Identifying gaps between science and practitioners perspectives on land use: the case of managed realignment in the German Baltic coast

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Abstract

Through state-of-the art ecosystem modelling supported by ecological experimental data, the COMTESS Project (funding: German Federal Ministry of Education and Research) investigates potential synergies and trade offs in ecosystem service provision under different land-use scenarios in two German coastal areas till 2100. Overall goal is to explore alternative sustainable land-use strategies to best adapt to climate change.

Two science-based land-use scenarios were developed for two study regions on the Baltic and North Sea coasts to contrast a business-as-usual scenario. We focus here on the Baltic Se case region. The underlying premise of these alternatives is managed realignment of current dikes inland for: 1) climate mitigation through wetland re-naturation or 2) multiple land use, including biomass harvesting for energetic purposes (Baltic Sea). Managed realignment is increasingly considered as a valid coastal defence strategy to lower long-term costs of hard coastal defence and restore critical coastal and experiments have been initiated since the 1990s in a number of northwest European countries. Though politically highly controversial and facing much public antagonism, managed realignment is effectively embedded in the current coastal management policy of the state of Mecklenburg Vorpommern on the German Baltic coast. Implementation, nevertheless, faces many obstacles.

Project-based scenarios for the Baltic Sea were first evaluated by key regional and local policy, management and land use practitioners, each expert in their field of activity. Their evaluation and recommendations were subsequently used to develop a fourth land-use scenario.

Using qualitative empirical social research methods we analyse divergences and convergences between expert views on the projects scenarios. We argue that managed realignment is currently being mainstreamed in science, policy and resource management arenas although representatives of local land users and inhabitants do not endorse this strategy and still foster a hard defence approach to coastal zone management. This is best illustrated in recurrent social mobilisation and resistance to managed realignment proposals. This points at important perception and preference gaps between science, policy and land users / inhabitants, which need to be resolved to formulate and implement sustainable and socially acceptable land use strategies.

Introduction

Since the 1970s the dominant paradigm of hard coastal defence has been challenged from a number of perspectives, resulting in the emergence of softer coastal defence approaches, which seeks to restore and work together with natural coastal processes, including managed realignment (Hanson et al., 2002). Managed realignment presupposes the removal or relocation of coastal defences inland to re-establish natural intertidal buffers and has the potential to lower long-term costs of hard coastal defence and restore critical natural habitats (Burd, 1995). Though politically highly controversial and facing much public antagonism, managed realignment is since the 1990s being experimented with in several European countries, in particular in the UK, France and Germany (Goeldner-Gianella, 2007; Rupp & Nicholls, 2007). Managed realignment is at scientific, policy and management levels increasingly being considered as a valid coastal adaptation option (Nicholls and Klein, 2005), which indicates a major departure from the traditional hard defence paradigm in coastal management (Rupp & Nicholls, 2007). In place, it is already explicitly embedded in current coastal management policy frameworks. For instance, in the UK the Natural Environment White Paper (HM Government, 2011: 12) articulates managed realignment as a key strategy to maintain and restore important coastal ecosystem services.

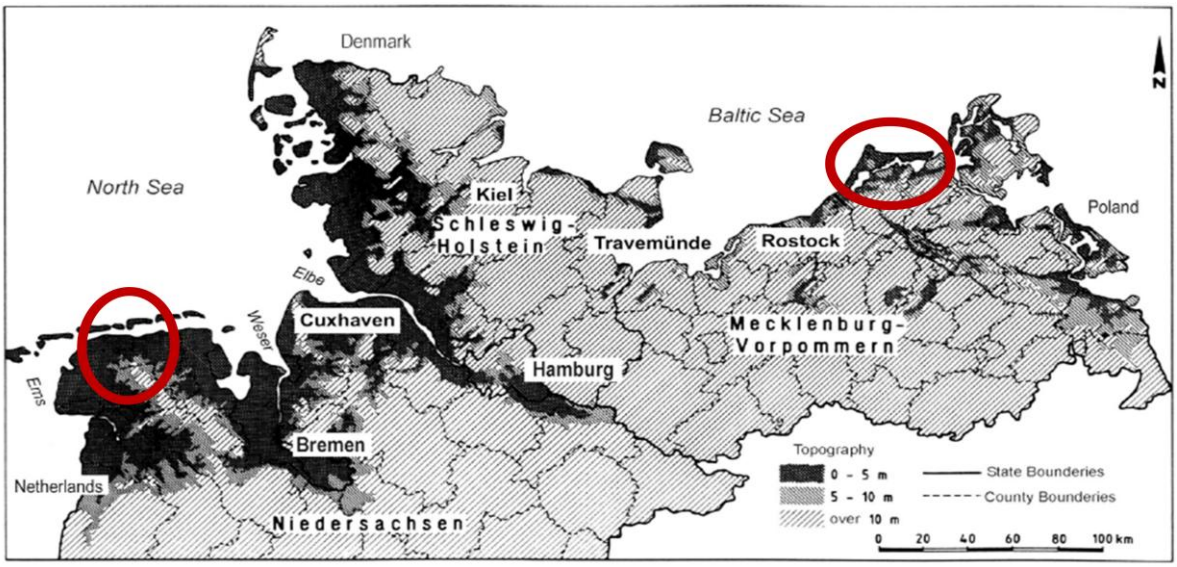
In this paper, after a rapid overview on German coastal zone management and potential impacts of climate change, we introduce our work within the COMTESS Project "Sustainable Coastal Land Management Trade-Offs in Ecosystem Services". Our goal is to explore consistencies and discrepancies in the views of land use policy and management practitioners as well as land users and their representatives with respect to the coastal land use strategies envisaged within the project for the Baltic coast; these being primarily based on the premise of managed realignment. We thereby wish to contribute to a more contrasting and differentiated panorama of views on future coastal adaptation to climate change on the German Baltic coast.

German coast and approaches to coastal zone management

Sterr (2008) provide an exhaustive overview of the key characteristics of the German coast. Divided into the North and Baltic Sea, the German coast is 3.700 km long. It is primarily composed of unconsolidated quaternary sediments and is currently eroding over two thirds of its length. It is predominantly low lying, with ca. 11,000 km^2 coastal plain below 5 m above mean sea level (Sterr, 2008; See Figure 1). This is particularly the case in the North Sea coast, which has been very much shaped by coastal communities through centuries of land claim through dike construction and complex drainage systems. At present ca. 3,400 km^2 coastal plain are artificially drained, of which ca. 30% is flood prone. Moreover, in total, half of the German coast has some form of coastal protection, be it hard (e.g. dikes) or soft (e.g. groynes, beach and dune nourishment) defence.

Since Germany is a federal country, coastal zone management is decided and managed at the subnational level of the four coastal states, although the federal government does contribute to financing coastal defence, especially in the North Sea. The distinct physiographic and meteorological contexts of North and Baltic Seas, as well as their particular history of coastal settlement and occupation explain significant differences in current coastal policy and management between the two basins. For the North Sea, Rupp-Armstrong and Nicholls (2007) do not consider that managed realignment is not likely to be adopted at large scale, since its implementation would require substantial investments. The authors, however, argue, that managed realignment seems particularly appropriate for the Baltic Sea coast, where tidal range is negligible, many dikes are reaching the end of their design life, protected areas are comparatively small and compartmentalised and coastal surges infrequent. Since the legal framework of the state of Mecklenburg Vorpommern sets the priority of coastal defence on the protection of settlement and disengages itself from the protection of purely agricultural land (Ministerium für Lanwirtschaft, Umwelt und Verbraucherschutz Mecklenburg-Vorpommern, 2009: 31), managed realignment is in principle feasible, though not yet explicitly endorsed as coastal adaptation strategy. Nevertheless, a number of micro-scale ecological re-naturation and managed realignment programmes are on-going[1]. Implementation, however, faces many obstacles, due to overt opposition from affected land user parties[2].

Figure 1: The German coast (from Sterr, 2008) and COMTESS case study areas



Goals and approach within COMTESS

[1] Online Managed Realignment Guide – Map - http://www.abpmer.net/omreg/view_map.aspx (29.09.2012)
[2] Civil Association "Hände Weg vom Deich" - http://deich.kein-kohlekraftwerk-lubmin.de/ (29.09.2012)

Sterr (2008) in his national vulnerability assessment of Germany summarises expected impacts of accelerated sea-level rise on the German coasts, which include: increasing beach and dune erosion, changes in storminess and coastal surge patterns and salinisation of coastal freshwater lenses. Consequences of these impacts in terms of people and economic and ecological assets at risks are expected to be low in comparison with highly vulnerable coastal areas of the world. The author thus argues that through adequate and timely coastal adaptation, climate change and sea-level impacts on the German coast should be technologically and economically feasible and manageable, despite significant increases in coastal protection costs. Nevertheless, the ecological costs of hard defence, according to Sterr (2008) would have significantly negative ecological impacts through the loss of valuable wetlands through coastal squeeze.

This is the starting point of the COMTESS project[3] (funding: German Federal Ministry of Education and Research, 2010-2015). The project is centred on the investigation of managed realignment as underlying coastal protection rationale. Through state-of-the art ecosystem service modelling supported by ecological experimental data, COMTESS investigates potential synergies and trade-offs in ecosystem service provision in two case study regions under different land-use scenarios on the German coast till 2100 (See figure 1). Overall goal is to explore alternative sustainable land-use strategies to best adapt to climate change. To this end, specific aspects of climate change have been used as boundary conditions (Table 1). Moreover, areas under 2 m a.s.l. under current coastal defence are considered to be potentially at risk of inland flooding / coastal surge through climate change impacts.

Table 1: Boundary conditions for land use scenarios in the COMTESS Baltic Sea case study sites

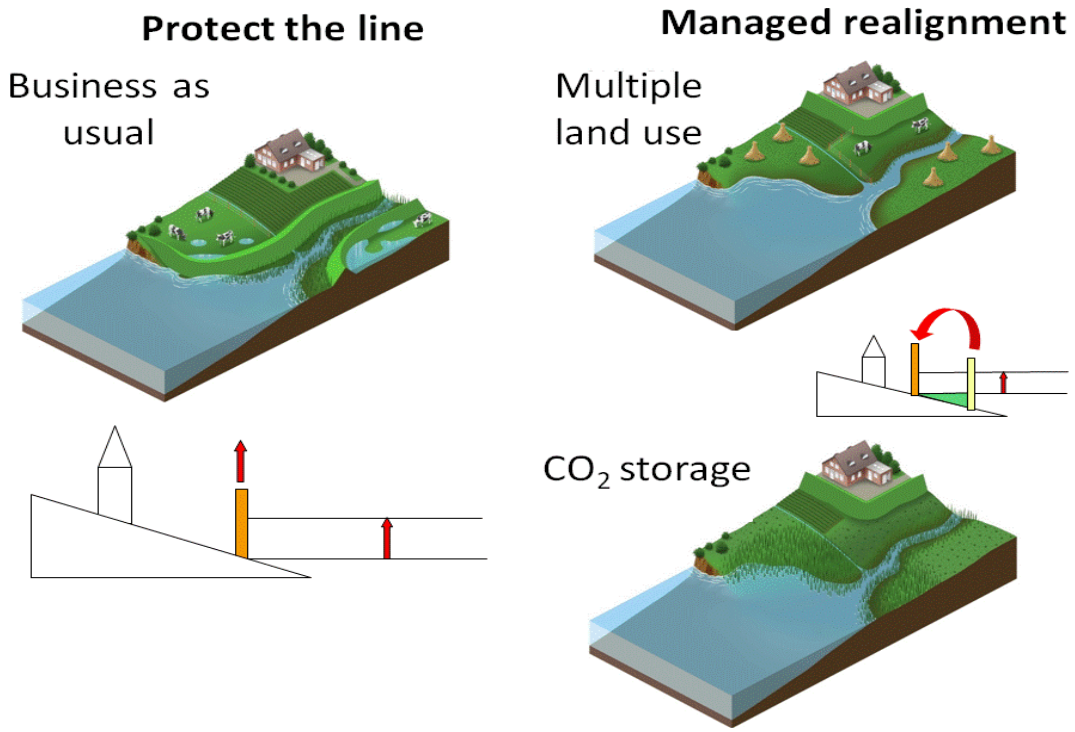
	Optimistic	**Intermediate**	**Worst Case**
Sea level rise	+ 25 cm / 100 years	+80 cm / 100 years	+ 1.5 m / 100 years
Rainfall	+ 20% in winter - 20% in summer	See optimistic	+ 20% in winter - 40% in summer

We focus here on the two land-use scenarios developed for the Baltic coast to contrast a business-as-usual scenario. Effectively, out of the three generic coastal adaptation options envisaged in the IPCC Common Methodology (IPCC; 1990), two are considered within COMTESS: namely “hold the line” and “managed retreat” (here termed “managed realignment”) (See Figure 2).

1. The *business-as-usual scenario* is a control scenario that presupposes the continuation of the present coastal defence strategy: the upgrading and maintenance of coastal dikes and the artificial drainage of inland freshwater. This choice clearly departs from traditional coastal vulnerability assessments, for which the control scenario is “do nothing” (no upgrade / maintenance of dikes).

[3] General presentation of the COMTESS project: http://www.comtess.uni-oldenburg.de/en/ (04.10.12)

Figure 2: Two generic coastal adaptation options considered in COMTESS (Baltic Sea)[4]



COMTESS envisages managed realignment based on the provision of the coastal zone policy of the State of Mecklenburg-Vorpommern that focuses on the protection of the coastal population. Accordingly, dikes in the COMTESS scenarios are relocated inland to secure settlements, while dikes which protect current low lying agricultural land are removed.

2. In COMTESS managed realignment serves two mutually exclusive strategies:

   a. *CO_2 storage* for climate mitigation. Here, land use is abandoned to allow the expansion of reed vegetation and the restoration of wetlands in areas under 2 m a.s.l. As wetland surface elevation increases, coasts may keep up with sea-level rise.

   b. *Multiple land use*. Here, land use is adapted to cope with potential climate change impacts. Envisaged land uses include salt meadows, which have high biodiversity value, and the harvesting of reed biomass for energetic purposes. Effectively, when focusing on land use only this scenario may also be seen as a version of the IPCC Common Methodology "Accommodate" adaptation option.

[4] Note Figure 1 shows time step 2 for the Baltic Sea, when dikes have been relocated inland. Under business as usual inland flooding behind dikes is more frequent

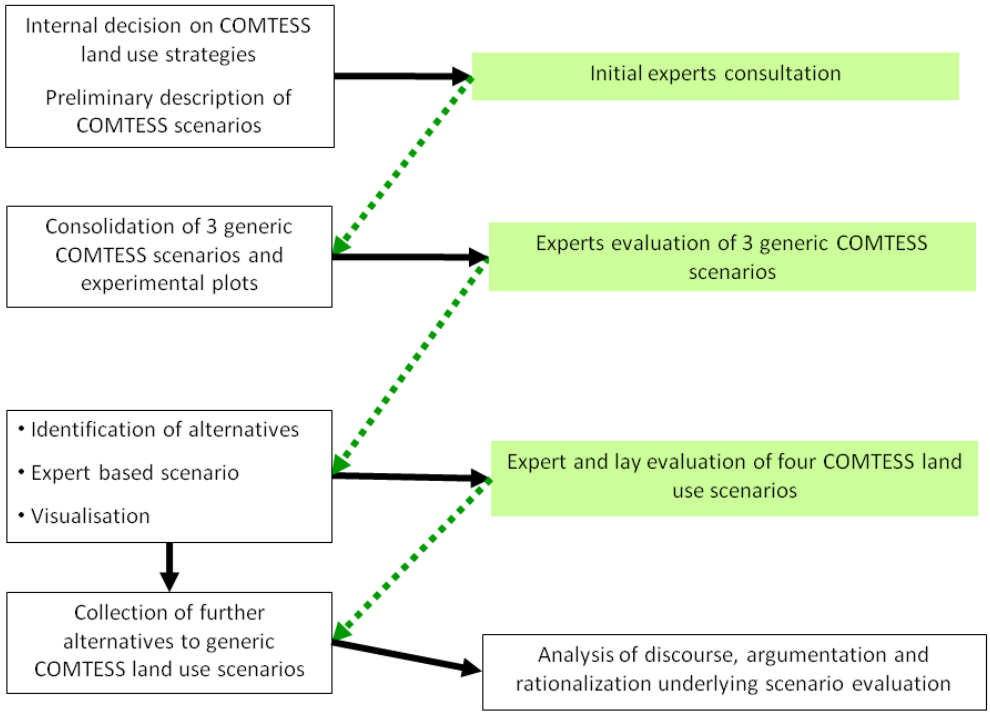
Our specific aim within the COMTESS project is to investigate the congruence and plausibility of COMTESS land use scenarios for stakeholders. We distinguish between: 1) key practitioners from policy and management as well as relevant sector representatives (our "experts"), and 2) members of the general public ("lay"). Here, we focus on "expert" perspectives.

The underlying hypothesis is that different stakeholders have distinct perceptions, priorities, and preferences for coastal / land use management, which may coincide with the COMTESS science-based land use scenarios, but not necessarily. Our aim is thus to identify and collect alternative stakeholder perspectives to complement science-driven ecological and economic modelling approaches embedded in the project. Towards this end, the COMTESS land use scenarios were depicted in a schematic way to support to discussion and evaluation.

We followed a participatory approach based on empirical qualitative social science research methods (FLICK 2011). Figure 3 depicts the different steps carried out. Our aims were twofold:

1. to collect information on stakeholders opinions on the COMTESS scenarios and preferences as well as the argumentations and discourses stakeholders used to ground these; and
2. based on stakeholders perspectives to identify alternative land use strategies, from which a "expert-based" land use scenario per region could be articulated.

Figure 3: Participative evaluation of COMTESS scenarios



In the Baltic Sea region, an initial stakeholder analysis was performed, guided by one main partner (from the National Park Vorpommersche Boddenlandschaft) complemented by exhaustive internet searches and further recommendations from interview partners. We conducted 19 interviews with 24 experts from regional administrations, local authorities, the farming community, non-governmental and private organizations and a local voluntary fire brigade (flood hazard rescue). Experts were chosen to depict different perspectives on coastal defence, natural resource management, conservation, regional planning and tourism issues. Interviewed experts were introduced to the COMTESS scenarios and the areas to be sampled and modelled in detail. A template questionnaire was adapted for each interview partner. This contained questions on the responsibilities experts had within their business / organisations and general views on climate change, sustainability and coastal adaptation. They were further asked to consider important factors, which influence land use decisions and adaptation in the region, to evaluate the three COMTESS land use scenarios and to formulate alternatives land use paths. Interviews were transcribed verbatim for later detailed content analysis following accepted methods.

Table 2: Expert interviews

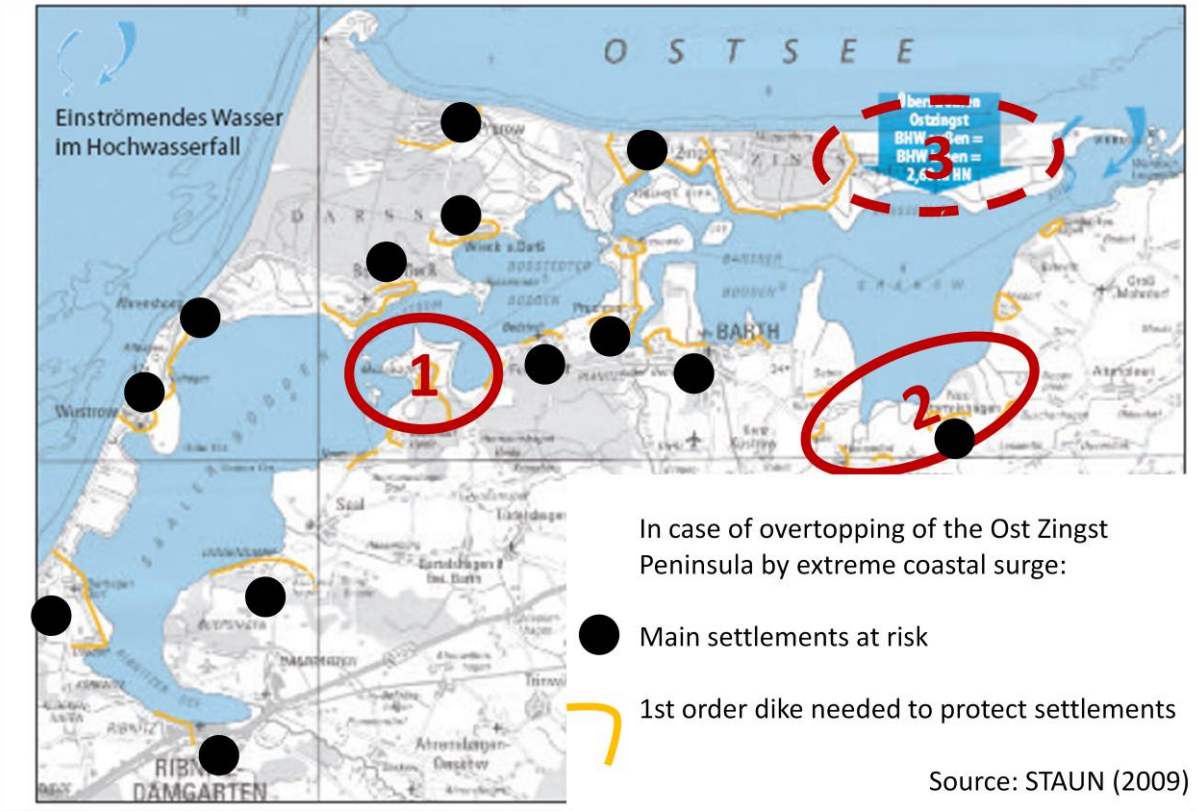
Sector	**Interviews**
Conservation	
Gov	3
Non Gov	2
Local authority	3
Coastal zone management *Regional planning administration*	4
Soil & Water associations	2
Agriculture	
Gov	1
Private	2
Tourism	1
Fire brigade (flood hazard rescue)	1
Total	**19**

COMTESS Baltic coast case study areas

The Darß - Zingst Peninsula and Bodden on the north-eastern German Baltic coast is a barrier island and lagoon system composed of unconsolidated Quaternary sediments still connected to the inland coast through the thin Fischland coastal cordon (STAUN, 2009). Erosion of the Darß and Zingst dunes and beaches on the open coast to the north are prevented through hard and soft defences, while the barrier island complex is a natural protection for the backing inland coasts of the Bodden. At present only a narrow in- and outlet located to the north east of the peninsula connects the Baltic Sea with the lagoon to the south. This natural complex reinforced by hard and soft defence structures substantially reduces the potential impact of coastal surges in the Bodden coast (Figure 4).

Here, different legal frameworks conflict in principle with each other. Indeed, on the one hand, the eastern part of the Peninsula, Ost Zingst, belong to the National Park "Nordvorpommersche Boddenlandschaft" and as a core zone, neither construction nor land use should be permitted. At the same, time the Darß – Zingst Peninsula, in particular Ost Zingst, is the cornerstone of the local coastal protection concept for the Bodden coast. Figure 4 shows the extent of dikes needed to protect settlements in the area in case of overtopping of Ost Zingst during a coastal surge. To optimise coastal defence costs, rather than strengthen the dikes around each settlement of the Bodden coast, it was decided in recent years to reinforce Ost Zingst. Starting 2004 a new dike is being constructed, which ironically runs in the middle of the National Park core zone. To compensate for the ecological damages related to dike construction, a vast re-naturation programme due to start after dike completion in 2014 was agreed upon. This foresees the abandonment or active breaching of existing dikes in Ost Zingst (Figure 5).

Figure 4: Main settlements at risk of extreme coastal surges in Darß – Zingst and Bodden and necessary protective structures in case of overtopping of Ost Zingst (STAUN, 2009). Note in Red: COMTESS sampling and modelling sites. 1: Michaelsdorf; 2: Neu Barthelshagen; 3: Ost Zingst (not included in the modelling exercises)



Areas marked in red in Figure 4 indicate the specific areas to be investigated in the COMTESS project, while their main land characteristics are summarised in Table 3.

Figure 5 Coastal protection and ecological re-naturation in Ost Zingst (STAUN, 2009)

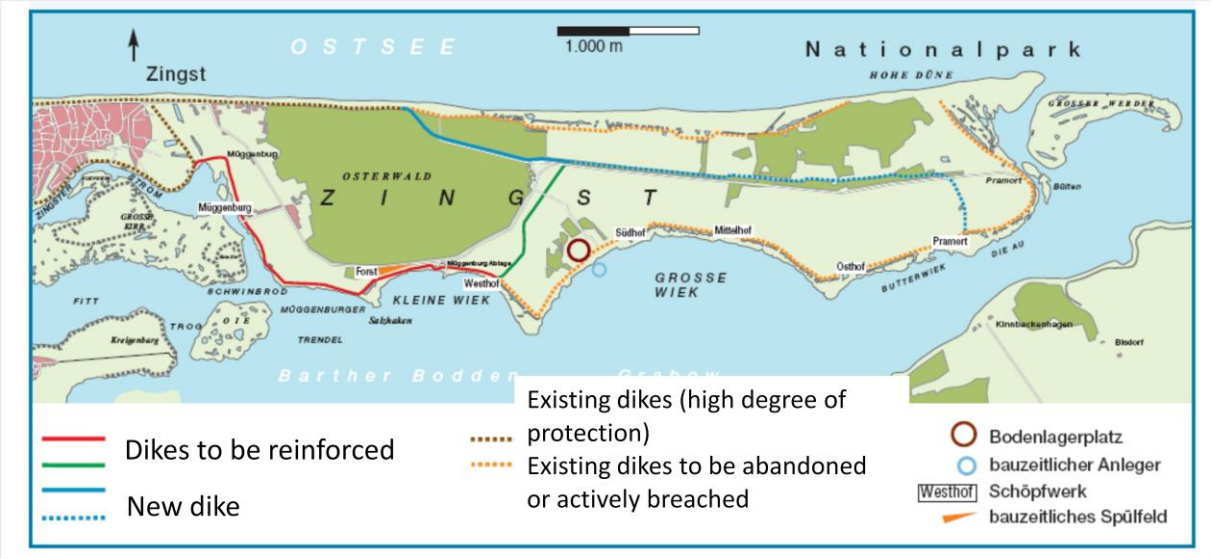


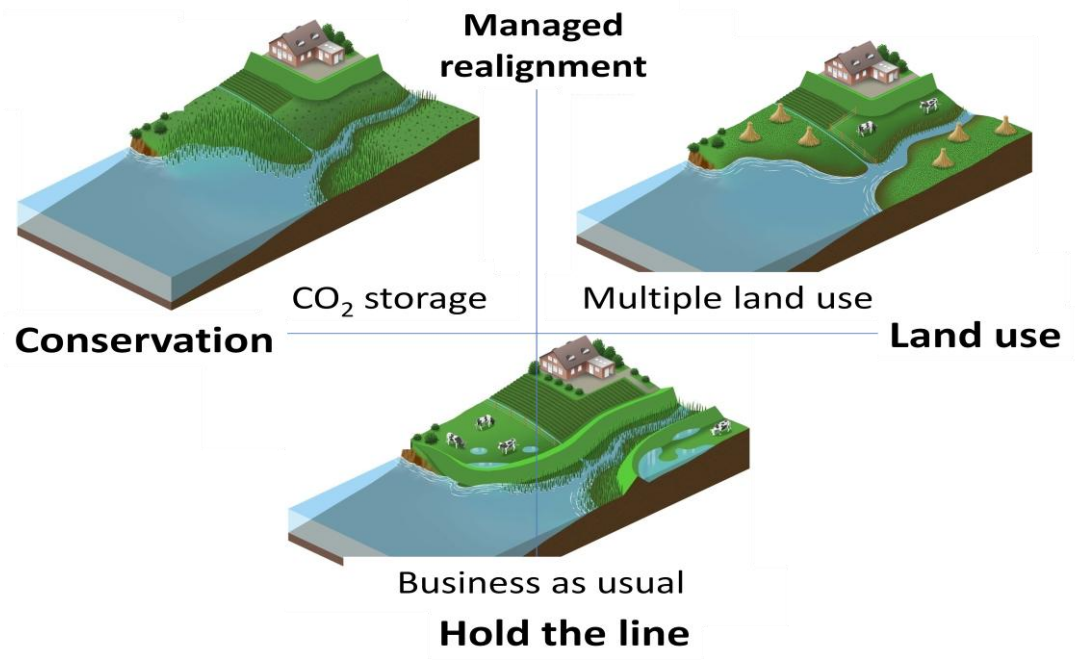
Table 3: COMTESS case study sites in the Baltic coast

	1	2	3
Name	Michaelsdorf	Neu Bartelshagen	Ost Zingst
Present coastal defence	Agricultural 2nd order dikes	1st Order Dike protects a large part of the area To the west, 2nd order dikes	1st Order Dikes All dikes in Figure 5 are to be completed, maintained and upgraded apart from existing dikes in Ost Zingst to the north and south (indicated in hatched brown lines).
Responsibility	Local land users and population under Soil and Water Association	1st Order Dike under state responsibility. Current attempts to transfer responsibility to Soil and Water Association, which already caters for 2nd Order dikes	State of Mecklenburg- Vorpommern
Dominant land use	Pasture (sheep)	Arable land Pasture (cattle)	To the north and west no land use. To the south (Sundische Wiese), pasture Expected impacts through re-naturation: • on the Sundische Wiese, salt meadows to be established / maintained through pasture • to the north, the present woodland will be progressively degraded through salinisation from dike overtopping. • To the west, the Osterwald remains under dike protection and is not affected by the renaturation programme
Land tenure	National Park / Private	Private	National Park

Results

The three original COMTESS scenarios have been organized along two axes (Figure 6). The first pictures the coastal defence option (hold the line vs. managed realignment), while the second land use vs. conservation focus.

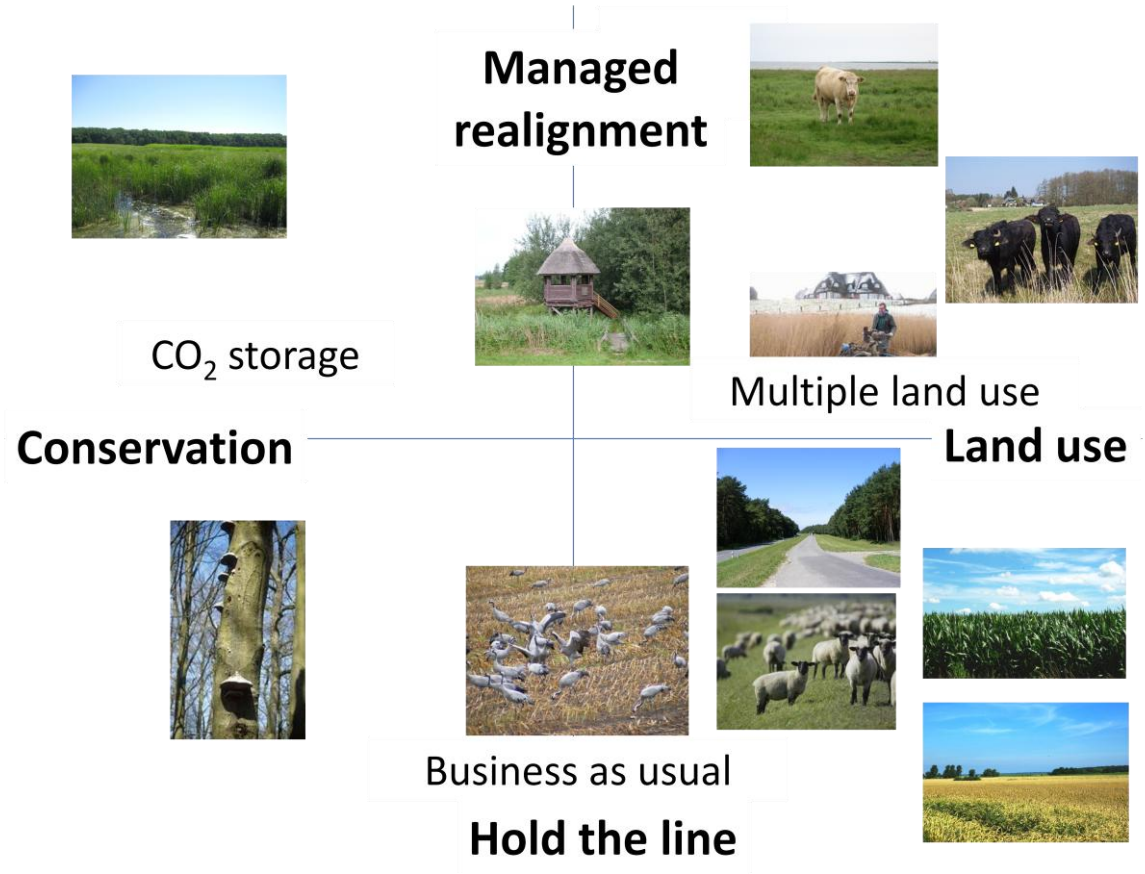
Figure 6: Restructuration of COMTESS land use scenarios



Current / plausible land uses envisaged in the COMTESS project for the areas investigated have been re-organised along this matrix and thereby highlight synergies and incompatibilities between existing and potential land uses (Figure 7). Synergies emerge in different combinations of coastal protection and land use strategies as envisaged by COMTESS. For example, cranes can feed on harvest remains from maize cultivation under business as usual. Sheep grazing on dikes combine pasture with low cost maintenance of protective structures, while dike tops used as cycle paths are an important touristic infrastructure. Similarly, carbon storage in moorland may also fulfil specific conservation goals. Moreover, a range of alternative land uses that may be compatible with managed realignment are currently being experimented with. For example, if current cattle breeds can pasture on wet salt meadows, water buffaloes are better adapted to semi permanently flooded pasture conditions. Also, potential applications of reed, a traditional resource for roofs, and other moor vegetation are been explored and tested upon in the Project VIP[5]. However, specific strategies and goals are clearly mutually exclusive. For instance, moor re-naturation is incompatible with reed harvesting, while process-based conservation (wetland growth in pace with sea-level rise) that could be fostered with managed realignment, cannot be reconciled with the conservation of specific freshwater / terrestrial biotopes (e.g. Osterwald), which are currently protected from salinisation / flooding through hard defence.

[5] Vorpommersche Innitiative für Paludikultur - http://www.paludiculture.com/index.php?id=35 (29.09.12)

Figure 7: Synergies and incompatibilities in land use and coastal defence strategies



Based on project documentation and expert interviews, we identified an initial list of arguments, which support different combinations of coastal defence and land use strategy encompassed within the COMTESS scenarios (Table 4). Since interviews used open questions, not all aspects considered below were mentioned by any one interviewee. This preliminary list forms one column of the analytical framework of the detailed content analysis currently in process.

Table 4: Positive elements associated with the COMTESS scenarios

	Managed Realignment	**Hold the line**
Conservation	• Climate mitigation • Restoration of natural processes / habitats • Landscape naturalness	• Freshwater biotope conservation
Both	• Optimisation of adaptation costs • Improvement of inland drainage • Release of compensation areas	• Feeding grounds for migrating birds (habitat conservation)
Land use	• Preserving cultural landscapes and diversity • Alternative sustainable income sources	• Maintaining agricultural productivity, local economy and tourist attractiveness • Fostering food security • Contributing to renewable energy goals

Preliminary results suggest important overlaps as well as critical differences in focus, interests and priorities among different experts involved (Table 5).

Table 5: Different priorities mentioned by different actors involved in COMTESS.

	COMTESS	Policy / Management	Local authorities	Conservation	Agricultural sector
Climate mitigation	X	X		X	
Restoration of natural processes and habitats	X			X	
Landscape naturalness	X			X	
Optimisation of long term adaptation costs	X	X			X
Improvement of inland drainage	X	X	X		X
Release of compensation areas		X			
Preserving cultural landscapes and diversity			X	X	X
Alternative sustainable income sources			X	X	X
Biotope conservation			X	X	
Process conservation	X			X	
Feeding grounds for migrating birds (habitat conservation)				X	
Maintaining agricultural productivity, local economy and tourist attractiveness		X	X		X
Fostering food security			X		X
Contributing to renewable energy goals through reed	X				

Interestingly experts from different institutions may support managed realignment, while emphasizing different priorities. Thus, from a regional planning perspective managed realignment may help to secure compensation areas for development projects, from a coastal zone management view, it may contribute to optimize coastal adaptation budget, from an environmental management perspective, it may help to fulfil regional climate mitigation goals, and finally from a conservation perspective, to further ecological restoration. The diversity in these answers highlights the potential synergetic effects of managed realignment in different dimensions of policy and management. In contrast, different experts may stress a similar priority, but envisage very different, possibly incompatible strategies to achieve it. For example, optimizing coastal protection costs for a policy expert may imply managed realignment, whereas for an expert from the agricultural sector, it might primarily mean technological improvements to reduce energy costs needed for drainage.

Moreover, the perception of expected, desired or feared outcomes appears to significantly influence how specific coastal zone management and land use strategies are judged. For example, the expected outcomes of managed realignment mentioned above can partly explain the generally positive attitude of the experts from governmental administration interviewed. In contrast, for experts, whose constituencies, environment or activities may be directly affected, managed realignment and re-naturation programmes are primarily associated with potential land loss, and thus as a threat to the local agriculture, employment

opportunities and local development. Also, if the restoration of near natural landscape processes and dynamics may be welcomed by conservation experts, it may be associated with the fear that specific cultural landscape may turn wild and landscape variety and biodiversity lost. Interestingly, the negative perception of landscape uniformity can also work against the business as usual scenario, as seen in the often expressed rejection of monoculture maize plantation.

Further, experts perceive the necessity to prepare for possible future climate change impacts and its degree of urgency differently. Overt positions on climate change range from scepticism towards the notion of climate change and the credibility of climate impact science to full endorsement. Interviewed experts from governmental administration and conservation organization tend to underscore mainstream climate change discourse, while local private sector / authority experts may either openly question or discredit climate impact discourse or though acknowledging it, argue that other matters have higher priority.

Perceptions on the feasibility, desirability or legitimacy of specific strategies or activities therein are again very diverse. For example, if bionergy from reed is largely dismissed by many interviewed experts as technically inefficient, bionergy from maize is often judged morally unacceptable, since it threatens food production and security. Interesting is the argumentation used by different experts to embed their approval or rejection of managed realignment in a wider debate on individual and societal responsibility. For example, one expert openly questions costly long term coastal adaptation that protects individual assets such as luxury (holiday) homes. Also, if an expert from the farming sector may argue that food security issues legitimate federal subsidies for coastal protection, a conservation expert may fundamentally question the agricultural subsidy system that is believed to artificially maintain the economic viability of agricultural activities on marginal land and makes ecological re-naturation so difficult to implement.

Expert-based scenario

If experts generally agree that coastal surge and flooding can seriously impact the region and require appropriate anticipatory adaptation action, they in general disagree on the approach envisaged in the managed realignment COMTESS scenarios. Two main aspects have generally been criticised by interviewed experts:

- The COMTESS scenario envisage one single land use strategy over the modelled area (e.g. carbon storage), which is uniformly implemented in time and space. The relocation of coastal defence occurs in the first modelled time step and remains valid for the whole modelled period (i.e. till 2100).
- The COMTESS scenarios do not take into consideration the complex interactions of policy, economic and societal drivers that influence land use decisions. Thus, land use decisions are for interviewed partners often primarily driven by changes in economic viability of agricultural production, which in turn is critically influenced by public European Union subsidy programmes, world prices, national markets, lifestyles etc.

The solution proposed for the expert-based scenario has thus been to include a differentiation rule, to allow gradual managed realignment and land use changes. The priority is set on the maintenance of land use as long as it is economically viable. The later is included in the modelling based on indicators of productivity and agricultural returns. A sequence of land use change is thus embedded in the expert-based scenario, as follows:

1. Continuation of current land use (business as usual)
2. Once kipping point in viability is reached, a first managed realignment occurs. Areas that are still productive are protected by dikes, while land use on marginal land fronting the dike is adapted (multiple land use)
3. Once a further kipping point in viability is reached, dikes are constrained to settlements and land use is abandoned (carbon storage)

This differentiation is thus to be applied temporally (e.g. as sea-level rise) and spatially (e.g. as areas become progressively unfit for business as usual land use). This implies a more complex and realistic representation of land use changes and adaptation, although it remains very coarse and fundamentally ignores important the complex interplay of global to local factors and processes that lead to land decisions.

It should be noted, that this sequential managed realignment can only by envisaged due to specific factors in the German Baltic region:

- the low exposure to, and magnitude of, extreme coastal surges (in comparison to the North Sea)
- the legal framework of the State of Mecklenburg – Vorpommern, which permits public authorities to disengage themselves from the task of protecting agricultural land and thus the transfer of responsibility on Soil and Water Associations
- the recent upgrade of major structural coastal defence works, i.e. the new dike across Ost Zingst. Indeed, this already affords critical protection and coastal surge attenuation for the Bodden coast for the next decades.
- the locally high soil quality (e.g. Neu Bartelshagen) and favourable current EU subsidies, which still allow a high viability of cereal production on protected land. Thus, farmers and the responsible Soil and Water Association would probably choose to upgrade at their own costs the coastal dikes, should the State step out of this responsibility, rather than let go of the land.

Discussion

The COMTESS land use scenarios are implicitly founded on a rationale of ecological and economic optimisation of coastal resources. The choice of managed realignment as coastal adaptation option explored in COMTESS scenarios relies on a number of premises and hypotheses.

- Climate change will lead to substantially increases in dike upgrade and maintenance and drainage costs
  - ➔ Long-term coastal policy and management aims at optimising these costs
    - ➔ Alternatives that reduces the long-term economic costs of adaptation are desirable

- Managed realignment has the capacity to:
  1. reduce long-term economic costs of adaptation;
  2. promote the re-establishment of natural habitats and processes, which can:
     a. allow coasts to keep pace with sea-level rise
     b. act as valuable carbon storage
     c. form adequate sources of bioenergy
  - ➔ Managed realignment is in principle beneficial both economically and ecologically
    - ➔ Managed realignment is in principle a desirable coastal adaptation option

- Modelling results on synergies and trade offs can be important decision making tools in land use policy and management
  - ➔ Different land use strategies have different implications for the local provision of ecosystem services.
    - ➔ Modelling informed by detailed experimental work leads to a better understanding of complex interactions that substantially influence ecosystem service provision under specific land use strategies and trade offs between these.

Some of these premises may be shared by a number of experts involved in the COMTESS scenario, but not necessarily all to them. These premises as well as the COMTESS scenarios can be associated with the overall goal of optimising coastal ecosystem services and adaptation costs in the context of accepted scientific discourse on potential climate change impacts. Interestingly, it appears that since the turn of the century a slow process of mainstreaming of the managed realignment strategy is taking place in Northwest Europe. From localised experiments in a dominant “hold the line” discourse, managed realignment is gradually becoming endorsed explicitly or not in regional and national legal and planning framework, though only envisaged in areas of high exposure, low population and / or capital assets, where hard defence would be a costly long-term commitment.

The arenas where this mainstreaming is arguably most visible include research on climate change impact and adaptation and coastal ecological processes (a precursor of COMTESS, RegIs performed the first UK coastal vulnerability assessment to envisage explicitly managed realignment, Holman and Loveland, 2001), applied sciences on renewable energy and climate mitigation (e.g. the VIP project mentioned above), coastal zone management administrations (e.g. the UK the Natural Environment White Paper, 2011) or conservation administrations and non-government organisations (e.g. see the white paper on re-naturation from the leading German conservation NGO, NABU, 2012).

Since managed realignment is a substantial departure from historical trends in coastal land claim, it is politically still a sensitive issue. Managed realignment and ecological re-naturation are at local level often the cause of strong social mobilisation and rejection, as seen for example in the "Hände Weg vom Deich" (take your hands off my dike) movement. This resistance to let go of land claim can be associated with deeply engraved conceptualizations of the occupation and use of coastal regions, perceptions of landscape aesthetics and cultural identity, while other factors such as land tenure, definition and perception of coastal risk, lack of understanding of coastal dynamics also play an important role (Goeldner, 1999; Goeldner-Gianella, 2007; Rupp & Nicholls, 2007).

Conclusions

Our work points at key discrepancies between scientific and expert rationalisations, leading to distinct positions, argumentation and legitimisation related to coastal land use and managed realignment, indirectly related to different perceptions and prioritisations of ESS and acceptable trade offs. To a certain extent, we are witnessing a process of mainstreaming of managed realignment, which results in the harmonisation of science and policy discourse. However, locally affected land users and inhabitants continue to show a very vocal resistance to managed realignment and a strong attachment to the traditional "hold the line" coastal defence paradigm. More complex frameworks, examining which international to local factors and processes affect strategic vs. local land use decisions as well as those that facilitate / hinder adaptation are needed to better understand expressed discourses on controversial land use strategies, such as managed realignment.

We recommend:

- Research frameworks that focus less on complex ESS modelling per se, than on defining WITH society, which land use paths are worth exploring. To this end, a more bottom up approach to agenda setting should be fostered, in direction of real rather than pay-lip co-design.
- Modelling should be seen as a MEAN to achieve vaster societal AIMS, and thus be subordinated to the pursuit of critical societal goal.
- The political dimension of land use and ESS modelling should be explicitly considered
- Polemics issues should be investigated in their full complexity and in context

To this aim, it appear important to see science as a process, which enable to explore, make visible, discuss and come to terms with critical and perhaps irresolvable contradictions and conflicts, rather than seek elusive Win-Win solutions. Only then may meaningful convergences and synergies be identified.

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