of mitigation than of adaptation (58 % felt they were informed "very well" or "fairly well," while only 35 % were as confident about adaptation strategies).

Survey participants not only recognized the importance of sustainable development but also could propose a whole range of actions to facilitate it, perhaps because sustainable development discourse is prioritized on several political agendas. Sustainable development is, for example, an overarching principle of the EU Treaty, and many EU documents encourage or demand implementation of its various aspects. However, the measures Polish and Russian respondents proposed to support sustainable development were only weakly related to local problems and experiences. In their responses, fairly casual reasoning and general knowledge were prevalent. Raising environmental awareness was mentioned, but marine issues were not explicitly cited. Local perspectives were also lacking when respondents were asked to indicate the most pressing regional problems. A similar lack of local perspectives was observed in the previous BSR study (Eisenack et al. 2007). Apart from political agendas, there are also market-driven and voluntary examples of practical adoption of the sustainability concept (Clark and Lund 2007; Munasinghe 2010). As climate influences sustainability, these issues cannot be considered separately. Putting sustainability into practice might ease the incorporation of climate change issues into everyday management practices (Munasinghe and Swart 2000).

Further Analysis

Analysis indicates that many stakeholders have limited or imprecise knowledge on climate change. We believe that this is part of a wider problem related to lack of interaction between scientists and politicians. Accordingly, we discuss some constraints that may influence perceptions of climate change, possibly contributing to the science–policy lag.

First, climate change decision making is complex and difficult, and is therefore often neglected (Haanpää and Peltonen 2007). The situation is better in some countries (e.g., Finland, Sweden, and Germany), but even there the layperson's general knowledge is still very limited. Even when knowledge and awareness exist, putting them into planning or management practice is difficult (Haanpää and Peltonen 2007). This is partly because the actions that decision makers are willing to undertake depend mainly on their personal knowledge and values. In addition, they are also influenced by financial and social constraints, such as various stakeholder demands, political agendas, rigidity, intolerance of high risks and failures, and the need to

demonstrate practical results in a relatively short time (Bradshaw and Borchers 2000; Moser 2009).

Geographic scale is also a problem. Climate change is a global issue; policy decisions are usually made at the national level, while institutions involved in planning are often local or regional. Hence, problems of institutional fit concerning management across boundaries and policy versus implementation often arise (Cash and Moser 2000; Tompkins and Adger 2005).

Understanding of climate change is lacking for several reasons. First, as our surveys indicate, climate change and its consequences are overshadowed by other urgent, short-term problems. Other policy goals and the need for better education were clearly identified by Polish and Russian respondents. They did not mention climate change even once as among the most important policy goals, perhaps because the problem is not very concrete and other “here and now” issues attract greater attention. As well as social and economic problems, more acute environmental problems not considered gradual and creeping are prioritized (Wolf 2011).

Policy and decision making are social processes strongly influenced by the values and opinions of the groups of people they affect. Civil society plays a key role here: the more actively the public participates in or follows the scientific debates relating to climate change, the more it can influence and enrich the governance processes (Wolf 2011). If social pressure is not strong enough, politicians feel no direct need to undertake any action that might not be politically beneficial. Many people have heard about climate change, but still do not consider it important. Although in 2004 almost 50 % of EU citizens were worried about climate change, many did not relate the effects of global warming to their personal lives or to society (Lorenzoni and Pidgeon 2006). It is difficult to have a personal attitude toward climate change consequences, so they are not recognized as personally threatening (Lorenzoni and Pidgeon 2006). Limited personal involvement can, however, stem from limited or unsuccessful political action. Lack of political action can create a mental barrier blocking citizen engagement (Lorenzoni et al. 2007; Garvey 2009). Finally, most everyday experiences involve simple systems, in which inputs and outputs are closely related in time and space. Climate change is different, because it is a complex phenomenon with feedback loops and time delays (Chen 2011). Because action is costly and the results delayed, a “wait-and-see” approach prevails.

Limited time and resources are closely connected with prioritizing policy goals. Decision makers and coastal managers must deal with problems in the local institutional sphere. They have little time to address issues not defined by upper-level policies, even though these issues are often related to their responsibilities (Moser and Tribbia 2006).

This situation can be observed, for example, in the case of coastal protection. More frequent coastal flooding is anticipated to be a major problem related to climate change. However, decision makers often do not see the relationship between coastal protection and climate change. In general, they may not find it easy to link weather phenomena (e.g., droughts or stronger and more frequent storms) with climate change (Eisenack et al. 2007).

Time and resources can also constrain the learning process at the individual level. The learning process itself is difficult because science is disconnected from everyday life. Scientific discourse uses a specific and constantly revised jargon based on particular assumptions and uncertainties. Finally, scientific publications target other science professionals, not laypeople or policy makers (Bradshaw and Borchers 2000; Tribbia and Moser 2008). Individual level problems that officials interested in science may experience likely include: difficulty finding data; conflicts between information, values, and experience; and information overload (Lorenzoni et al. 2007).

CONCLUSIONS

This Study

Problems related to climate change are widely acknowledged when directly explored by survey questions, though they are often overshadowed by other social, economic, and environmental problems. With few exceptions, respondents believed climate change negatively affected most sectors of human activity. Simultaneously, climate change was perceived as distant in space and time, so only the need for soft actions, related mainly to education, was acknowledged. Adaptation and mitigation were regarded as of secondary importance, although respondents claimed considerable self-rated knowledge of these topics. The situation has changed little since the last cross-BSR survey (Eisenack et al. 2007). Understanding of the consequences of climate change remains abstract, vague, and not region based. There is still a need for information and knowledge that would enable a shift in thinking that could promote more adequate adaptation and mitigation actions.

Other Studies

Extensive scientific literature on climate change is available, but global warming issues are not defined clearly enough to meet decision-making demands. It is not particularly easy to inform decision makers based, for example, on scientific modeling. Although scientific consensus regarding global warming is broad based, agreement as to its effects is lacking (Bray 2010). Consequently, as even

organizations and individuals directly concerned with climate change consider other issues more important, few operational agendas for mitigation and adaptation are available in the BSR (Eisenack et al. 2007). Responsibility for these actions is delegated elsewhere. Achieving coherent climate change response policies would benefit from an appropriate information strategy and lifelong learning programs, though these actions are not enough. Simply raising the awareness of coastal planners, policy makers, and decision makers will not create the needed solutions. There is also a serious need for regularly delivered understandable information linking environmental problems and possible solutions (Moser and Tribbia 2006). Such solutions should take into account the institutional context, and highlight management options that are feasible at the local, regional, national, and international levels. Managers and spatial planners should be involved in interactive learning, including practical examples and experience exchange. When combined, the above approaches might build the social capacity to improve the common understanding of the need for climate change adaptation strategies that would inform policy making.

Acknowledgments This study represents a contribution to the project Advanced Modeling Tool for Scenarios of the Baltic Sea Ecosystem to Support Decision Making (ECOSUPPORT), which has received funding from the EC's Seventh Framework Programme (FP/2007–2013, Grant 217246) in conjunction with BONUS, the joint Baltic Sea research and development program, supported by the Russian Fund of Basic Research (Grant 08-05-92421) and the Polish Ministry of Science and Higher Education (Grant 06/BONUS/2009). It also contributes to the project Baltic Challenges and Chances for Local and Regional Development Generated by Climate Change, funded by the European Regional Development Fund's Baltic Sea Region Programme, 2007–2013.

REFERENCES

- BACC Author Team. 2008. *Assessment of climate change for the Baltic Sea basin*, 474. Berlin: Springer.
- Belle, N., and B. Bramwell. 2005. Climate change and small island tourism: Policy maker and industry perspectives in Barbados. *Journal on Travel Research* 44: 32–41.
- Biesbroek, G.R., R.J. Swart, T. Carter, C. Cowan, T. Henrichs, H. Mela, M.D. Morecroft, and D. Rey. 2010. Europe adapts to climate change: Comparing national adaptation strategies. *Global Environmental Change* 20: 440–450.
- Bradshaw, G.A., and J.G. Borchers. 2000. Uncertainty as information: Narrowing the science–policy gap. *Conservation Ecology* 4: 7. Online: <http://www.consecol.org/vol4/iss1/art7/>. Accessed 8 Sept 2011.
- Bray, D. 2010. A survey of the perspectives of climate scientists concerning climate change and climate science in the Baltic Sea Basin. International BALTEX Secretariat Publication No. 48, Geesthacht, Germany, 83 pp.
- Bray, D., and G. Martinez. 2011. A survey of the perceptions of regional political decision makers concerning climate change and adaptation in the German Baltic Sea region. International BALTEX Secretariat Publication No. 50, Geesthacht, Germany, 93 pp.
- Cash, D.W., and S.C. Moser. 2000. Linking global and local scales: Designing dynamic assessment and management processes. *Global Environmental Change* 10: 109–120.
- Chen, X. 2011. Why people misunderstand climate change? Heuristics, mental models and ontological assumptions. *Climatic Change* 108: 31–46.
- Clark, W., and H. Lund. 2007. Sustainable development in practice. *Journal of Cleaner Production* 15: 253–258.
- Curran, S., A. Kumar, W. Lutz, and M. Williams. 2002. Interactions between coastal and marine ecosystems and human population systems: Perspectives on how consumption mediates this interaction. *AMBIO* 31: 264–268.
- Eisenack, K., V. Tekken, and J.P. Kropp. 2007. Stakeholders perception of climate change in the Baltic Sea region. *Coastline Reports* 8: 245–255.
- EEA. 2005. Vulnerability and adaptation to climate change in Europe. European Environmental Agency, Technical Report 7/2005, Copenhagen, Denmark, 79 pp.
- EEA. 2006. The changing faces of Europe's coastal areas. European Environmental Agency, Report 6/2006, Copenhagen, Denmark, 107 pp.
- EEA. 2008. Impacts of Europe's changing climate: 2008 indicator-based assessment. European Environmental Agency, Report 4/2008, Copenhagen, Denmark, 246 pp.
- EU Commission. 2007. Green paper from the Commission to the Council, the European Parliament, the European Economic and Social Committee and the Committee of the Regions. Adapting to climate change in Europe: Options for EU action. No. COM(2007) 354 Final (SEC(2007)849), Commission of the European Community, Brussels, Belgium.
- EU Commission. 2009a. Commission staff working document. Impact assessment accompanying the White paper—adapting to climate change: Towards a European framework for action. SEC(2009)387/2. Commission of the European Community, Brussels, Belgium.
- EU Commission. 2009b. White paper—adapting to climate change: Towards a European framework for action. COM(2009)147 Final. Commission of the European Community, Brussels, Belgium.
- EU. 2010. The European Union regional strategy for the Baltic Sea region: Background and analysis. Office for Official Publications of the European Union, Luxembourg, 156 pp.
- Folke, C., T. Hahn, P. Olsson, and J. Norberg. 2005. Adaptive governance of social–ecological systems. *Annual Review of Environment and Resources* 30: 441–473.
- Füssel, H.M., and R.J.T. Klein. 2006. Climate change vulnerability assessment: An evolution of conceptual thinking. *Climatic Change* 75: 301–329.
- Garvey, J. 2009. *The ethics of climate change: Right and wrong in the warming world*. London: Continuum International Publishing Group.
- Haanpää S., and L. Peltonen. 2007. Institutional vulnerability of spatial planning systems against climate change in the BSR. http://www.gsf.fi/projects/astra/sites/download/ASTRA_institutional_vulnerability_final_SH_YTK_160507.pdf. Accessed 9 Sept 2011.
- HELCOM. 2007. Climate change in the Baltic Sea area: HELCOM thematic assessment in 2007. Baltic Sea Environment Proceedings No. 111, Helsinki, Finland, 48 pp.
- IPCC. 2007a. Synthesis Report of the Fourth Assessment Report Climate Change 2007: Contribution of Working Groups I, II and III to the Fourth Assessment Report of the Intergovernmental Panel on Climate Change. IPCC, Geneva, Switzerland, 104 pp.
- IPCC. 2007b. Summary for policymakers. In *Climate change 2007: Mitigation. contribution of working group III to the fourth*

- assessment report of the intergovernmental panel on climate change, eds. B. Metz, O.R. Davidson, P.R. Bosch, R. Dave, and L.A. Meyer, 3–23. Cambridge: Cambridge University Press.
- Leiserowitz, A. 2007. International public opinion, perception, and understanding of global climate change. Human Development Report 2007/2008, Human Development Report Office Occasional Paper. http://hdr.undp.org/en/reports/global/hdr2007-8/papers/leiserowitz_anthony6.pdf. Accessed 21 March 2012.
- Lorenzoni, I., and N.F. Pidgeon. 2006. Public views on climate change: European and USA perspectives. *Climatic Change* 77: 73–95.
- Lorenzoni, I., and M. Hulme. 2009. Believing is seeing: Laypeople's views of future socio-economic and climate change in England and in Italy. *Public Understanding of Science* 18: 383–400.
- Lorenzoni, I., S. Nicholson-Cole, and L. Whitmarsh. 2007. Barriers perceived to engaging with climate change among UK public and their policy implications. *Global Environmental Change* 17: 445–459.
- McCarthy, J.J., O.F. Canziani, N.A. Leary, D.J. Dokken, and K.S. White. 2001. *Climate change 2001: Impacts, adaptation and vulnerability*. Geneva: IPCC.
- Meier H.E.M., B. Müller-Karulis, H.C. Andersson, C. Dieterich, K. Eilola, B.G. Gustafsson, A. Höglund, R. Hordoir, et al. 2012. Impact of climate change on ecological quality indicators and biogeochemical fluxes in the Baltic Sea—a multi-model ensemble study. *AMBIO*. doi:10.1007/s13280-012-0320-3.
- Metzger, M.J., D. Schröter, R. Leemans, and W. Cramer. 2008. A spatially explicit and quantitative vulnerability assessment of ecosystem service change in Europe. *Regional Environmental Change* 8: 91–107.
- Moser, S.C. 2009. Whether our levers are long enough and the fulcrum strong? Exploring the soft underbelly of adaptation decisions and actions. In *Adapting to climate change: Thresholds, values, governance*, ed. W.N. Adger, I. Lorenzoni, and K.L. O'Brien, 313–334. Cambridge: Cambridge University Press.
- Moser, C.S., and J. Tribbia. 2006. Vulnerability to inundation and climate change impacts in California: Coastal managers' attitudes and perceptions. *Marine Technology Society Journal* 40: 35–44.
- Moser, C.S., and A.L. Luers. 2008. Managing climate risks in California: The need to engage resource managers to successful adaptation to change. *Climatic Change* 87: 309–322.
- Munasinghe, M. 2010. Can sustainable consumers and producers save the planet? *Journal of Industrial Ecology* 14: 4–6.
- Munasinghe, M., and R. Swart. 2000. *Primer on climate change and sustainable development: Facts, policy analysis and application*. Cambridge: Cambridge University Press.
- Naess, L.O., G. Bang, S. Eriksen, and J. Vevatne. 2005. Institutional adaptation to climate change: Flood responses at the municipal level in Norway. *Global Environmental Change* 15: 125–138.
- O'Brien, K., L. Sygna, and J.E. Haugen. 2004. Vulnerable or resilient? A multi-scale assessment of climate impacts and vulnerability in Norway. *Climatic Change* 64: 193–225.
- Parry, M.L., C. Rosenzweig, A. Iglesias, M. Livermore, and G. Fischer. 2004. Effects of climate change on global food production under SRES emissions and socio-economic scenarios. *Global Environmental Change: Human and Policy Dimensions* 14: 53–67.
- Reidsma, P., F. Ewert, A.O. Lansink, and R. Leedmans. 2009. Vulnerability and adaptation of European farmers: A multi-level analysis of yield and income responses to climate variability. *Regional Environmental Change* 9: 25–40.
- Scheraga, J.D., and A.E. Grambsch. 1998. Risks, opportunities, and adaptation to climate change. *Climate Change Research* 10: 85–95.
- SEPA. 2009. What's in the sea for me? Ecosystem Services Provided by the Baltic Sea and Skagerrak. The Swedish Environmental Protection Agency, Report 5872, Stockholm, Sweden, 40 pp.
- Stehr, N., and H. von Storch. 2005. Introduction to papers on mitigation and adaptation strategies for climate change: Protecting nature from society or protecting society from nature? *Environmental Science & Policy* 8: 537–540.
- Sundblad, E.-L., A. Biel, and T. Gärling. 2009. Knowledge and confidence in knowledge about climate change among experts, journalists, politicians, and laypersons. *Environment and Behaviour* 41: 281–302.
- Tompkins, E.L., and W.N. Adger. 2005. Defining response capacity to enhance climate policy change. *Environmental Science & Policy* 8: 562–571.
- Tribbia, J., and S.C. Moser. 2008. More than information: What coastal managers need to plan for climate change. *Environmental Science & Policy* 11: 315–328.
- Upham, P., L. Whitmarsh, W. Poortinga, K. Purdam, A. Darnton, C. McLachlan, and P. Devine-Wright. 2009. Public attitudes to environmental change: A selective review of theory and practice. Report for ESRC/LWEC. Manchester, UK, 143 pp.
- Wolf, J. 2011. Climate change adaptation as a social process. In *Climate change adaptation in developed nations: From theory to practice*, ed. J.D. Ford, and L. Berrang-Ford, 21–32. Heidelberg: Springer.

AUTHOR BIOGRAPHIES

Joanna Piwowarczyk (✉) is a doctoral candidate in the Marine Ecology Department, Institute of Oceanology, Polish Academy of Sciences. Her research takes an ecosystem approach to marine spatial planning, societal governance, and marine ecosystem services, and to their indicators and valuation methodologies.
 Address: Department of Marine Ecology, Institute of Oceanology, Polish Academy of Sciences, 55 Powstancow Warszawy Street, 81-712 Sopot, Poland.
 e-mail: piwowarczyk@iopan.gda.pl

Anders Hansson is an Assistant Professor in the Department of Thematic Studies, Linköping University. He conducts social science research into the development of energy technology and science and technology studies (STS).
 Address: Centre for Climate Science and Policy Research and Water and Environmental Studies, Department of Thematic Studies, Linköping University, Norrköping, Sweden.
 e-mail: anders.n.hansson@liu.se

Mattias Hjerpe Ph.D. in Water and Environmental Studies, is an Assistant Professor at the Centre for Climate Science and Policy Research at Linköping University. His current research examines civil society actors' role in climate change governance and how local government and civil society actors respond to global environmental and economic change, particularly in the Baltic Sea Region and China.
 Address: Centre for Climate Science and Policy Research and Water and Environmental Studies, Department of Thematic Studies, Linköping University, Norrköping, Sweden.
 e-mail: mattias.hjerpe@liu.se

Boris Chubarenko is Deputy for Science in the Atlantic Branch of the P.P. Shirshov Institute of Oceanology of the Russian Academy of Sciences, and Head of the Institute's Laboratory for Coastal Systems Studies. His scientific interests include lagoon and coastal hydro- and sediment dynamics as well as local consequences of and adaptation to climate change.

Address: Atlantic Branch of the Institute of Oceanology, Russian Academy of Sciences, Kaliningrad, Russia.
e-mail: boris.chubarenko@atlantic.ocean.ru

Konstantin Karmanov is a doctoral candidate and research assistant in the Laboratory for Coastal Systems Studies in the Atlantic Branch of the P.P. Shirshov Institute of Oceanology. His thesis will analyze

hydrodynamic structures in the lagoons and coastal zone of the Southeast Baltic using remote-sensing data, and examine probable local responses to global climate change.

Address: Atlantic Branch of the Institute of Oceanology, Russian Academy of Sciences, Kaliningrad, Russia.
e-mail: mr.pocketoff@rambler.ru