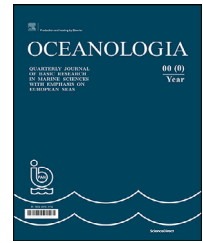


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ORIGINAL RESEARCH ARTICLE

Perceptions of an endangered Baltic Sea

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Abstract In a series of ad-hoc surveys at different academic institutions in the Baltic Sea region, students and young scholars were asked about their views about the environmental issues of the Baltic Sea, and who would be responsible for the management of the Baltic Sea. Overfishing, climate change and waste were considered the most significant issues, while tourism and constructions (of bridges, etc.) were less often recognized as severe. The responsibility for the management of the Baltic Sea was mostly attributed to the European Union or to the respective national governments.

Since climate is one of these issues, one question has dealt with the main task of climate science. It turns out that the most frequent assertion was not the genuine scientific task of generating knowledge about the dynamics of the system. Instead, the task of solving the problem and, equally often, supporting climate activism was favored.

The results are not representative – neither for the separate surveys, nor for the selection of the sites of surveying. However, when taken all surveys together, the emergence of consistent perceptions may be considered evidence for a general attitude among students and young scholars in the Baltic regions. However, differences between groups – in terms of nationality, seniority and discipline - may be related to sampling randomness.

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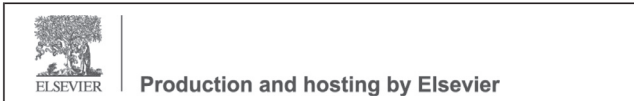
1. Introduction

The Baltic Sea region is highly populated, with a variety of natural resources exploited in agriculture and forestry. Significant human history extends across 2000 and more years, and has led to a variety of cultures, reflecting in many languages and ethnicities. Thus, history is full of conflicts, including colonialism, but also frequent constructive interactions among people (Schnakenbourg, 2017).

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A consequence of this cultural richness is not only a complex history but also different attitudes and values of how to use the resources provided by the joint Baltic Sea. What is considered appropriate for a Russian may not be seen so by a German, and vice versa.

However, in all countries, science is attributed a significant role in determining which options in using the resources and managing the environment. But, reflecting the different environmental and cultural conditions, perceptions about the utility and societal norms, are diverse among the people living at the Baltic Sea. We expect therefore a broad consistency in the response patterns of the surveys, which are evaluated in this article, but also to minor degree some divergences. Because of the ad-hoc character of the selection of sites to be surveys, coincidences likely stand for similar views across nationality and disciplines, whereas differences should be considered mere hypotheses.

The Baltic Sea is exposed, or perceived to be exposed to a large number of natural processes and human stressors such as regional climate change, sea-level rise and vertical land movement, coastal processes, nutrient loads and eutrophication, hypoxia, acidification, submarine groundwater discharge, or the import of non-indigenous species, as well as land use and changing land cover (Reckermann et al., 2021; Szymczycha et al., 2019). Some of these are related to natural variations in the Earth system (such as the vertical movement of the Earth crust), whereas many are related to regional and local human activities, in particular: agriculture and forestry, aquaculture, fisheries, river and coastal management, offshore wind farms, shipping, the release of organic contaminants, unexploded and dumped warfare agents, marine litter, underwater noise, construction of bridges and tunnels, tourism (Reckermann et al., 2021). Another account with a focus on ecological issues is provided by Blenckner et al. (2021).

Our survey is asking for a list of these issues which are considered of greatest significance.

Different knowledge claims exist about the role and significance of these factors – one set of claims is based on scientific constructions (as documented in the BACC reports; BACC Author Team, 2008; BACC II Author Team, 2015), another on cultural constructions, i.e., perceptions, conditioned by societal values and preferences. The scientific construction is mostly identical across countries, while the cultural constructions differ from country to country. The BACC process (BACC Author Team, 2008; BACC II Author Team, 2015) has helped to clarify the consensus across the scientific community dealing with the Baltic Sea region (see also Reckermann et al., 2020). However, the diversity of perceptions is seemingly less often considered.

Thus, this study sets out to build hypotheses of what students and young scholars in the field of environmental studies, ranging from geography, oceanography, to geology and ecology, think about the Baltic Sea, with an extra focus on the role of climate and climate science.

Only rarely surveys about the perceived significance of environmental stressors were made in the past. Piowarczyk et al. (2012) asked representatives of institutions, and found then, in 2012, the climate topic of relatively minor interest. Lundberg (2013) asked “stakeholders representing authorities, scientists, NGOs and national interest organizations”, and found a similar focus on eutroph-

Table 1 List of surveys – institution, faculty, country plus number of responders.

	Institution	Samples
1	Hamburg Univ., Geology, Germany	22
2	Hamburg Univ., Oceanography, Germany	9
3	Univ. Gdańsk, Geography and Oceanography, Poland	69
4	IO PAN, Oceanography, Sopot, Poland	5
5	Univ. Göteborg, Marine Science, Sweden	26
6	Univ. København, Chemistry	7
7	Univ. Latvia, Environmental Studies	25

ication. Indeed, in the process of assembling the knowledge about climate, climate change and impact in the BACC process (BACC Author Team, 2008; BACC II Author Team, 2015), some noticed a bias towards the eutrophication problem among established scientists. Given our present results, but also the intensity of the public discourse, one would presume that this has changed in the meantime.

Such studies of perceptions among scientists, and resulting hypotheses may contribute to a better understanding of the public debate and democratic policy-making, which to large extent depends on the cultural constructions and less so on purported “scientific truth” (von Storch, 2009).

2. The surveys

The idea of constructing short surveys to be answered by students and young scholars of environmental studies goes back to 2015, when Hans von Storch and Dennis Bray could survey Chinese students at the Ocean University of China (von Storch et al., 2019). In that survey and identical following surveys at two graduate schools on climate science, the questions dealt only with climate and climate science. Specifically, the questions about the main tasks of climate science were formulated back then, and have not been changed since then. Later, in the framework of the “Baltic Earth” project, a number of questions dealing with the state and management of the Baltic Sea were added to the unchanged climate questions.

Here we report about the outcome of asking students and young scholars in Poland, Sweden, Germany and the Baltic States, mostly Latvia and Lithuania. The questionnaires were distributed by teachers at a number of institutions (see Table 1), with different disciplinary focus. The selection of the institutions was done by personal contacts to teachers. Thus, the choice of locations was ad hoc, and no claims of representativity can be made. Also, the views of the young researchers are hardly representative for their discipline nor nationality – in particular it can be that the attitudes of the teachers had an influence on the responses. But the students never had any contact to Hans von Storch.

The lack of representativity renders also all efforts of explanatory analysis useless – thus, we do not subject

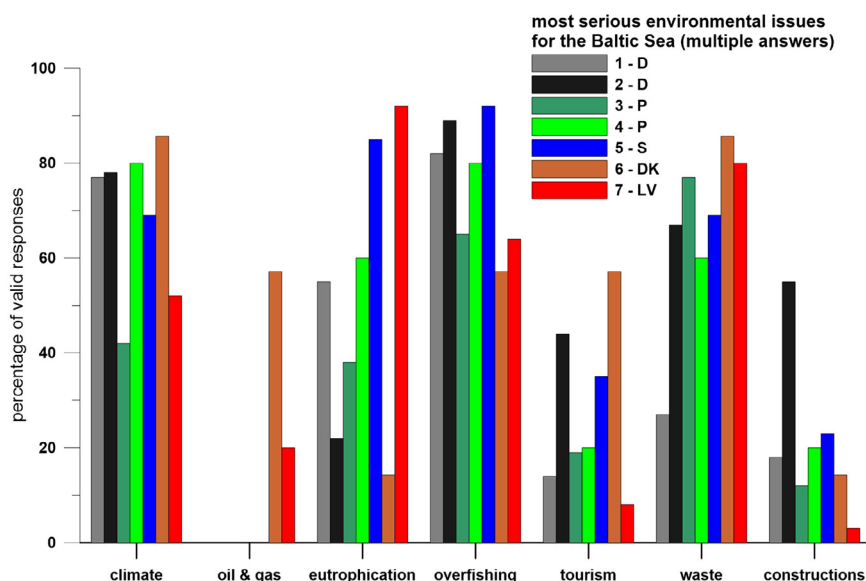


Figure 1 Frequency of selected issues as “most serious” for the Baltic Sea. Respondents were asked to tick off a maximum of three issues.

the data to any statistical testing (see also [Trafimov and Marks \(2015\)](#)).

In all cases the surveys were identical, except for adding one response option in one of the questions (see below), for mysterious reasons which cannot be reconstructed.

Here, we address two blocks of questions: on the stressors and the management of the Baltic Sea ([Section 3](#)) and on climate and climate science ([Section 4](#)).

3. Significant issues concerning the Baltic Sea

The key question in the state of the Baltic Sea was:

The Baltic Sea is under human pressure. Which of the following issues are serious, and need political attention?

Climate Change

Eutrophication

Overfishing

Tourism

Deposition of waste

Constructions (pipelines, bridges).

Respondents were asked to select up to three choices. In case of the samples 6 (DK) and 7 (Lv), for some unknown reasons, the option *Oil and gas extraction* was added, even though such activity is very limited in the Baltic Sea (e.g., [Szymczycha et al., 2019](#)) and has hardly received any media attention in recent years.

Three issues were listed as most serious, namely “overfishing”, “climate change” and “waste”, with “overfishing” attracting most concern ([Figure 1](#)). There are differences in detail, between countries and disciplines, but as outlined before, given the ad-hoc character of sampling, not too much weight should be given to these. Of secondary concern the issue “eutrophication” emerged, while all others more of tertiary concern. Interestingly, even though eutrophica-

tion was less often ticked off across the 7 surveys, this issue got most attention in Latvia but also in the Swedish sample.

Somewhat of mystery is the high frequency of selecting “Oil and gas” in the Danish sample, which was, however, quite small. One wonders if these respondents did not really know a lot about the environmental state of the Baltic Sea.

An intriguing aspect is that it was neither the eutrophication issue, which attained massive attention in recent decades (HELCOM), nor the much-voiced overarching concern for climate change issue showed a clear lead in the overall sample. Instead, overfishing and waste were listed as more serious or similarly serious. Note that this result was not due to just one or two of the subsamples; instead, these issues got in all samples high response rates.

Another question dealt with the responsibility of dealing with the environmental issues of the Baltic Sea; the participants were asked:

Is the improvement of the environmental conditions of the Baltic Sea mostly
a national issue
an EU issue or
an international issue?

Some preferred to not answer, but the percentages of valid responses are summarized in the following table ([Table 2](#)).

Thus, in most cases, the responsibility was attributed to the European Union: the majority of the small sample of Danish respondents pointed towards the international community, possibly referring to the presence of Russian activity.

4. Climate

A number of general questions, namely to what extent a warming is going on, and to what extent this warming may

Table 2 Response rates to the question of whether the improvement of environmental conditions of the Baltic Sea is either “national”, “EU”, or “international” issues. D, P, S, DK, and LV stand for Germany, Poland, Sweden, Denmark and Latvia, respectively. The numbers in the headline refer to the list in Table 1.

Survey %	D (1+2)	P (3+4)	S	DK	LV
national	0	9	0	0	4
EU	89	88	100	25	52
international	11	2	0	75	44

be attributed to human action, has been raised not in all surveys, but only in the case of the Polish, Danish and Baltic (Latvian) students; in case of the others, these questions were not raised, in order to keep the survey short and in the expectation, based on a variety of earlier surveys among other populations (von Storch et al., 2019; von Storch and Gualdi, 2019), that the results are quite predictable, namely a very clear majority for *How convinced are you that climate change, whether natural or anthropogenic, is occurring now?*, and a still very large but slightly smaller majority for *How convinced are you that most of recent or near future climate change is, or will be, a result of anthropogenic causes?* The difference in the two questions is thus if a change is taking place irrespective of the mechanism, while the second is asking if this change is to be attributed to human activity. One would assume, that all, who respond positively to the second question, would respond also positively to the second, with even higher confidence. Similarly claims that no change is taking place would be expected with a rejection of linking such a change to humans.

In Figure 2 we show the frequency of agreement, while not considering the small number of “don’t know” and “no response” answers – first with solid blocks the agreement to the reality of the warming (first question), and then, with hatched blocks, the percentage difference between the degree of acceptance of the warming (first) and the human cause (second question). In the case of the small Danish sample, these differences are sensitive to a difference of agreement by just one person – therefore, we show only the Polish and the Baltic country responses.

Figure 2 supports the expectation that there is both an overwhelming acceptance of the assertions on the reality and on the human cause of climate change. The options 1–3 are never, or almost never ticked off; the indifferent 4 is chosen by a few participants, but most go for the support of the assertions, 5–7. The largest values are attained for degree 7 in both questions. For the issue of the human cause, very few skeptical voices show up.

The distribution of the degree of agreement among the Baltic participants is shifted from “reality” to “human causes” towards smaller values (from a mean of 6.55 to 5.78, in the range of 1–7), but in the case of the Polish respondents, towards larger values (from a mean of 5.95 to 6.06). This is counterintuitive; a plausible reason for this shift is difficult to construct.

A question, which had resulted in earlier surveys in some surprising results, was:

- Today, what would you rate as the most important task facing the climate science community?*
- define the climate problems and attribute cause of climate change;*
- determine solutions to climate change;*
- motivate people to act on climate change;*
- don’t know.*

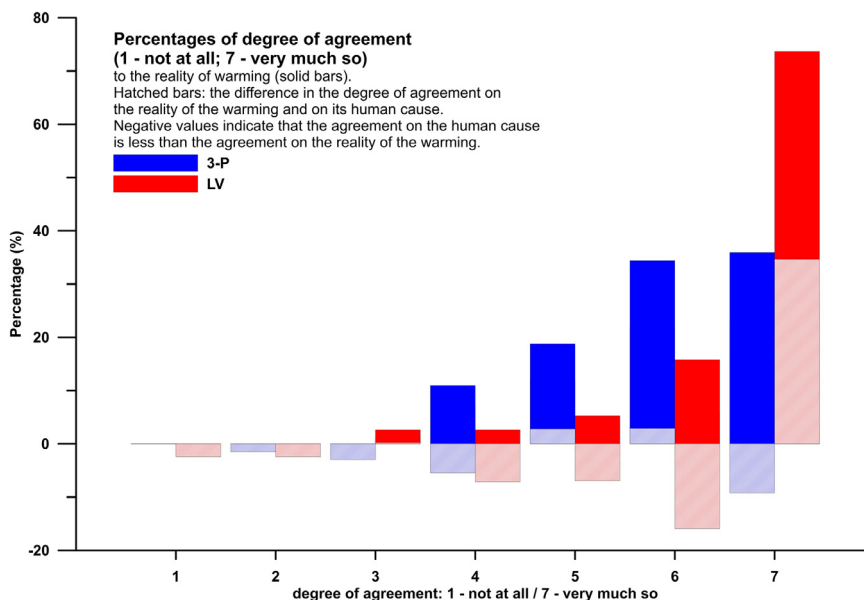


Figure 2 Distribution of the degree of agreement on the reality of climate change (1st question, change irrespective of mechanism; solid bars), and the difference between this degree and the degree of agreement on the human cause of this change (2nd question, attribution of change to human activity) (hatched bars). Negative hatched bars point to a larger agreement to the assertion of a human cause than the agreement on the reality of climate change. In percent of all valid answers. Only Poland (samples 3+4) and Baltic countries (sample 7).

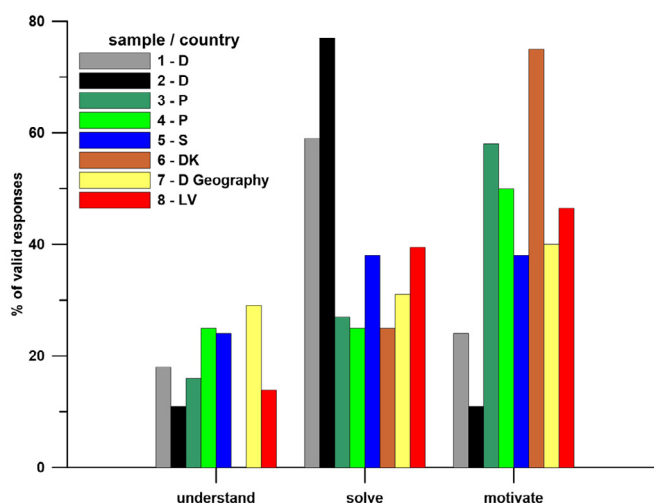


Figure 3 The share of choices as “most important task of climate science” in the surveys given as percent of all who gave a qualified response. “Understand” stands for “define the climate problems and attribute cause of climate change”; “solve” for “determine solutions to climate change”; and “motivate” for “motivate people to act on climate change”.

The percentages for all surveys, which have picked one of the first three choices, is displayed in [Figure 3](#).

Most votes go for “solve” or for “motivate”, least for “understand”, which differs a little from earlier surveys, when “motivate” was the preferred option. But as before, the genuine and traditional task of science, namely to generate knowledge about the dynamics is not perceived of being the main task of climate science; instead, the engineering/political dimension “solve” or the activist dimension “motivate” is favored.

5. Discussion

As in almost all cases of surveys, the first question provides knowledge about an interesting population of social beings. These beings are in this case students and young scholars in the multidisciplinary field of environmental sciences in the Baltic Sea region. The strategy of sampling opinions from these populations was ad-hoc – that is, when a suitable contact at a university was available, we asked this person to run the survey. Thus, the participants came from groups from different universities, from different countries, from different disciplines, who had been influenced by different professors, elder scientists, regional Zeitgeist and different media coverage. As such, none of the single surveys can claim to be representative.

However, when taken together, we argue that there is some representativity, namely that in all groups we find similarities, namely that overfishing, waste and climate and considered the most significant issues of the Baltic Sea, while eutrophication received a little less attention; that the management of the Baltic Sea should sit with the European Union, and that the main task of climate science is to prepare solutions and to join political activism. These aspects seem to be common to the different groups. We saw also a number of differences between the groups, and it is tempting to speculate which social conditions, for instance, if trained in a physical or biological back-

ground, would cause these differences. However, these differences should be taken at best as a hypothesis, which would need more analysis to determine if they are stable or not.

The results concerning the main task of science differ from previous responses to the same question in surveys run a few years earlier at other European institutions, where the motivation of people “to act” was the favorite choice. More recent surveys gave consistent results (not shown) – it will be interesting to learn if the change from the earlier surveys concerning the Baltic Sea region domain is indicative of a change of preferences in recent times – and, consistently, when the participants of the 12 Klimatagung in Germany in March 2021 were asked what they think about the main task of climate science, the votes were split evenly among the three choices. The difference could also relate to the chosen studies – with a possible preference among students of climate science for an activist position.

Finally, it may be worth adding a subjective outlook. Surveys among students and scholars help to recognize that science is indeed a social process ([von Storch, 2009](#)), which has an effect on both the research process and on the published findings. Not surprisingly, in environmental sciences, many actors hold worldviews about the role of the environment and anthropogenic influences, which are based not on science, but on normative frameworks and social constructions (e.g., “Nature strikes back”). This is certainly unavoidable, but we have to recognize such processes and should try to limit the degree of subjectivity. This is particularly difficult in environmental sciences, which is in a postnormal phase (e.g., [von Storch, 2011](#)), where for the public and many scientists the utility of science for achieving political goals is more important than methodical rigor and principles of good science in the kind of CUDOS norms ([Grundmann, 2012](#); [Kim and Kim, 2018](#)). Surveys like the present one help to understand, to recognize, and to deal with such challenges.

It would be advisable if the curricula of environmental courses would contain lectures on the history of ideas and on the ethics of science.

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