Tracking down compound events in coastal communities in northern Germany – An iterative process of knowledge co-production

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Basis für maßgeschneiderte Klimaservices für die Anpassung
WAKOS
WASSER AN DEN KÜSTEN OSTFRIESLANDS

Introduction

Climate change adaptation increasingly has to incorporate compound events whose consequences extend far into the social and economic system via cascading effects leading to widespread impacts that span space and time. Such phenomena are so far not considered adequately on a regional level neither in disaster risk reduction nor in the context of climate change adaptation management. But how might compound events and cascading effects manifest themselves within a coastal community now and in the future? Which understanding do practitioners have from compound events? How can practitioners and scientists learn from each other? Within this contribution we present our findings of a transdisciplinary research setting applied in the context of the WAKOS "WAter at the COaSt of East Frisia"- project. The main aim of WAKOS is to co-produce robust and reliable knowledge on the manifestation of compound events and resulting cascading effects that helps decision-makers on the regional and local level to cope with uncertainty when developing resilient adaptation strategies.

Compound events are systemic risks in coastal communities

A compound event is "… a combination of multiple drivers and/or hazards that contribute to societal or environmental risk …" (Zscheischler et al., 2020). Weather and climate compound events are constituted of drivers, hazards and impacts. Hazards, such as droughts, floods, or wildfires are of central importance. Individual hazards themselves need not to be extreme to have devastating impacts when co-occurring in combination. One ore multiple climatic drivers, such as precipitation, temperature, coastal water levels, wind or river flow trigger compound events. The complexity of interconnected extreme events means that these events are clearly distinguishable from extreme events occurring isolated.

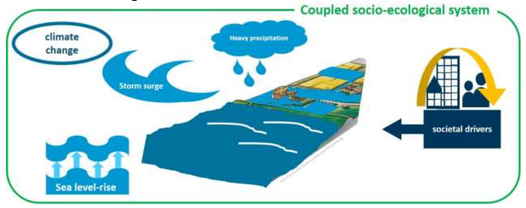

Figure 1: Schematic of a compound flooding resulting from a comination of natual and societal drivers

Compound events can be understood as systemic risks because they have the potential to cause cascading failures across multiple systems and because they are associated with systemic risks such as climate change. In contrast to individual risk, referring to direct impacts of an individual event systemic risk created by compound events is a result of interdependencies between the elements of the system. There is a need for an integrative and holistic approach, relying on a participation of diverse actors (Renn, 2021; Renn et al., 2020) that allows for analyzing systemic risk, which is a prerequisite for its proper management (Hochrainer-Stigler et al., 2019). Transdisciplinary research is assumed to be a suitable approach drawing on both disciplinary and interdisciplinary methods of knowledge generation as well as methods for integrating differently structured bodies of knowledge (Bergmann et al. 2010; Hirsch Hadorn et al. 2006; Pohl et al. 2021) from science, politics, civil society and business (Giddens 2009; Rupp et al. 2014).

Context

The project region of western East Frisia is a low-lying, predominantly rural coastal region in northwestern Lower Saxony and primarily comprises the district of Aurich with the medium-sized centers of Aurich and Norden and the district-free city of Emden. East Frisia is protected from the North Sea by a 70-kilometer-long dike line. The terrain surface is below sea level in large areas of the region which makes steady drainage of precipitation an imperative.

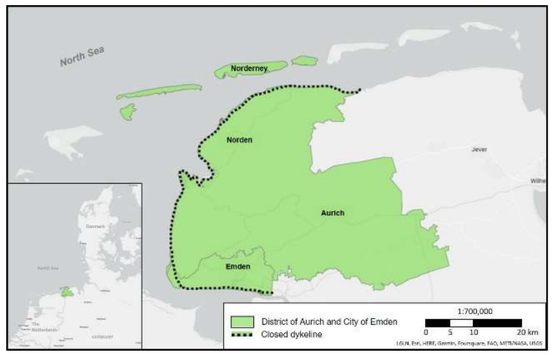

Figure 1: The WAKOS project area comprises the western part of the East Frisia Peninsula

Climate change poses major risks for the East Frisia region: The greatest challenge is posed by the water masses acting on the region from four directions. In addition to the accelerated rise in sea level, the future increase in winter precipitation and the associated increase in runoff, as well as a rising groundwater table, also pose risks. In addition, it is likely that the occurrence of compound events will increase.

Methods

We apply a transdisciplinary approach in order to identify plausible compound events associated with cascading effects that might most likely hit the study area in the future. Characteristic for a transdisciplinary project is (A) that the problem is framed collaboratively together with non-academic actors and thus the framework for the transdisciplinary research is determined; (B) the knowledge is co-produced through collaborative research and (C) the produced knowledge is re-integrated in scientific and societal practice (Jahn 2008). Within this contribution we focus on (A) and (B).

(A) Framing the problem collaboratively and building a science-practice collaboration

Before the WAKOS project started, stakeholders have expressed the need to consider the impacts of climate change on coastal protection and inland drainage together for better and holistic climate adaptation, allowing for cross-sectoral action planning. A scientific consortium was put together to work on the project from an academic perspective. The project team consisting of natural scientists, modelers, social scientists and a practice partner introduced the concept of compound events as it provides a comprehensive framework for combining societal and academic requirements. We first identified relevant stakeholders by means of stakeholder analysis (Table 1). The main intention was to bring together actors from different sectors and to integrate different bodies of knowledge and expertise in order to analyze regional compound events in a model-based way in order to quantify the expected impacts on society.

Table 1: A variety of different stakeholders are engaged in the WAKOS project

Sector	Stakeholders
Coastal protection and water management	Dike Associations, Water Associations, Public Utilities of the City of Emden and the City of Norderney, Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency (NLWKN)
Nature conservation	Wadden Sea National Park Administration of Lower Saxony (NLPV), Municipal Environmental Authority, Lower Environmental Protection Agency, nature protection organisations (NABU, BUND),
Agriculture	Chamber of Agriculture East Frisia, East Frisian Farmers' Association
Spatial planning	Agency for Regional Development Weser-Ems, Regional and Spatial Planning Administration of the District of Aurich
Civil protection and disaster response	City of Emden, City of Norderney, District of Aurich, Fire Brigades, Federal Agency for Technical Relief (THW)
Economy, Infrastructure, tourism	Seaport of Emden (NPorts); Waterways and Shipping Authority; Chamber of Industry and Commerce; Shipping Companies, Tourism Association
Politics	City of Emden, City of Norderney, Krummhörn Municipality
Society and culture	Frisian Forum; Wieken Association

(B) The iterative process of co-producing knowledge on possible compound events in East Frisia

COVID-19 restrictions posed a significant challenge to collaboration. Thus, we chose to start the science-practice collaboration by means of video-mediated focus groups. Later in the project, when COVID-19 restrictions allowed face-to-face meetings, workshops were organized to enable collaboration between researchers and stakeholders. These formats were planned as iterative activities to allow for reflections on the identified compound events (schematic is shown in Figure 2).

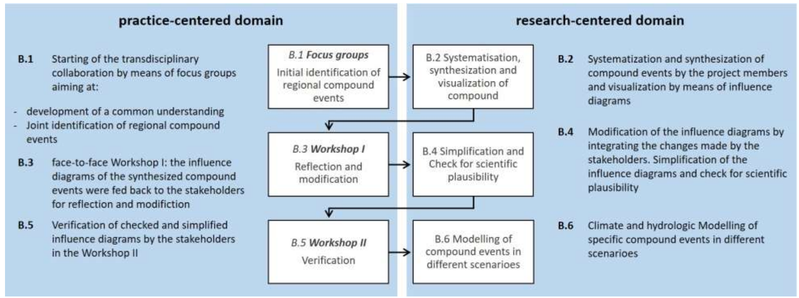

Figure 2: The WAKOS project area comprises the western part of the East Frisia Peninsula

Focus groups were assumed to provide a fruitful and trustful collaboration. Besides creating a common understanding of compound events in East Frisia, mutual stimulation when sharing thoughts and compiling drivers, events and impacts we assumed to initiate a fruitful discussion and in the end create a more comprehensive perspective and consensus among the stakeholders. A total of six video-mediated group discussions were conducted, each with two to six regional actors. After a short introduction, a five-minute video visualizing a real compound event and its' cascading effects was shown to evoke feelings and create an emotional connection to the experience. On this basis, participants reflected on past events with regional relevance that may be categorized as compound events and collaboratively identified drivers, hazards and events that may combine to compound events in the future as well as resulting cascading effects.

Subsequently, the compound events and cascading effects were systematized and synthesized using influence diagrams, similarly to for example Zscheischler (2020), Raymond (2020), Leonard et al. (2014), to visualize und understand cause-effect relations between drivers, events and cascading effects propagating through the system and to improve the understanding of multi-sectoral cascading impacts and risks. As an example, the complex compound flooding due to water from four directions from the perspective of regional stakeholders is shown in Figure 3.

In the context of two **face-to-face workshops** the influence diagrams were fed back to the stakeholders, first modified and later validated (Figure 2). In between the workshops changes from the stakeholders and researchers have been incorporated and the influence diagrams have been simplified and checked for scientific plausibility (Figure 4).

Results

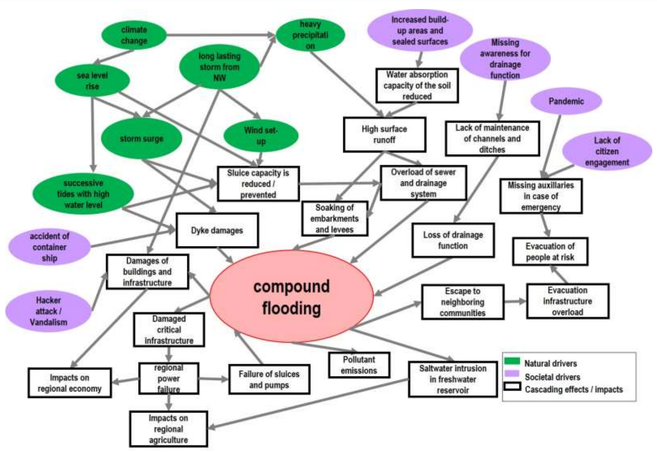

Figure 3: Influence diagram of a compound flooding as perceived by the stakeholders (result of step B.2)

Iterative & reflective process

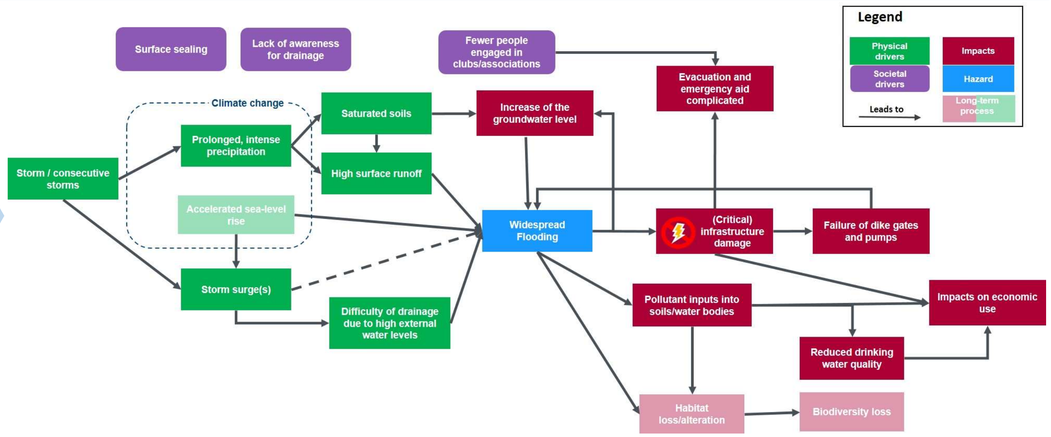

Figure 4: *Influence diagram of the compound flooding event after beeing modified, checked and simplified (result of step B.2)*

Conclusion

The iterative and reflective, transdisciplinary approach is a promising approach for identifying and analyzing regional compound events and the resulting cascading effects.
The use of the influence diagrams throughout the whole project turned out to be a means of communication that enabled stakeholders as well as researchers

- to identify the system at risk,
- reflect on uncertainty and later on
- gives the opportunity to identify suitable adaptation measures to to attenuate the events and interrupt the cascades if necessary.

The mostly academic concept of compound events was transferred and applied to the life world of the stakeholders givng them the opportunity to reflect on their perception and provided them with the necessary trust in their expertise and competencies. A broad range of practitioners and societal actors recognized their potential affectedness und thus were able to contribute to the transdisciplinary research which results in a very comprehensive picture of regional compound events.

This bottom-up process helps to assess systemic risk in coastal communities on a descriptive level by

- Depicting cause-effect relations
- Defining the boundaries of the system at risk
- Assessing transboundary risk
- Reflecting on tipping-points and
- Incorporating adaptation responses

On a normative level the reflection on compound events structures the dialogue on finding a rationale for developing resilient adaptation strategies by co-producing knowldge on undesirable condtions.
Besides this output the transdisciplinary research had valuable outcome for both researchers and stakeholders. Mutual learning has been initiated when reflecting on the stakeholders perspective of compound events. The process of exchange enabled the integration of existing, local knowledge as well as the develpment of new solution-oriented knowledge.

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