

Climate Change and Biodiversity— Implications for the Local Fisheries Sector



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1 Background

1.1 Context AWI

The North Sea has been and still is one of the most intensely used marine areas worldwide. Shipping (trade and private), the exploration/exploitation of energy resources (oil, gas and wind), fisheries and tourism compete for the scarce space (Holm et al. 2017). Especially, in German waters, resource-use conflicts rise between stakeholders. The construction of wind farms and the expansion of nature reservation areas and other marine and coastal protected areas are leading to the closure of areas for other activities, such as fishing and aquaculture. In order to solve these conflicts and to better manage the interests of stakeholders of such densely populated and intensely used marine areas, multi-disciplinary approaches are needed to reach a sustainable, economic and environmentally friendly development.

The working group *Marine Aquaculture, Maritime Technologies and ICZM* at AWI Bremerhaven is focusing its research for several years on a sustainable use of marine resources and has developed strategies and concepts for the multi-use of offshore structures of wind turbines for aquaculture (Buck et al. 2008; Buck et al. 2004; Buck and Buchholz 2004) and passive fisheries (Stelzenmuller et al. 2016; Pogoda et al. 2016), to solve some of the interest-conflicts occurring in the German Bight.

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2 Scope and Motivation

2.1 Background Setting

Since our oceans and seas are under the above mentioned continuous anthropogenic pressure, additional effects of climate change, such as increasing temperatures and/or sea level rise add even more pressures on marine ecosystems. Changing temperatures have induced shifts in the composition of marine flora and fauna worldwide (Doney et al. 2012; Cheung et al. 2009), and we can observe those changes right at our doorstep, in the North Sea (Philippart et al. 2011; Beaugrand 2004; Franke and Gutow 2004). The North Sea is naturally susceptible for environmental changes due to its topographic, geological and geographical settings. From a geologic history perspective the North Sea is a young, shallow and enclosed shelf sea and is affected by changing climate and a diversity of anthropogenic activities. Its high biodiversity of habitats provide many essential ecosystem goods and services, such as productive fishing grounds or the Wadden Sea National Park (WSNP). The latter declared as UNESCO world heritage due to its high protection status, it also attracts millions of visitors per year.

Yet, especially in these southern reaches of the North Sea, water temperatures and sea level have and are predicted to increase faster than in other regions (Emeis et al. 2015). In the waters around Helgoland the annual mean temperature rose by 1.7 °C since 1962 (Wiltshire et al. 2010). These data are alarming as these changing parameters have tremendous effects on the abiotic and biotic environments and indirectly on the connected and reliant economy and society along the densely populated North Sea coast.

The increasing water temperature already triggered a northward shift of fisheries-relevant species in the north-east Atlantic, native species like cod and plaice migrate to colder and deeper waters, whereas Lusitanian species like anchovy and horse mackerel have become more abundant in the North Sea (Rijnsdorp et al. 2009). This will affect the North Sea fisheries as the fishing vessels have to go further north to catch their target species and catch quota have to be adapted to new species (Cheung et al. 2012). For North Sea aquaculture, temperature will likewise have effects, both positive and negative, on cultured organisms like salmon and blue mussel. Growth, feed intake and oxygen demand will change, and diseases and parasites as well as non-native species and harmful algal blooms will become bigger threats to the aquaculture production (Callaway et al. 2012).

2.2 Target Audience

At the German North Sea coast, the fisheries and aquaculture sector includes small-scale coastal (flat fish and brown shrimp) and high-sea fisheries as well as production of blue mussel (*Mytilus edulis*). Associated with the fisheries and

aquaculture production is the further fish processing industry, which is located and since 1885 traditionally operating in the fisheries harbour in the City of Bremerhaven (Northern Germany). Since the coastal fisheries and blue mussel production is conducted in the vicinity of the protected WSNP, stakeholders involved in nature conservation (e.g. NGOs and public authorities) and tourism have to be considered. Furthermore, the academic community from biology, physics, chemistry, economy and social science departments detect and monitor the effects of climate change on the North Sea environment.

In order to identify potential threats and opportunities of climate change on local communities, the project “Climate change and biodiversity: Threats and Opportunities for local actors of the North Sea” took a transdisciplinary approach. Key stakeholders were identified and addressed as well as further involved by drawing from and integrating their knowledge to find solutions and strategies for the mitigation of future environmental changes and challenges.

3 Materials and Methods

The project was set-up and divided into three subsequent phases in which knowledge was gathered and curated (1), direct stakeholder engagement took place (2) and the results and gathered knowledge was used to stimulate joint efforts (3) (Fig. 1). All three phases only represent parts of a process of continuous and simultaneous knowledge gathering and transfer, as there were no hard borders between them.

Phase 1: At the beginning of the project, data on the recent and future effects of climate change on the biotic and abiotic environment of the North Sea were collected from various sources, such as reports published from the VECTORS project (www.marine-vectors.eu), publications from peer-reviewed journals as well as from proceedings from ICES (International Council for the Exploration of the Sea Data Centre), from the EC (e.g. EU Habitat Directive) and from national authorities (e.g. German Federal Agency for Nature Conservation [Bundesamt für Naturschutz—BfN]). Additionally, expertise from scientists (AWI) and other stakeholders in the fields of climate change, biodiversity, local ecosystems and socio-economics were gathered. Based on this information, key stakeholders affected by climate change and the associated changes in biodiversity, located at the German North Sea coast, were identified.

Phase 2: In this phase, stakeholders were engaged through participation in workshops, which served not only as tool to gather information from the



Fig. 1 Project setup: on the basis of gathered and curated knowledge, stakeholders were identified and engaged to facilitate knowledge transfer and to stimulate joint efforts

stakeholders, but also facilitated bidirectional communication and knowledge transfer between the participants themselves. Two workshops were held in order to assess the stakeholders' perceptions towards and discuss the impacts of climate change on their respective fields of expertise. In both workshops the topic of climate change and its effects on biodiversity, fisheries, aquaculture, invasive species, species communities and pollution was shortly introduced prior to further discussions. The first workshop, hosted at the AWI Bremerhaven, was directed towards a broad audience of local stakeholders from fisheries, science, and fish processing industry, NGOs and the local authorities. Due to the broad nature of the stakeholders' backgrounds, this workshop was prefaced with talks by three invited experts from the scientific community to help all participants starting with the same knowledge baseline and facilitate discussion in the later parts of the workshop. In the second workshop, hosted at the *YouMaRes 7* conference in Hamburg, young scientists (Bachelor, Master, Ph.D. students and early post-docs) from different research fields (biology, chemistry and social science) discussed the impacts of climate change and the future of climate change related research. In addition to these two workshops, meetings by local fisheries associations (mussel farming, German Fisheries Association [Deutscher Fischerei-Verband]) were attended to approach more stakeholders.

Phase 3: In the final phase of the project the information and outcomes of the first and second phase and its resulting discussions were evaluated and the gathered knowledge distributed through different channels and types of communication. Different types of media, such as the internet websites of the Earth System Knowledge Platform (ESKP 2017) as well as AWI (2017), electronic newsletters and print media (brochures, other publications), were used to communicate the results and outputs of the project to a wider, mainly non-scientific, audience. Furthermore, the data gathered in the workshops are planned to also be published in a peer-reviewed journal.

4 Results

4.1 *What Was Done Directly (Activities)?*

The stakeholder engagement in the workshops is the major part of the project as the participants successfully provided very important information about the stakeholders' perceptions on various aspects of climate change. By categorizing the impacts of climate change according to the four dimensions environment, society, economy and policy, the workshop participants suggested an order according to their personal sensation and importance. Most of the climate-related impacts were viewed as closely interlinked, since changes in the environment, e.g. weather extremes, affect not only the economic feasibility of the fisheries sector, but also those people living at or in the vicinity of the coast. The modern fishery above all needs vessels that are adapted to severe conditions, such as storms or high waves.

The coastline needs reinforced protective measures, which in turn alter the local landscape and can heavily influence biodiversity-rich coastal habitats by destruction and permanent flooding. Even though the composition and distribution of native species populations change, new species in turn migrate from warmer water origins (e.g. anchovy) or are introduced through human activities. These “new” species may have the potential to replace their former counterparts in their ecological and economical role or open up new niches.

These interlinkages between the environmental, economic and social processes highlight the importance of climate-adapted strategies in the management and governance of the southern North Sea region. In fisheries management, it will be important to act flexible in adapting catch quota to changing species distribution and abundances. Science thereby plays a key role by integrating social and environmental dimensions, providing data and communicating the results not only to the governmental authorities, but also directly to all affected stakeholders.

4.2 Outputs Directly of the Project (What Was Achieved?)

The workshops were the first step of bringing together the different stakeholder groups, facilitating a dialogue and creating a network of relevant stakeholders for future communication and cooperation on aspects of climate change and biodiversity.

In order to reach a wider audience a brochure was created by translating findings and expert knowledge into a ‘common stakeholder language’. Gathered knowledge from both literature research and the two workshops was incorporated in this publication (available printed and online in German and English, via the ESKP website and the AWI hosted project website), to inform a non-academic audience, such as local fishermen, representatives from the political arena, and those people who live at or visit the German North Sea coast.

For the academic and science-interested audience, intermediate and final outcomes were communicated via the ESKP (Dzuba et al. 2016; Buck and Hörterer 2017) and AWI web site. A biannual newsletter will be released to inform the network of stakeholders about recent and future activities and projects.

5 Reflection and Lessons Learned

5.1 What Can We Draw from the Activity

One of the most important lessons learned is the importance of facilitating direct communication between stakeholders by bringing them together in personal dialogues. Workshops focusing on a diverse group of stakeholders, often with opposing perspectives, benefit from direct communication and from the knowledge and perception of different stances.

Furthermore, in comparing the results of both workshops, we noticed that the perception within the stakeholder groups can differ with age. Especially in science, young scientists have a different focus and thus identify different problems and different strategies to counter them. Additionally, they are aware that inter- and transdisciplinary approaches are needed in climate change research and management. They also possess an inherent drive to talk about and spread their scientific findings to the wider public and have a clear understanding of the importance of science education and communication.

5.2 What Can We Learn for Knowledge Transfer?

In both workshops we experienced that a direct and clear transfer of knowledge between the different stakeholder groups, especially but not solely between science and fisheries, is crucial to increase the wide understanding of the processes and impacts of climate change (Fig. 2).

Traditionally, knowledge is transferred unidirectional, as in fisheries management, when scientists propose catch quota, based on scientific data, to governmental bodies (EU), these implementing the suggestions and the fisheries industry following those. Unidirectional communication, containing a translation component, is helpful to give information to a wider audience. But, even more important is to acknowledge necessity to meet in person and communicate with each other directly to keep up the transfer processes. This bidirectional communication can help to prevent misunderstandings and to promote positive outcomes.

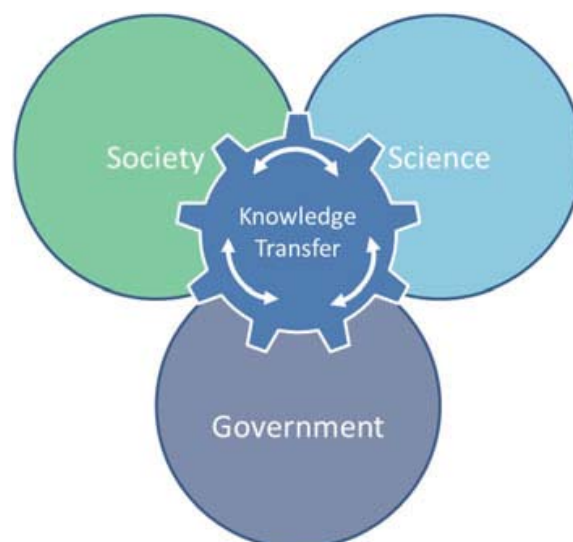


Fig. 2 Role of Knowledge Transfer in stakeholder communication: all groups involved have to communicate with each other to increase understanding of the processes and impacts of climate change

6 Outlook

The next steps in the project are the further development of a close network of stakeholders in order to facilitate direct communication in the future. Based on the findings of this project, we want to publish a research agenda to show a way for future research concerning climate change and its impacts on the North Sea system, its biodiversity and stakeholders. The research topics are based on the outcomes of both workshops and will be verified through interviews with representatives of the relevant stakeholder groups. The main conclusion from the multi-stakeholder workshop was that future cooperation between scientists, fisheries, local authorities and others is needed to develop a climate adaptation strategy for the southern North Sea region including Bremerhaven, the coastline of Lower Saxony and the WSNP with focus on ecology, research and governance.

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