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Including local knowledge in coastal policy innovation: comparing three Dutch case studies

Floortje M. d'Hont[a] and Jill H. Slinger[a,b]

[a]Faculty of Technology, Policy and Management, Delft University of Technology, Delft, The Netherlands; [b]Institute for Water Research, Rhodes University, Makhanda, South Africa

ABSTRACT

In the context of a growing emphasis on research and application of citizen engagement methods in environmental planning and management (e.g. Reed 2008; Von Korff et al. 2010), we compare three collaborative activities aimed at finding innovative coastal policy solutions in the Netherlands. In these activities, participants across the citizen, science and policy divide were involved in designing nature-based interventions for specific areas in the Netherlands. The activities are compared in terms of the theoretical promise stakeholder engagement holds for influencing participants' understanding of the respective bio-geophysical systems, the actor networks and for effecting knowledge sharing. We find local knowledge offers the potential for crafting coastal policy solutions to fit the specific bio-geophysical and societal context. The empirical analysis revealed the deep competence of local people, who generally understand their lived environment in a systemic way, and the knowledge that can be harvested to broaden and enrich the design space for coastal solutions – in addition to a willingness on the part of the stakeholders to collaborate in developing local solutions for sustainable futures. Although measures to reduce power differences and enable local knowledge inclusion served to broaden the design space for innovative solutions in our case studies, they also constrained the scientific and technical quality of the contributions from professional experts such as bio-geophysical scientists, engineers, spatial planners and policy analysts. As such, future work addressing the dilemma of integrating high quality professional inputs into coastal policy solutions founded on local expertise is advocated.

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Coastal management; participation; policy making; the Netherlands; stakeholder engagement; nature-based solutions

1. Introduction

To maintain the coast, to protect land against the sea and to build infrastructures that provide the desired living environment now and in the future, Dutch coastal management has traditionally involved collaboration between different social actors and decision-makers (Avoyan and Meijerink 2021). In the last few decades, coastal management in the Netherlands has shifted towards even more community engagement in coastal decision-making. Indeed, the current trend in decision-making along the coasts has faced challenges in embracing local knowledge and moving towards more innovative or potentially equitable solutions.

CONTACT Floortje M. d'Hont f.m.dhont@tudelft.nl Faculty of Technology, Policy and Management, Delft University of Technology, PO Box 5015, 2600 GA, Delft, the Netherlands; Jill H. Slinger j.h.slinger@tudelft.nl Institute for Water Research, Rhodes University, PO Box 94, Makhanda 6140, South Africa

The existing tradition of stakeholder engagement in Integrated Coastal Management (ICM) (Taljaard 2011, 2012, 2013; de Juan, Gelcich, and Fernandez 2017; Bontje and Slinger 2017; Cvitanovic et al. 2015; Frantzeskaki et al. 2010) and the growing emphasis on research and application of citizen engagement methods in coastal and environmental management (e.g. Reed 2008; Von Korff et al. 2010), give rise to the question of how to balance stakeholder values and perspectives with scientific information when seeking effective solutions for coastal problems.

Coastal regions are associated with a wide range of interested stakeholder sectors, including local interest groups, tourism, agriculture, fisheries, nature development and the public sector with interests such as flood defence. Within these coastal commons, many environmental and coastal management agencies have been relying upon a "decide, announce, and defend" strategy of dealing with stakeholders (Forst 2009, 299; Van Gils and Klijn 2007; Meijerink 2008). This creates an arena where decision-makers defend their plans and seek to persuade stakeholders to agree, or to not oppose (Forst 2009). Additionally, we have seen examples where the exclusion of the local community network and the subsequent lack of knowledge of local, social institutions has resulted in a narrow and misinformed design space, to the point where ignorance of local perspectives actually led to low quality of designed coastal solutions (e.g. Witteveen and Enserink 2007; D'Hont 2020, 135). On these grounds, we identify a need for (and the trend towards) stakeholder involvement earlier in coastal decision-making processes, in which stakeholders are involved when options are still open. For instance, local communities equipped with relevant scientific knowledge, have shown the potential to build consensus and contribute to sustainable coastal solutions that fit with the local environmental conditions (Slinger et al. 2005). However, such involvement requires different forms of collaboration between the three groups: (1) scientists, (2) decision makers and (3) local communities.

Coastal management, in general, and especially in the Netherlands, where these case studies take place (Figure 1), provides unique contextual conditions. Flood risk management is an overriding theme in the Netherlands – it is a single issue that can dominate in determining the objectives for coastal management (Mulder et al. 2011; Van Raak 2004). Actors exhibit a willingness to try out new ways to improve coastal management practice, as exemplified by the frequent use of pilot projects (Bontje 2017; Vreugdenhil 2010; Van Raak 2004). Pilots focussed on innovative dike re-enforcements, and nature-based solutions (e.g. vegetated foreshores, dunes in front of dikes and mega nourishments (Ecoshape 2022)) illustrate that interventions in the physical environment are the favoured approach. The Netherlands is an innovator in coastal management practice, owing to a combination of necessity, low elevation, high urbanisation in the Dutch coastal zone and a long-standing, consensus-seeking style of governance, involving citizen consultation in politics and spatial planning (Broekx et al. 2011; Argento and van Helden 2010). However, current monitoring and evaluation practices tend to focus on the physical environment of a coastal solution, and there is less structural attention for social changes, including the perspectives and learning of the local stakeholders (Bontje and Slinger 2017; Vreugdenhil 2010). This sets the normative coastal policy context for our study and constrains the types of knowledge that can deliberately be included in this research setting. For instance, the artistic and spiritual experience of the coast is not specifically addressed. Instead, the focus lies on exploring the bio-geophysical and social attributes of the coastal environment and drawing in the lived experience of participants. In this case study-based paper, we investigate three collaborative activities aimed at finding innovative coastal policy solutions in the Netherlands. Our analysis leans on social-ecological systems theory (Redman, Morgan Grove, and Kuby 2004; Berkes, Colding, and Folke 2008), policy analysis (Walker 2000; Enserink et al. 2010; Thissen and Walker 2013, 2001) and transdisciplinary learning (Jahn, Bergmann, and Keil 2012; Bergmann et al. 2012) through stakeholder engagement. The theoretical promise of such engagement in a complex coastal system (elaborated in Section 3) serves as a framework for identifying the different types of outcomes and the knowledge necessary to resolve the local coastal problems. In these activities, participants across the citizen, science and policy divide were involved in collaboratively designing nature-based interventions for specific areas in the Netherlands. The

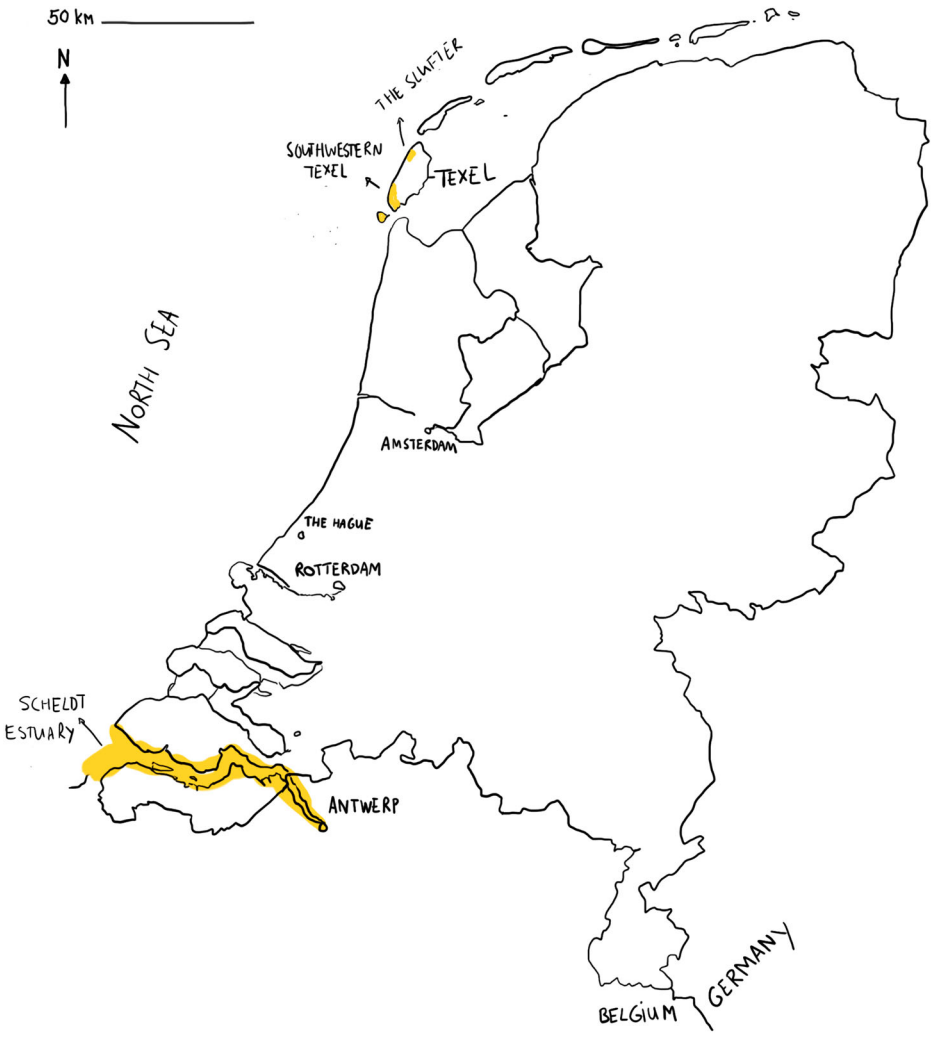

Figure 1. Schematic map of the location of the case study activities (in yellow) in the Netherlands (adapted from D'Hont 2020).

activities are compared in terms of their effects on the participants' understanding of the respective bio-geophysical systems, the actor networks and on knowledge sharing.

Section 2 describes the methodological approach. Section 3 explores the theoretical promise of including local knowledge in collaborative coastal activities, introducing the framework of analysis. Section 4 describes the observed case studies, the associated local coastal environment and its policy problem. Section 5 provides an overview of the results, and in Section 6, we discuss our findings.

2. Methodological approach

We are interested in learning from empirical evidence about the degree to which the promised benefits of stakeholder engagement – the theoretical promise according to social-ecological systems theory, policy analysis and transdisciplinary approaches – were achieved. As such, we adopt a case study methodology, in which we characterised the collaborative activities in the Dutch coastal management context and then analysed these empirical data in terms of the

theoretical promise. Most particularly, we look at whether local knowledge was included, what its role was, and whether this made a difference, and reflect on points for improvement.

Case study research involves the analysis of complex social phenomena within their context, where the distinction and boundaries between context and the phenomena to be investigated are not always clear (Yin 1994). In examining the empirical material, we observe and analyse a number of collaborative activities in the form of workshops in Dutch coastal policy practice (see Section 3.1.). The activities we investigate in this research are strongly embedded in, and influenced by, their "real-world" context (see also Bergmann et al. 2012; Jahn, Bergmann, and Keil 2012). The richness of generated knowledge within a particular case, its ability to deal with real management situations and close interactions with stakeholders and practitioners are reasons why case studies are acknowledged to be useful tools in management research (Gibbert and Ruigrok 2010, 2008). Although the extent to which generalisable conclusions can be drawn from a detailed study of a particular case remains an issue of contention (see Gobo 2004; Flyvbjerg 2006), Stake (2005) argues that case studies can serve as exemplars from which much can be learned. Accordingly, we adopt a qualitative case study approach in exploring and understanding the meanings that various actors ascribe to the investigated problems (see also Creswell 2013).

The empirical material consists of observations of three activities, a reconstruction of the dialogue and descriptions of the setting in which the workshops occurred. Observations on the methods, analysis and the quality of workshop products were noted down, and interactions and responses during the activities were observed. This information was supplemented by reflective surveys by the participants and cross-compared with project-specific documentation. The observation notes, and other collected material, were structurally analysed and categorised using a policy analytical evaluation scheme (after Thissen and Twaalfhoven 2001), as reported in D'Hont (2020). This structural analysis differentiated inputs to the activity, from the activity –the workshop – itself and its outcomes, categorising substantive content and process aspects throughout. As such, it sheds light on the contribution of the workshop activities to the knowledge integration required for innovative coastal management solution development.

2.1. Case study selection

Each of the three activities selected for study are real-world examples of workshops happening in the current coastal management network. They have in common that they are searching for innovative coastal policy solutions in the Netherlands. Furthermore, the activities all aim at collaboration and seeking knowledge sharing between people coming from different backgrounds. The workshop activities employ different methods, but all relate to situations in which coastal erosion is problematic.

Table 1 summarises the selected collaborative activities, which meet the following similarity requirements: (1) the collaborative activities themselves, and information on the collaborative activities, are accessible through the professional network of Dutch coastal management; (2) the focus lies on problems related to the coast within the context of Dutch coastal flood defence; and (3) the workshop activities are characterised by the need to integrate knowledge at the interface between science and society and across scientific disciplines. In all cases, the workshop activities extended over half a day to a day, professional experts such as engineers, spatial planners and policy analysts provided inputs in the form of presentations, and these alternated with collaborative knowledge integration tasks which involved local participants sharing their lived experience. The scientific and technical knowledge can be described as descriptive and even explorative rather than normative, aiming to equip participants to co-design or co-evaluate changes in the coastal system and to develop shared knowledge of their coastal environment. The workshop activities differ on the following characteristics (Table 1). Notably, the Scheldt estuary activity is directly linked to an ongoing decision making process, whereas the Slufter and South-West Texel are more experimental and can be viewed as occurring parallel to decision making processes. In the Scheldt estuary activity,

Table 1. The collaborative activities and their key characteristics.

Activity (date)	Coastal management issue	Focus of the activity	Knowledge holders	Relation of the activity to policy making
The Scheldt estuary (24 Oct 2018)	Monitoring programme on the Scheldt estuary	Building a long-term perspective on the Scheldt estuary – nature and use. Takes place within the context of monitoring the Scheldt estuary.	Scientists (ecologists, geo-morphologists, modellers) Policy analysts Stakeholders (representing diverse interests such as recreation and nature)	Yes. Because the activity contributes to an advice to the Flemish-Dutch Scheldt Committee (VNSC)
Beach erosion on South-West Texel (2 Dec 2016)	Sand nourishment programme. Erosion hotspot on-South-West Texel	Co-design of solutions using natural channel-shoal dynamics	Scientists (engineers, geo-morphologists, ecologists, modellers, spatial planners) Policy analysts, regional and local decision makers Local community (with personal connection to South-West Texel)	No. Explorative research-based activity parallel to an ongoing decision-making process.
Mouth management of the Slufter, Texel (6 Feb 2014)	Mouth management and environmental monitoring of the Slufter.	Explore the role of system understanding in participants' policy preferences in relation to mouth management	Scientists (engineers, geo-morphologists, ecologists, modellers) Policy analyst, regional and local decision makers Local community (with personal connection to the Slufter)	No. Explorative research-based acitivity.

our role was purely observational. While in the South-West Texel activity, we were responsible for the workshop initiation, design and observation, in the Slufter activity, our responsibilities were limited to designing one component of the workshop and observation.

3. Theoretical promise of including local knowledge in collaborative coastal activities

The multi-faceted and multi-actor character of the coastal context implies that optimal solutions to coastal management challenges do not exist (Kothuis, Slinger, and Cunningham 2014; McEvoy 2019; Rittel and Webber 1973). Collaboration between citizens, researchers, scientists and other experts in coastal management is therefore increasingly understood as necessary to find solutions that are societally acceptable and technically viable (Taljaard, Slinger, and van der Merwe 2011, 2012; Mulder et al. 2011; Bergmann et al. 2012).

But, what promise does stakeholder engagement hold in this regard? In this paper, knowledge of the local specificity, held by people living in the coastal environment, is emphatically viewed as something that can potentially be used in designing and improving supported policy solutions, that can be increased, and that can be shared between scientists, experts and (local) stakeholders. In other words: Local people potentially have something to offer in crafting solutions.

Accordingly, the theoretical promise in this research is captured in a framework of analysis, underpinned by three research fields engaged in resolving "real-world problems" for which society requires integrated solutions. We adopt a social-ecological systems view and draw on policy analysis and transdisciplinary concepts of knowledge integration to distil the theoretical promise that such collaborative activities hold (see also D'Hont 2020). In particular, we expect that including local knowledge in the generation of potential policy options is necessary to achieve integrated solutions (see Heylighen 2008; Nowotny, Scott, and Gibbons 2001). *Social-ecological systems thinking* (Redman,

Morgan Grove, and Kuby 2004; Berkes, Colding, and Folke 2008) provides a lens to resolve complex problems by conceptualising, analysing and treating the system – the set of interrelated component elements – as a whole (Ackoff 1979; Checkland 1999; Miser and Quade 1985). The concept of the environment as linked, nested and interacting systems of humans and natural ecosystems, emphasises that humans are part of – and not apart from – nature (Berkes and Folke 1998). *Policy analysis* rests on systems thinking (Slinger, Taljaard, and D'Hont 2020), and offers purposeful, systematic and structured analytical approaches to investigate the effect of policy activities on their real-world contexts (Walker 2000; Enserink et al. 2010; Thissen and Walker 2013, 2001). *Transdisciplinary approaches* recognise varied sources of knowledge as relevant in establishing system understanding, including environmental and social science, practice, local knowledge and governance knowledge (Jahn, Bergmann, and Keil 2012; Bergmann et al. 2012).

In the framework of analysis, we synthesise these insights to distinguish three ways in which including local knowledge in collaborative coastal activities holds theoretical promise, namely: (i) enhanced shared understanding of the natural (bio-geophysical) system; (ii) enhanced shared understanding of the social system; and (iii) improved knowledge sharing between and across the scientist and actor networks (Figure 2 and Table 2).

First, coastal problems, such as flood defence issues, coastal erosion or liveability problems, may require intervening in the physical system. As such, for an enhanced shared understanding of the *bio-geophysical system*, we seek recognition of the biotic (living) and abiotic (non-living) elements that exist in a coastal natural system. The extent to which activities address knowledge on the geophysical and ecological subsystem elements gives an idea of the solution space for the resolution of the respective problem. Similarly, we consider the system boundaries that are adopted, including the effects of the coastal system on its nested surrounding systems, as well as the effects of the environment (external influence) on the coastal system in turn.

Second, because potential solutions for coastal problems don't always lie in the physical system but also exist in the social, institutional and governance systems (e.g. changed beach nourishment strategies, nature protection laws, changed use functions or forming actor coalitions to make change happen) we turn to analysing the shared understanding of *social system complexity*. We emphasise the representation and role of local and indigenous knowledge of the coastal system, the link with the policy context and the identification of constraints, requirements and opportunities that the institutional framework imposes on the lived experience of coastal communities.

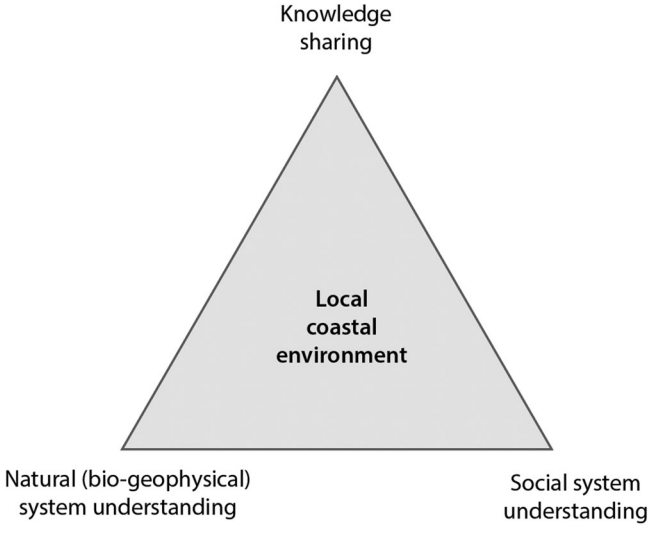

Figure 2. Structuring the theoretical promise as a triangle.

Table 2. Theoretical promise of collaborative activities aimed at finding local solutions for the coastal environment.

Promised outcome		Type of knowledge	
1	Enhanced shared understanding of natural system complexity, for instance including the following elements	a	Addressing the interrelations between the geophysical and ecological subsystems
		b	Within the geophysical system, advanced interpretation of geomorphological and hydrodynamic influences.
		c	Analysis of the character of the geophysical system's ability to maintain the diversity and quality of habitats characteristic of the ecological system.
		d	Analysis of environmental impacts on a complex coastal system, within practical spatial bounds.
		e	Improved representation of external influences, such as meteorological impacts and climatological impacts on the coastal system
2	Enhanced shared understanding of social system complexity, for instance including the following elements:	a	Representation of local and indigenous knowledge of the coastal system
		b	Addressing the knowledge and perceptions of involved actors and non-involved local stakeholders
		c	Addressing the differences and interrelations between the social, institutional and governance subsystems
		d	Early consideration of solutions that lie within the social components of the coastal system, especially relating to multi-actor complexity and institutional complexity
		e	Linking solutions to the policy context, by designing or implementing adaptive, long-term planning within feasible budget ranges and time frames, robust governmental changes.
		f	Addressing the constraints and opportunities offered by institutions (rules, norms, habitual procedures etc.) for potential solutions.
3	Improved knowledge sharing	a	Sharing of scientific knowledge on the abiotic and biotic aspects of the coastal system, technical/engineering knowledge, and social science knowledge on policy making, institutions, and governance of the coastal system.
		b	Identification of interactions and interfaces between subsystems (social, governance, environmental).
		c	Knowledge exchange between inter- and transdisciplinary participant groups
		d	Using compatible scales by aligning solutions and appropriate time and spatial horizons.

Third, we look for *knowledge sharing* that occurs at the interface between scientific issues and societal problems, relevant in a coastal context. Indeed, multi-actor collaboration characterises (Dutch) coastal management, which is interdisciplinary in nature. In complex systems, the premise exists that solutions (partially) lie on the interfaces between natural, social and governance realms, especially for problems for which we seek solutions with long-term societal benefits. As scientific knowledge is located across disciplinary fields, policy knowledge is scattered across administrative zones and sectors and experiential knowledge is located in the local communities, knowledge sharing is imperative. The framework examines the extent to which this happens. The transdisciplinary character, the richness, the breath of the knowledge and scale preferences regarding temporal and spatial horizons vary across the different stakeholders and experts. We look at whether different types of knowledge are included, as knowledge from actors other than decision makers and (civil) engineers is needed in the search for integrated solutions to societal and coastal problems.

Summarising, we conceptualise the environment as a coherent system of bio-geophysical (ecological) and social factors, that interact in a dynamic, sustained and continuous manner. The framework of analysis thus contributes to the scientific discourse on the potential of systems approaches to advance multidisciplinary sustainability science (see also Reis, Stojanovic, and Smith 2014). The framework is intended to serve as an initial guide to identify desired outcomes, and supports ex-post evaluation of community-engaged activities in practice.

4. Three cases of coastal community engagement

This section describes the environment of the associated local coastal problem and the observed activities, respectively.

4.1. The Scheldt estuary

The Scheldt estuary lies on the border of the Netherlands and Belgium and is one of the largest fully tidal estuaries of the North Sea. The Scheldt estuary has a full salinity gradient and sand flats that contribute to the richness in habitats and biodiversity. However, environmental changes and human interventions in the area have had negative effects on the Scheldt estuary. The changes in tidal movement, the limited influx from the rivers and the dumping of dredged sediments may contribute to more muddy waters, which affects the primary production and has other effects in the ecosystem. Human interventions in the system, such as dikes, empoldering, dredging and hard structures, have made the estuary narrower, the channels deeper and the estuary shorter. As such, the high tides have become higher. The area also has economic and social functions, and a wide range of stakeholders are concerned with the area.

To achieve consensus in this actor arena over the factual basis for a new long-term perspective of the Scheldt estuary, the authorities commissioned the Long-Term Perspective Nature Scheldt estuary (LTP-N) in 2016 to investigate the robustness and resilience of the Scheldt estuary, considering climate change and use of the estuary. The observed workshop activity formed part of an overarching participatory process aimed at creating shared system understanding in collaboration with local stakeholders. There is a direct link with policy processes, as the intended outcome of the process is to advise the Vlaams-Nederlandse Scheldecommissie on further management strategies related to the estuary.

The observed meeting was on 24 October 2018, and a core group of ten participants was present. The participants are local people living around the Western Scheldt, most of them associated with organisations described as stakeholders in the context of the project. They include the provincial authorities, nature organisations, recreational organisations and port authorities from Belgium and the Netherlands.

The activity focused on joint fact-finding and building a shared understanding of the Scheldt as an (eco-)system. The stakeholders were required to assess the quality of the system analysis, the product of a previous workshop, and to ground their normative valuations on facts, that is, is it going well or badly and if so, why? The goal of the activity was stated as:

> the system analysis focuses on the way in which biotic and abiotic components in the estuary develop. The analysis should make clear whether the nature is sufficiently robust and resilient to retain characteristic estuarine values against a background of climate change and human use.

The discussed topics were: low-dynamic littoral subsystem, soil biology, pioneer vegetation, abiotic factors and birds. Discussions were about the identification of the weak links in the system and what interventions on which particular system elements would be the most effective. The focus of this system analysis was the ecosystem. Humans were not explicitly considered in the system analysis, nor were social constructs such as decision-makers, institutions, (recreational and industrial) use of the ecosystem, et cetera.

4.2. Beach erosion on South-West Texel

Existing Dutch coastal policy is aimed at preventing erosion by maintaining the Dutch coast through sediment nourishment. This policy ensures that the erosion hotspot south-west Texel receives a large sediment nourishment budget. However, the existing coastal management institutions are constantly challenged by pressing issues like climate change, societal usage of the coast and

increasing knowledge about the coastal system (Mulder et al. 2011). According to a national policy evaluation carried out in 2007 (Lubbers et al., 2007), there is a need to improve and develop spatial integration and coherence between different parts of the Dutch coast. This need is exacerbated by the future increase in nourishment demand. Another important evaluative conclusion is that functional integration in Dutch coastal management is only partially achieved (Lubbers et al. 2007). The need to maintain the coastline using sand nourishments for coastal functions goes beyond only coastal safety (Mulder et al. 2011). However, nourishment claims for other user functions (e.g. recreation in coastal towns) require relatively expensive beach nourishments, whereas safety issues can be served more effectively by cheaper shoreface nourishments. The island of Texel is a nature-rich area, and the south-western point of the island is unique. The island community of Texel is a close-knit community, and citizens know how to access and alert relevant authorities (D'Hont, 2020). Local citizens are well-organised and are vocal in stakeholder groups, such as village committees or the organisations that represent "National Park Duinen van Texel". Additionally, local and regional authorities frequently organise participatory processes and multiple scientific research projects have been running and are currently run on the island (see De Vos et al. 2010).

The workshop activity was initially envisaged as investigating the feasibility of a new multi-functional concept that involves depositing a more "concentrated nourishment" in the marine environment, further out from the coast of Texel Island, to counter coastal retreat and to provide social benefits (e.g. recreation and nature) in an integrated, flexible and more cost-effective manner (Wijnberg et al. 2013). This concentrated nourishment was conceived as solving erosion problems over the long-term while also paying off in terms of short-term benefits (Slinger, Taljaard, and D'Hont 2020). As such, this case study focussed on a workshop activity that explored the issue of beach erosion on the island of Texel, the Netherlands, in which coastal experts, policy makers and local community stakeholders were asked to co-design integrated solutions bringing in their own expertise. Fourteen local stakeholders were asked to co-design potential solutions visions for their island, considering a wide range of issues, including the site-specific biophysical, social and institutional context, considering flood defence issues and liveability. Six professional experts had an advisory role in the workshop, including morphodynamicists, hydrodynamic modellers, ecologists concerned with flora and fauna in the sea, the foreshore and the beach-dune systems. The resulting designs showed dilemmas in stakeholder values and deep knowledge of all participants with respect to their living environment. The analysis and the discussion demonstrated that collaboratively designing aids in identifying existing social tensions, can help in painting a picture of the diversity in actor perspectives and in broadening the solution space. We found that the wide scope of the activity positioned coastal management problems in their local environmental context, by utilising local, scientific, practice-based and other forms of knowledge in an egalitarian fashion.

The South-West Texel workshop activity aimed to find a solution space for a complex system with different problem perceptions and long-term values of local people. While the breadth of the complex coastal system was addressed in terms of social-cultural and bio-geophysical complexity, the actual effects occurred more in the actor-network (an inherent component of a complex social system), as opposed to the designs themselves directly affecting the bio-geophysical system. For instance, we observed that local people were equipped to engage with the authorities better and to build coalitions amongst themselves, in part owing to the setup of the workshop.

4.3. Mouth management of the Slufter, Texel

The Slufter is a unique nature reserve on Texel, an island in the Wadden Sea area of the Netherlands. The Slufter comprises coastal dunes, an estuarine channel, a salt-marsh and an intertidal zone landwards of the coastal dunes. The entire Slufter is about 1 kilometre wide (from mouth to sand dike) and over 2 kilometres long. The Slufter is a small system, with an intermittently closed mouth and seasonal freshwater inflow of unknown total volume. The dynamic intertidal zone is bounded by a sand dike and sandy dunes. Diversity in the substrates and a lack of disturbance mean the

Slufter exhibits high species richness in its vegetation (Pedroli and Hoekstra 1992; Balke 2013). The Slufter area, including the sand dike, forms a component of the primary flood defence of Texel, and protects the hinterland from flooding from the North Sea.

While the existing management practice is to periodically straighten the estuary mouth so as to mitigate the flood risk to the dike landward of the Slufter, new coastal modelling insights led to an incentive for the water board to re-evaluate their mouth management strategy of the Slufter. Although there was no urgency for policy change from a flood defence perspective, there was room to allow for more natural dynamics in the area, resulting in a regimen that is more in line with societal and ecological values.

The activity was initiated as the water board HHNK wanted to reduce management interventions at the mouth of the estuary by potentially letting nature take its course in the Slufter in the future. Triggered by insights from simulations with new storm wave models (van Rooijen and van Thiel de Vries 2013), a research goal was to create new system knowledge on stakeholders' perceptions and estuary morphodynamics in a collaborative setting in which current practices in managing the inlet of the Slufter were under discussion. The study, therefore, set out to explore the role of system understanding in support of integrated management of a small estuary, investigating the effect of feeding expert modelling insights to the participants while also investigating the degree to which participants reconsidered their preferred policies and the importance of Slufter characteristics. To achieve this goal, outcomes from a system dynamics study (see also D'Hont, Slinger, and Goessen 2014) were used to open up the discussion and learning on behaviour of the estuary system. A causal model based on Slinger (2017) was used to describe the constraining effect of the sill height and mouth cross-section on the in- and outflow of water through the estuary mouth.

This activity involved a process of stakeholder engagement in which the perspectives and values of local stakeholders were explored with the aid of system dynamics modelling insights (D'Hont and Slinger 2020). The Slufter activity explored the role of formal knowledge in deepening system understanding through a stakeholder engagement in a workshop setting on 6 February 2014. A synthesised understanding from the system analysis, including the simulation model outcomes and stakeholder analysis, was presented to the participants in a workshop setting in the form of two presentations. The participant's group was a mixture of researchers familiar with coastal modelling and citizens from the island, all with individually different viewpoints and substantial, ready, real-world knowledge of the Slufter. The discussions in the activity focussed on system dynamics ("how the system works"), as opposed to defining the system "what the system is". Similarly, discussion of stakeholder values, system understanding and the ecosystem services that natural systems deliver, can create a space in which participants can share knowledge.

As such, the stakeholder engagement session explored the role of local knowledge in early policy design phases. This fits with the current practice of stakeholder management, especially for smaller projects that include interventions in coastal, ecological systems. The approach adopted in the Slufter activity assessed and identified human values and used functions, in addition to the bio-geophysical qualities of these systems. The choice to conceptualise a dynamic coastal nature reserve as a social-ecological system allowed for the involvement of a wide range of stakeholders and accommodated dealing with the dynamic behaviour of the ecological system.

The local district water board authority, involved in many local decision making processes, had the role of facilitator and host of the activity. The water board strives for participation, but stakeholders do not necessarily perceive their actions as neutral, which has affected the efficacy of policy activities in the Netherlands (Deelstra et al. 2003; Kolb, Jin, and Hoon Song 2008).

5. Results

A detailed summary of the activity outcomes is provided in Table 3.

5.1. Evidence of enhanced shared understanding of bio-geophysical complexity

The Scheldt estuary. The key focus of the Scheldt estuary activity, and of the associated nested process, was to build an understanding of the current state Scheldt (eco-)system, and to assess its health. Local stakeholders contributed to the valuation of the desirability of the current state. The investigation focussed on pioneer vegetation, soil biology, low-dynamic littoral, coastal birds and seasonal migratory birds. Causal relations between species, in terms of a food network, were considered in detail. For example, the effect of increasing soil biota on molluscs, which in turn will attract bird species. The environmental impacts on the estuary were only considered in terms of robustness and resilience of the Scheldt estuary.

South-West Texel. The focus of the South-West Texel activity lay on collaboratively designing utopian and dystopian futures. Participants were encouraged to envision over 50–100 year time horizons. The designs were to be physically realistic but not constrained to the current situation. Accordingly, the designed future visions sketched images of possible futures that would require changes in the bio-geophysical system or even the institutional system. An interdisciplinary team of six scientists from a variety of disciplines relating to coastal systems were invited to their share knowledge as needed, during the design process. Ecosystem characteristics, such as the geomorphological relation of the island to an offshore ebb tidal delta in the sea and the intrinsic value of flora and fauna were thoroughly discussed. However, geomorphological and hydrodynamic influences on the coastal system were not emphasised by the participants in their designs.

The Slufter. The Slufter mouth is particularly dynamic, as sediment deposition and erosion shape the inlet and associated intertidal landscape, enhancing freshwater-seawater gradients and contributing to the highly valued biodiversity (i.e. diversity in vegetation, invertebrates and birds). One topic of discussion followed directly upon a presentation on abiotic estuary dynamics and behaviour. In this presentation, participants were encouraged to consider the situation of normal weather conditions and ordinary tidal dynamics, as opposed to other meetings and workshops on the Slufter that commonly emphasised flood defence and, consequently the situation of exceptional storm weather conditions. While a hydrodynamicist denied the inflow of freshwater in the Slufter, contesting its definition as an estuary, local community participants identified that there is some freshwater inflow from specific sites, especially in wet seasons after a rainfall – information of which the participating hydrodynamic modellers were unaware. The question of how significant the freshwater influx was in terms of mouth dynamics remained. At the time, freshwater inflow was not subject to measurement in the Slufter. A further topic of discussion focussed on dynamic behaviour and system boundaries in relation to the individual real-world experiences of the participants. As expected, this discussion quickly diverted from water safety and ecosystem function so that participants could discuss the potential consequences of dynamic estuary behaviour on vegetation and birds, based on the expert information supplied in the workshop activity. This topic was of particular interest to the participants and engendered a lively exchange of opinions.

5.2. Evidence of enhanced shared understanding of social system complexity,

The Scheldt estuary. The focus of this system analysis was the ecosystem of the Scheldt estuary. Humans were not emphasised nor considered in the system analysis, apart from flood safety considerations or evaluations on the safety from flooding and navigability brought into the discussions by experts. The focus did not lie on the underlying values of the participants, nor on the values held by the broader population living around the Scheldt area, and the knowledge and perspectives of the involved and non-involved actors were not discussed explicitly. Possible (human) interventions in the natural system, such as sand mining and maintenance dredging of the navigation channel, were mentioned.

In *South-West Texel*, the activity of building shared system understanding among participants led to rich discussions, appreciation of different viewpoints and appreciation for the collaborative activity itself. As participants stated in their feedback, they appreciated that the local knowledge

Table 3. Summary and comparison of the outcomes of the activities, in terms of the theoretical promise as presented in Table 2.

Elements that enhance shared understanding of natural system complexity	Elements that enhance shared understanding of social system complexity	Elements that improve knowledge sharing
The Scheldt estuary		
The key focus of this activity was the bio-geophysical and ecological subsystems (1a). Causal relations between the existence of species, in terms of a food network, were considered in detail (1c). Changes in the Scheldt estuary due to climatological and environmental impacts were explicit focus of the activity and process that the workshop was embedded in (1d and 1e)	Relevant actors were present. Stakeholders were selected to represent a wide range of local interests (2a and 2b). Values of actors were revealed when the group was asked to assess the current figures (2a). However, the focus did not lay on the underlying values of the participants, and not on the other values that were present in the population living around the Scheldt area (2a and 2b). The outcomes of the process (of which the workshop was part of) linked findings to the policy context (2e). Issues and solutions were discussed in terms of the natural system, and not the social or institutions (2d and 2f). Constraining legal frameworks were discussed (2f), but seen as external to the process the workshop was part of (2c)	Local knowledge was present in this process (2a, 2b). Additionally, where the participants may not have been experts at the beginning of this stakeholder engagement process, by the time of the observed activity they had a very high level of detailed knowledge about the Scheldt-estuary system, including vast knowledge about bio-geophysical subsystems. This contributed to knowledge exchange between participants across backgrounds (3c). Sharing of scientific knowledge occurred through the experts that were also present in the activity, which was a deliberate design choice of the activity (3a)
Beach erosion on South-West Texel		
In the activity, presentations on the bio-geophysical system were given to the participants, including the interrelations between the geophysical and ecological subsystems (1a). The participants were asked to co-design utopic and dystopic visions on long temporal scales (30–50 years, even as far as 100 years). Recent insights on geomorphological and hydrodynamic influences on the coastal system were presented in the workshop considered by the participants in designing their visions (1b) Experts gave input on geomorphological and hydrodynamic influences, on state-of-the-art research outcomes regarding geomorphology, and on the coastal system's ability to maintain the coastal ecosystem (1c) The role of environmental changes and storm events were discussed during	The activity of building shared system understanding among participants led to rich discussions, appreciation of different viewpoints and appreciation for the collaborative activity itself (2a) In co-design workshop 1, the activity of building shared system understanding among participants led to rich discussions, appreciation of different viewpoints and appreciation for the collaborative activity itself (2a) The main focus points for the designs were how any proposed changes would affect the socio-economic subsystems (2c). The co-design visions were presented as directions for long-term solutions for the island, and physical changes in several visions were linked to the policy and institutional contexts (2e), or required institutional designs (2f)	Participants explicitly appreciated the co-learning and the expert presentation(3a and 3c). The spatial bounds of the designed future visions matched the living environment of the participants well (3d) Focus points for the designs were how any proposed changes would affect the socio-economic subsystems (3b). In other words, changes in and the effects on the living environment of the participants were considered. The focus on future utopian and dystopian visions Promoted thinking and designing beyond purely coastal management strategies towards shared (desired, undesired and realistic) futures (3d).

(*Continued*)

Table 3. Continued.

Elements that enhance shared understanding of natural system complexity	Elements that enhance shared understanding of social system complexity	Elements that improve knowledge sharing
these expert presentation (1d and 1e). This was reflected in the workshop outcomes, as visions showed consideration of deeply uncertain factors such as climate change and sea level rise, and their potential impacts on Texel (1d and 1e)		
Mouth management of the Slufter, Texel		
The character of the nature reserve's ability to maintain the diversity of habitat characteristics was discussed extensively (1c). Particularly the local participants, but also the experts, were concerned with the Slufter's ecological value, as was the link with the ecosystem (1a). The activity delved into the hydrodynamics and geomorphological influences on the Slufter (1b). External influences such as climatological impacts or environmental changes were not explicitly discussed in depth (1d and 1e)	The difference and the interrelation between the social institutional and governance systems were addressed and explored by sharing knowledge and perspectives amongst participants and exploring whether changes occurred (2a and 2b). The interrelations between the social, institutional and governance system were not explicitly considered (2c). Moreover, links with the policy context were discussed, but limitedly (2e), nor were the opportunities offered by institutional and governance systems for potential solutions (2f). However, governance bodies were not completely ignored, as participants' access to authorities was considered key in the functioning of management of the area (2f)	In this activity, it was not the discussion of "what the system is", but the discussion of "how the system works" that facilitated knowledge exchange, including knowledge of abiotic and biotic system aspects, governance of the water boards, and stakeholder preferences (3a and 3b). Sharing of scientific knowledge on hydrodynamic and geomorphological aspects of the Slufter was one of the key objectives of the activity (3a). Expert knowledge and local knowledge were shared amongst participants (3c)

and local expertise was taken seriously, respected and included. Several times, the discussions moved from the bio-geophysical system knowledge to the character of Texel. In other words, changes in and the effects on the living environment of the participants were considered the most. For example, one of the economic challenges for Texel lies in the aging population and a lack of returning Texel youth. Sustainability of the economic system is a goal, which was linked to a local approach; for example, through local foods that emphasise the character of Texel. The main focus points for the designed outcomes were how any proposed changes would affect the social-economic subsystems. An additional example of the benefit of a wider solution space was provided by a discussion on changing municipal zoning rules (institutional interventions) to accommodate dynamic changes in the geophysical environment and associated changes in nourishment strategies (interventions in the physical system).

The Slufter. In this collaborative activity, researchers adopted a social-ecological lens from the outset, which means that the issue of mouth management was expanded to include the ecological and social value of the Slufter area. Identified use functions of participants, who were all people with direct knowledge of the Slufter, included

> (i) a component of the primary flood defence, (ii) a nature reserve with vegetation and birds, (iii) a location of sediment flows in the North Sea, (iv) recreational area, (v) part of a recreational route, (vi) a tourist attraction, (vii) a bird habitat for foraging, resting and breeding, and (viii) part of a migration route for birds.

The stakeholder values associated with the local nature reserve were explicitly discussed, in including recreational value and the inherent value of a nature reserve, as opposed to the Slufter as only having a primary (social) flood defence function.

5.3. Evidence of improved knowledge sharing

The Scheldt estuary. Part of the joint-fact finding process included: collaboratively formulating a plan of approach and the rules of the game in 2017, a series of interviews, five plenary workshops, a series of core group meetings between the workshops in which the next plenary workshops were prepared and the sharing of all preliminary products and results with the stakeholders. Experts fed information about the estuary into the activity, through reports of evaluations on the safety, navigability and nature. Local knowledge was included in this process through the collective task of constructing an ecosystem-based monitoring framework. Additionally, where the participants may not have been experts at the beginning of this stakeholder engagement process, by the time of the observed workshop they had a high level of detailed knowledge about the Scheldt-estuary system, including vast knowledge about the bio-geophysical subsystems – an indication of the sharing of expert knowledge.

In the case study of *South-West Texel,* four people were present as disciplinary specialists, in their professional capacity, and each of them had disciplinary expertise on the coastal system of Texel, supplying information and advising participants, sharing with participants their knowledge on abiotic, biotic and institutional aspects of the coastal systems. Participants explicitly appreciated the co-learning, noting that learning from scientists on the Texel environment from different perspectives made their participation worthwhile. Additionally, the local experts shared their own contextualised knowledge and lived experience on the coastal system of South-West Texel. The spatial bounds of the designed future visions matched the living environment of the participants well, and were limited to the island of Texel. Indeed, the methods allowed for engaging stakeholders early on in the decision making process, when options are still open.

The participant's group for *the Slufter*, was a mixture of researchers familiar with coastal modelling and citizens from the island, all with individually different viewpoints and substantial, ready, real-world knowledge of the Slufter. It was not the discussion of "how the system is", but the discussion of "how the system works" that facilitated knowledge exchange in the session. The workshop facilitated acknowledging these different scale perspectives amongst the participants, which in turn facilitated learning. Also, local and indigenous knowledge of the area played an important role in the workshop setting and in the accompanying research (see Wolff et al. 2019). An attempt was made to link these solutions and system understanding to the valuation of policy options. Unfortunately, the set-up of the group, which was mixed, resulted in a discussion where the more knowledgeable experts were more vocal in the discussion, hindering full knowledge exchange. The position of the water board as facilitator and the duality of their role (i.e. governance authority v. stakeholder; task-oriented v. stakeholder-engagement-oriented) did not help in this regard. The activity aimed to give the experts and local community equal standing, but the power dynamics and the group dynamics, resulting from the differences in knowledge and standing between the participants, limited the knowledge sharing and open discussions. Therefore, the activity of the Slufter, the level of citizen engagement and creative practice was unexpectedly limiting. Local people validated a simulation model, identifying that freshwater inflow in the system was significant, especially after rainfall and in specific seasons and could estimate the inflow volume. This is a clear example of local knowledge enriching expert modelling.

6. Discussion

This research examined collaborative activities to explore the link between promised outcomes and practice and to observe whether certain knowledge types – and thus, certain groups of people –

were excluded from policy debates. The underlying rationale is that the breadth of local and expert knowledge can potentially increase the quality and usability of the end results, supporting the search for environmentally just decisions that enhance the distribution of benefits while employing inclusive decision making practices. We drew on social ecological systems theory, policy analysis and transdisciplinary learning approaches to distil outcomes associated with including local stakeholders in collaborative coastal management activities. The empirical material derived from three case studies in Dutch coastal management, which is characterised by a historical focus on flood defence, a bias towards interventions in the bio-geophysical environment, for example, dike construction or nature-based solutions, and a high level of professional (bio-geophysical, technical and engineering) expertise. While the activities forming each of the case studies aimed to explore innovative solutions, the policy context and the power imbalances affected the degree to which this could be achieved and the degree to which the findings can be considered generally applicable.

We note that some of the activities were designed to address the social-ecological system as a whole (e.g. The Slufter, South-West Texel), whereas the Scheldt estuary activity focused on the understanding of the bio-geophysical system and neglected the social system. This acted to constrain the design space within which integrated solutions were sought. Although the South-West Texel case study focussed on including the lived experience of local stakeholders, it was not designed to generate technically feasible outcomes. Instead, the focus lay on collaboratively generating utopic and dystopic outcomes spanning as wide a range of futures as possible. In the Slufter activity, we noticed that the power differential between local and professional participants inhibited building a shared system understanding across the participant groups. The activity on the Scheldt (and the nested activities) focused on building a shared understanding of abiotic and biotic qualities through analysis of the (value of the) bio-geophysical environment – a time consuming practice that prohibited "getting to solutions".

Although we found that coastal management practice in the three case studies was not using locally crafted solutions, the analysis revealed the deep competence of local people, the knowledge that can be harvested to broaden and enrich the design space for coastal solutions, in addition to a willingness on the part of the stakeholders to become involved in crafting local solutions. We recognised that participants generally understand their lived environment in a systemic way – and/or are able to work towards such system understanding. Where measures were taken to counteract power differences between local and professional participants, such as in the South West Texel case, the technical feasibility of the generated solutions was more limited. Where the professional inputs were not constrained, for example, in the Slufter case, professionals dominated the discussion at times expounding on technically sound solutions yet hindering the shared knowledge development. Given that the inputs of professional experts are necessary in designing practical, feasible and specific coastal solutions to fit the social, ecological and technical requirements of the local environment along the Dutch coast, the dilemma inherent to such collaborative activities becomes clear. Measures designed to reduce power differentials and enable local knowledge inclusion serve to broaden the design space for innovative solutions, but can constrain the scientific and technical quality of the contributions from environmental scientists, decision makers and engineers.

Accordingly, we view the shared understanding developed through collaborative activities as forming a necessary foundational step in design processes that aim to include local knowledge. We note the breadth of the locally generated design space and view the next step as a search for design processes that retain this breadth while effectively combining such locally generated solutions with professional inputs. These professional inputs are envisaged as deepening the scientific and technical quality of such locally generated solutions. We posit that an effective process for including local knowledge in innovative coastal management may need to involve a sequence of activities, some with a focus on surfacing the breadth of local knowledge (where professional participants are in the background) and some with professional inputs in the foreground (where local experts serve as sounding boards rather than designing solutions themselves). Indeed, small or one-on-one groups can be effective for knowledge interventions oriented to improving system

understanding (Andersen, Richardson, and Vennix 1997). Accordingly, this paper contributes to the discourse on the need for appropriate methods for local community engagement and transdisciplinary co-design for sustainable futures, and demonstrates that there is a need to develop and study methods for engaging stakeholders in complex design processes (Sarmiento Barletti et al. 2020). Transdisciplinary activities offer the potential to reveal and integrate local knowledge into coastal policy solution generation, enabling the design of solutions that are place-specific and broader than those generated by professional experts alone.

We call for further research on approaches that aim to draw both local and expert knowledge into collaborative activities, highlighting the need to create environments in which the technical experts can utilise local knowledge to develop better interventions. Understanding the specificity of the local (coastal) environment and how to shape solutions to fit that context seems to be essential in making such engagement activities successful. In particular, the unique context of Dutch coastal management with its historical single issue focus and strong scientific, technical and engineering expertise base, highlights the need for exploration of the role of collaborative activities in broadening the knowledge base of coastal management solutions. We note that such collaborative activities are designed with the intent to achieve specific outcomes, related to the theoretical promise, assuming an underlying causality between design and result. Therefore, we also identify the need for research on success factors in developing stakeholder engagement methods that fit the local environment and ensure that local inputs are taken into account in subsequent decision-making. We argue that while the design of the site-specific collaborative activities needs to be contextual, insights on the process to be followed in designing and refining such activities may be generic. As such, we encourage the development of principles for crafting collaborative activities.

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