Project *brief*

Thünen-Institut für Seefischerei 2024/21a

Social-ecological tipping points in the North Sea

Anna Reichel[1], Maren Kruse[1], Jonas Letschert[1], Prince Bonsu[1], Vanessa Stelzenmüller[1]

- **Loss of area due to wind farms and marine protected areas as well as climate change are the most important factors influencing the fisheries socio-ecological system**
- **An abrupt change in the ecological species community was observed in 2003**
- **The future shift and concentration of fishing effort to open areas may have negative consequences for ecosystems and the economic viability of fishing operations**

Background and aim

Marine ecosystems around the world are suffering from the cumulative effects of anthropogenic activities, including climate change, making abrupt and unexpected changes, so-called regime shifts, in these systems more likely. The aim of the SeaUseTip project was to close knowledge gaps with regard to sustainable resource use in the southern North Sea. Through a holistic analysis of the dynamics of the fisheries socio-ecological system (SES), adaptive management strategies are to be developed to counteract the "tipping" of this system.

Approach

The ecological, economic, socio-cultural and socio-ecological vulnerability and adaptive capacity of the SES of the southern North Sea was investigated and ecological tipping point analyses were carried out. Interviews were conducted and eight spatial and socio-cultural future scenarios for 2025, 2030 and 2040 were developed and tested.

Results

An abrupt change in the ecological species community was observed in 2003. Until 2003, the species community was dominated by cod, dinoflagellates, and copepods, but now it is dominated by saithe, plaice, sprat and diatoms. The effects of fishing pressure and changing environmental conditions have led to a regime shift in the species community, which is now in a new stable state. These dynamics can have positive or negative effects. Plaice, for example, reached a positive tipping point and an unprecedentedly high biomass due to the successful implementation of the Common Fisheries Policy (CFP). By contrast, other species such as saithe and cod showed negative tipping points and there is no foreseeable recovery in sight despite a drastic reduction in fishing pressure. Although fisheries, and thus also the SES, have repeatedly adapted over the past decades, changes in fishing strategies reflect a decline in the sector's adaptability to adapt to global change.

In the southern North Sea, shrimp, flatfish and Norway lobster fisheries have been identified as the most important German fisheries. These are influenced by various socio-cultural, economic, oceanographic and meteorological factors, which differ in their strength and mode of action from fleet to fleet. A model (Bayesian network, see Fig. 1) was created for the German flatfish fishery SES that depicts the interrelationships within the system and shows the possible effects of management decisions on the adaptability and profitability of the fishery in a spatially resolved manner.

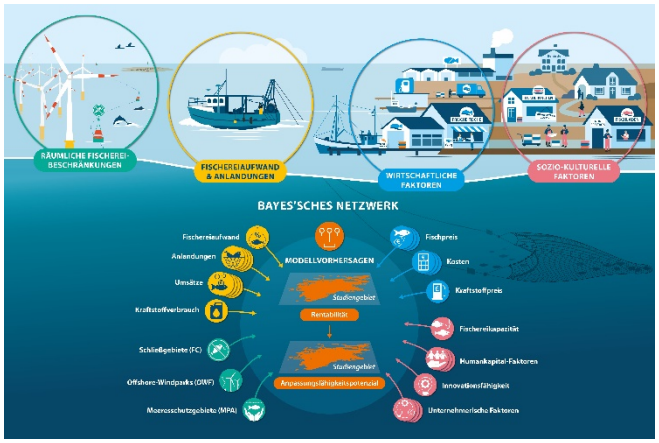

Fig .1: Illustration of the SES components whose interaction was analysed using a Bayesian network.

The loss of area due to the construction of offshore wind farms (OWFs) and marine protected areas (MPAs) as well as climate change were identified as the most important factors influencing the adaptability and profitability of the SES when analysing future scenarios up to 2040.

In the entire North Sea, a surface area of up to 60,000 km² is dedicated for OWF development until 2040. This is roughly twice the area of Belgium. In both OWF and MPA, fishing will only be partially permitted or not permitted at all. Our results show that in the next 20 years up to 45% of the German fishing grounds for Norway lobster will overlap with OWF and MPA.
Future spatial restrictions could lead to a strong shift and concentration of fishing effort in open areas. This can have negative consequences for ecosystems, but also for the economic viability of fishing. On the other hand, the introduction of hard substrate creates new habitats that offer refuge opportunities for potential new fishery resources, such as edible crabs (Cancer pagurus). Results show that a passive gear fishery targeting edible crab around existing and planned OWFs could be economically viable in the summer months.

The fishing sector is limited in its ability to adapt, partly because it is often not involved in political decision-making processes. Our interviews also show that German fishermen usually have little interest in entrepreneurship, the establishment of cooperatives or the development of alternative, more localised marketing strategies that could contribute to higher profitability.
We have developed an agent-based model that can simulate complex decision-making by fishermen beyond economic maximisation approaches (Fig. 2). In this way, possible adaptation strategies of the fleets to future changes such as spatial fishing restrictions or rising fuel prices can also be analysed.

A bio-economic model for mixed plaice and sole fisheries was developed to gain a better understanding of stock and market dynamics as well as consumer behaviour. Changes in wages can be partially offset by adjusted fishing effort, but fixed costs cannot.
The fisheries sector's lack of market power further limits its ability to adapt. There is a risk that many fishermen will not be technically able to cope with the shift and will have to close their businesses.

Fig.2: Factors influencing the decision-making process of fishermen taken into account by the agent-based model

How can the adaptability of the fishing industry be supported?

- Planning certainty for fishermen in which areas they can fish in the future
- Further ecological and economic studies on the feasibility and sustainability of co-utilisation
- New insurance regulations
- Uncomplicated financing of, for example, modernisation and adaptation measures
- Sensitisation of all stakeholders involved in fisheries management to the regime shift concept
- Integration of spatial regime shift dynamics into fisheries management
- Setting fishing quotas taking into account and communicating the risk of fish stock collapse

Additional Information

Contact

[1] Thünen-Institut für Seefischerei
vanessa.stelzenmueller@thuenen.de

Duration

03/2019-12/2023

Projekt-ID

2098

Consortium

Thünen-Institut für Seefischerei
Helmholtz-Zentrum Hereon
Universität Hamburg

Website

www.seausetip.de/en/

Selected Publications

Blöcker, A.M., Gutte, H.M., Bender, R.L. et al, 2023.. Regime shift dynamics, tipping points and the success of fisheries management. Sci Rep **13**, 289. https://doi.org/10.1038/s41598-022-27104-y

Bonsu, P.O., Letschert, J., Yates, K.L., Svendsen, J.C., Berkenhagen, J., Rozemeijer, M.J.C., Kerkhove, T.R.H., Rehren, J., Stelzenmüller, V., 2024. Co-location of fisheries and offshore wind farms: Current practices and enabling conditions in the North Sea. Marine Policy 159, 105941. https://doi.org/10.1016/j.marpol.2023.105941

Kruse, M., Letschert, J. , Cormier, R. , Rambo, H., Gee, K., Kannen, A., Schaper, J.. Möllmann, C., and Stelzenmüller, V. 2024. Operationalizing a fisheries social-ecological system through a Bayesian belief network reveals hotspots for its adaptive capacity in the southern North sea. J. of Env. Manage., 357, 120685. https://doi.org/10.1016/j.jenvman.2024.120685

Letschert, J., Kraan, C., Möllmann, C., Stelzenmüller, V., 2023. Socio-ecological drivers of demersal fishing activity in the North Sea: The case of three German fleets. Ocean & Coastal Management. 238, 106543. https://doi.org/10.1016/j.ocecoaman.2023.106543

Funding

FK 01LC1825

GEFÖRDERT VOM
Bundesministerium für Bildung und Forschung

DOI:10.3220/PB1719990045000