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Polyphony in water and coastal policy

Inaugural Address 28 May 2025

Jill Slinger

Professor of Transdisciplinary Policy Development

TU Delft

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"Mijnheer de Rector Magnificus, leden van het College van Bestuur,

Collegae hoogleraren en andere leden van de universitaire gemeenschap,

Zeer gewaardeerde toehoorders,

Dames en heren",

I commence this inaugural speech with questions that may be troubling many of you: What is polyphony? What is transdisciplinary policy development? Even, what is transdisciplinarity? I will answer the last question first by explaining how transdisciplinarity differs from multidisciplinary and interdisciplinary approaches.

Transdisciplinariity

Let us take as our starting point, a depiction of a disciplinary approach as a single ball (Figure 1). So, this could be an engineering discipline, or ecology, education or psychology, for instance - a field of study with its own standards and research methods. For a multidisciplinary approach two or more such disciplines collaborate in addressing the issue, each maintaining their own standards and approaches. In an interdisciplinary approach two or more disciplines interact and combine approaches to develop new knowledge. For instance, ecology and hydraulic engineering combine to generate eco-hydraulic insights in water systems. Now, in a transdisciplinary approach two or more disciplines may combine to use approaches or develop insights at a meta-level, extending beyond the boundaries of the disciplines themselves to generate impactful knowledge.

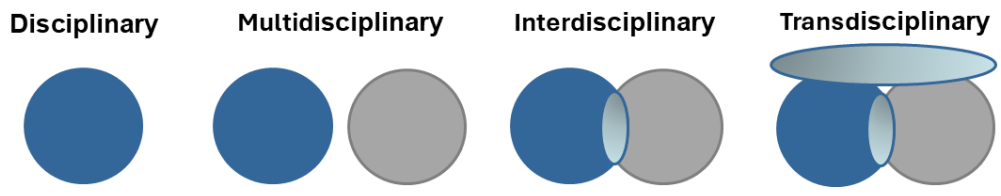

Figure 1: Transdisciplinarity compared with mono-, multi- and interdisciplinarity

However, the essence of transdisciplinarity, or TD as it is termed, is that it incorporates different types of knowledge, specifically the lived experiences and situated, place-based knowledge of non-scientists are considered valid and relevant forms of knowledge. So, it does not unduly

elevate science-based knowledge, although it places a high value on the rigorous research methods, principles and standards through which such knowledge is acquired and validated (Hesjedal, 2020). TD emphasises the rigour and relevance cycles (Bergmann and Jahn, 2008; Hevner, 2007). It takes into account who people are, where they have come from and what they value in the search for deeper understanding, new insights and societally-relevant solutions (Max-Neef, 2005; Mach et al., 2020). In essence, it listens to multiple independent voices, as we will now do.

Polyphony and policy analysis

We will listen to 'Baba Yetu', a version of the Our Father in Swahili and conducted by Christopher Tin at the 70th Annual Llangollen International Musical Eistedfodd, Wales in 2017. The soloists are Joel Virgil and Nominjin (Figure 2).

This music may be familiar to the gamers amongst you…as the theme song for Civilization IV. I have selected it because it features multiple independent melodies (voices), the traditional African call and response, blended with European harmonies, and is sung by a diverse choral group, including the KwaZulu-Natal Youth Chorus – the province in which I was born.

Figure 2: 'Baba Yetu' conducted by Christopher Tin at the 70th Annual Llangollen International Musical Eistedfodd, Wales, in 2017

Did you hear the multiple independent melodies contributing to the texture of this piece of music – its polyphonic character? Did you recognise the voices of society and nature in the background images? Listening to this represents a complex polyphonic experience. Another example is the dawn chorus of different bird species - independent voices, living in the same place, yet needing, wanting and articulating diverse things. And it is necessary to recognise that in society, and in policy or decision making, multiple independent voices co-exist and that they do not necessarily harmonise. They may be in contestation.

Indeed, it is the challenge of our time – in a world of increasing individuality, inequity, biodiversity loss, climate uncertainty and extremes (Gregory et al. 2024) to draw upon the best science to come up with decisions/policies/ solutions that accommodate a diversity of voices and yet forge a common and sustainable future (Figure 3) (Raworth,2017). Many attempt to address this growing science-policy gap focus at the global level (Miao and Nduneseokwu, 2024). But, it is my view that it is through focusing on local and regional solutions and place-based design and decision making, that we can successfully forge locally relevant, practical paths to a sustainable future. And, that it is a fallacy to think that this can be done without contestation – that we can seek for harmony, or one voice, in decision making and policy rather than polyphony (Heiberg and Truffer, 2022). No, we must accept as our starting point multiple independent and simultaneous voices in the locality in which we are searching for solutions (Enserink et al., 2022), and we must navigate this messy complexity.

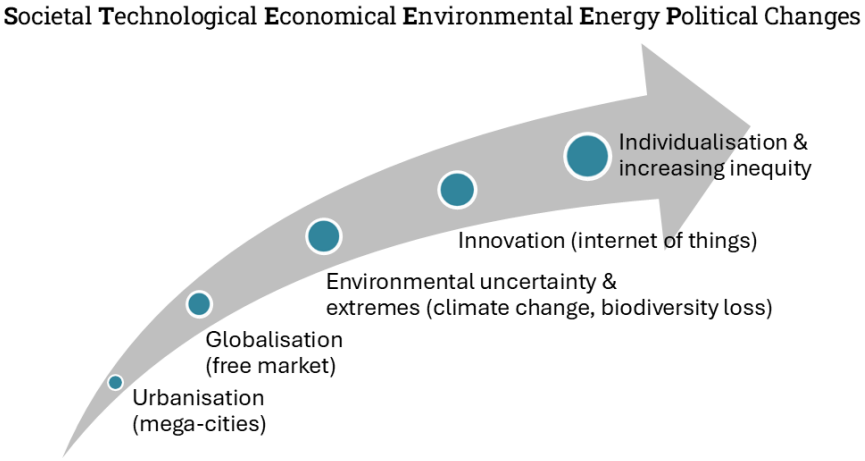

Figure 3: Our challenging future

Indeed, there is a need for innovative, nature-based, stakeholder-inclusive, value-based and locally relevant solutions. And we need transdisciplinary science in this endeavour.

So, in exploring how we can hear and accommodate multiple voices using transdisciplinary concepts and methods, drawn primarily from the field of policy analysis and mathematical modelling (Ackermann, 2012; Mayer et al., 2004; Meadows, D., 2008; Thissen and Walker, 2013), I will start with my own experiential story of crossing disciplinary boundaries and the science-policy divide to develop scientifically rigorous and societally relevant practices (cf. Augsburg, 2014). I will put in the spotlight, my knowledge development, how I learnt to hear and act upon multiple voices, leading to this chair in Transdisciplinary Policy Development.

My development as a transdisciplinary policy scientist

My personal journey began as a pure mathematician, who made the choice to move across to applied mathematics and become more relevant to the society in which I lived in South Africa. Since then, I have continued to work at the interface between Policy Analysis, with its richness in theory and methods, Hydraulic Engineering and Ecology, taking the Societal Context into account. I have applied methods such as Systems Modelling, and Ecosystem-based Assessment and Design, culminating in Building with Nature, and Transdisciplinary Research.

From my MSc on the Pongola Floodplain, I have focused on decision making regarding water and coastal systems. Here the issue was the modelling the timing and magnitude of flood releases and determining the effects on downstream ecosystems and people's subsistence livelihoods (Clifford-Homes *et al*. 2017). This resulted in revised operating rules for the Pongolapoort Dam to allow for "ecological floods" (Figure 4). Besides, civil engineers, ecologist and other policy analysts, I worked with anthropologists, learning to hear and understand the needs (the voices) of the people who lived on the floodplain. This experience of engaging with decision makers and local communities, working in a multi-disciplinary team where I acted as a boundary spanner and built interdisciplinary knowledge (cf. Neal et al., 2022), was foundational for me. I learnt about ecosystem-based management, configuring an interdisciplinary space and taking the societal context into account in advice to decision makers.

During my subsequent employment at CSIR, I specialized in estuary modelling and management (see Slinger, 2017; Slinger et al. 2017; Taljaaard et al. 2017; Slinger, 2024b). Here my experience with modelling estuaries, dealing with local residents at public meetings and translating scientific insights into practice deepened my appreciation of the skills needed to navigate across disciplinary, sectoral and communication boundaries. Indeed, the science-policy-practice divides became my working terrain.

Figure 4: The Great Brak Estuary (upper left), Pongolapoort Dam (upper right), Scheldt Estuary (bottom right), interviews with citizens (bottom middle) and workshop inputs (bottom left)

But it is in the process of advocating for including South African estuaries into the revision of the SA water law at the time of SA's shift to democracy that I really entered the world of policy development. As estuarine scientists we had developed an understanding of the role of freshwater in ensuring the functioning of these marine water bodies. I led a national project on decision support for estuarine management in which we established via a linked series of models that we could predict what would happen if freshwater flow was reduced and evaluate why it mattered (Slinger and Breen, 1995). It remained to convince the policy makers. I packed my bag and left Stellenbosch for a month to be near the seat of power in Pretoria. My strategy was not to knock on the door of the relevant policy makers in the Department of Water Affairs, asking to be heard. No, it was to let it be heard within their wider policy networks that we knew how to determine freshwater requirements for estuaries, that the science was established, so

that they would contact me with a request for information. This happened in the third week, and by week 4 we had a world premiere – South Africa would move to include estuaries, classified worldwide as marine water bodies, into the new freshwater law! Within 3 years, this was accomplished (RSA, 1998). When I look back, this doesn't seem as remarkable now, as years later the EU Water Framework Directive 2000/60/EC (European Commission, 2000) also included the concept of the ecological health of brackish / coastal water bodies into its water-related policy documents, but it was again a formative moment for me. I had moved from being an environmental scientist with a training in maths and modelling for decision support to advocating for model- and ecosystem-based policy, communicating about societally-relevant policy, and engaging with policy making. I had carried the voices of engineers, ecologists, social scientist, local communities and the coastal estuaries themselves into the policy arena.

This stood me in good stead when I was seconded to Delft Hydraulics as CSIR liaison, and later moved to Resource Analysis to work on the Long Term Vision for the Scheldt Estuary – the LTV (Figure 4). The binational policy agreement regarding the LTV was achieved by the Netherlands and Belgium within 2 years (LTV, 2001a; 2001b). It was an intensive policy development process in which I developed a modelling approach demonstrating the eco-morphological connection, in support of the Nature Working Group. Here, I applied my deep knowledge of estuaries, and my expertise in linking models and in boundary spanning, to develop "load-bearing" metaphors that allowed the decision making to proceed (Slinger, 2024a). The intermediary role of a policy analyst, undertaking boundary spanning modelling and integration activities in contested social situations (cf. Neal et al., 2022), was becoming second nature to me.

However, this complex policy process played out primarily between public officials on both sides of the border. Representatives of interest groups were included, but I was intrigued by the unheard voices. When I joined the Policy Analysis section of TU Delft in 2002, I set about acquiring EU funding to explore the policy preferences of the silent majority, the citizens, with those of scientists and policy makers (Figure 4). Intriguing findings were that in this regional context, the opinions of citizens were more closely aligned with policy makers' opinions than those of ecologists or engineers (Slinger et al., 2007). This was a final nudge for me, to develop methods and skills in using model- and ecosystem-based knowledge to support interactions with communities; science for people and nature.

These and subsequent learning experiences at the interface between Policy Analysis, Hydraulic Engineering and Ecology, and within a particular societal context (Figure 5), led me to the realisation that the intermediary role of a policy analyst, the boundary spanning undertaken in interdisciplinary modelling and the engagement with policy makers and society, find articulation in the concepts and methods of transdisciplinarity (Hesjedal, 2020; Mach et al., 2020).

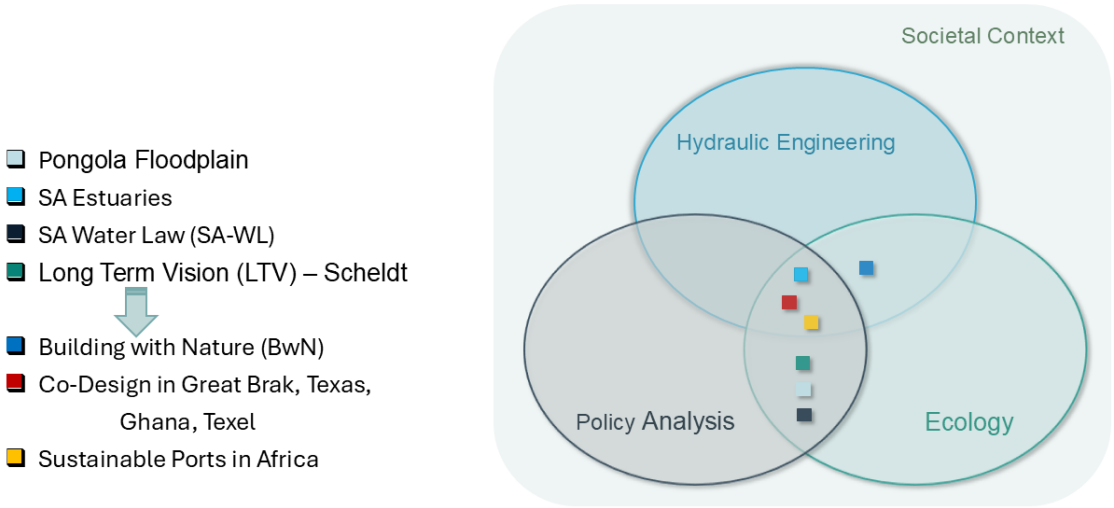

Figure 5: My personal journey in gaining knowledge and experience at the interface between policy analysis, ecology and hydraulic engineering, taking the societal context into account

So, at TU Delft, in collaboration with PhD students such as Dr Heleen Vreugdenhil, Dr. Lotte Bontje, Dr. Sadie McEvoy and Dr. Floortje d'Hont, Dr. Jai Clifford-Holmes and Prof Tally Palmer from Rhodes University, I found my voice as a transdisciplinary policy scientist and learnt to step with confidence, scientific rigour, and a listening ear across disciplinary boundaries and to navigate the science-policy-practice divide. These research activities served to deepen the foundations of policy analysis applications in river and coastal pilot projects (Vreugdenhil, 2010; Vreugdenhil et al., 2010; Bontje, 2018) as well as to establish new transdisciplinary methods of analysis and engagement (Clifford-Holmes, 2015; McEvoy, 2018; d'Hont, 2019). I will now illustrate with examples of the development and testing of a co-design process in South Africa, Texas, the Netherlands and Ghana. In each case Building with Nature concepts (Waterman, 2010; Slinger, 2022) were explained so that participants could apply these concepts in their designs for the future, also in the Sustainable Ports in Africa project.

Transdisciplinary co-design

The 6-step co-design process (Cunningham et al., 2014; Slinger et al., 2014), involves discussing and identifying key stakeholders / players. There are knowledge inputs on the system deriving from lived experience, governance information, ecosystem dynamics and mathematical modelling. Participants collaborate in designing strategic futures or visions. Visions are both utopic and dystopic, as this gives a fuller indication of the underlying values. Then the policies or actions are matched to the visions. This is a critical element. Pathways are not designed by sequencing actions towards the future, rather they are back-casted through this pattern-matching association (cf. Slinger, 2024a). The participants then vote on the visions and associated pathways, so that we can determine via principal component analysis what the underlying values are. This information is fed back to the participants and the discussion is mediated.

Together with CSIR and Rhodes University, we first applied the method to the problem of reduced freshwater supply to the Great Brak Estuary (Figure 4) from damming and consequent

increased closure of the mouth (Slinger et al., 2014). This leads to undesirable deterioration in water quality and interrupted opportunities for fauna to migrate in and out of the mouth. The promise of the method then led me to suggest it for application in the Galveston-Houston Bay area following the devastation of Hurricane Ike where there was contestation regarding then proposed dike and possible closure dam across the Bolivar Heads. This engagement with coastal community members struggling with an uncertain and dynamic future was truly challenging. However, the co-design process delivered a space for discussion and listening and some remarkable insights (Slinger et al., 2024). For instance the participants noticed that even the protagonists of the dike had not scored the visions in which it was present most highly. There were visions they preferred. An unexpected outcome of the process was their electing a representative and agreeing to meet going forward to lobby for more sustainable, nature-based futures in their environment. So, this weaving together of the threads of experience and knowledge from ecology, hydraulic engineering, with methods from game theory and policy analysis problem structuring showed promise for polyphonic policy contexts.

Co-designing Coastal Channel-shoal Systems (CoCoChannel), Texel

Let me turn now to a subsequent transdisciplinary engagement process that occurred in the Netherlands, on Texel, in the project CoCoChannel – Co-designing Coastal Channel-shoal Systems. For the Netherlands, the south-eastern corner of Texel represents an erosion hotspot. At that stage, 16,1 million m^3 of sand had been nourished, supplied to the 30 km coastal zone of Texel to compensate for sediment loss, over the previous 10 years. This compensation for loss, or maintaining the coastline in position, is required by the 1990 Coastal Defence Bill (see Slinger et. al. 2020: Chapter 2) and then cost an average of about 1 million euro per annum. Together with the University of Twente and IHE-Delft, we initiated the CoCoChannel project, using Delft3D and rule-based models to explore the sedimentary dynamics in the nearshore and beach-dune regions and engaging with local people and relevant authorities in exploring future long-term policy options for their coast (Wijnberg et al., 2015; 2023). This is relevant, because the offshore ebb tidal delta is moving progressively closer to Texel and will attach at some stage (Elias and van der Spek, 2017). So, the questions arise “Should we be nourishing this area at all? Is it actually unsafe?”. When a storm eroded the beach in SE Texel, it provided a golden opportunity to apply transdisciplinary co-design in engaging with this issue.

For Texel, instead of one long workshop spanning 1,5 days, we opted for a 3-phase process (Figure 6) (d’Hont, 2019). The first co-design workshop followed the first 5 steps of the original method, including identifying key stakeholders, building a shared system understanding, visioning and voting. Inputs included explanations of the latest modelling knowledge as well as presentations on Building with Nature options and how coastal flood risk management is organised in the Netherlands. Experts and representatives of the authorities then acted as a help desk during the visioning process. The information, the visions, from the first workshop were then passed to the expert design workshop, the 2nd workshop. Here a range of experts was tasked with detailing out the visions and checking them for technical feasibility. Finally, these (BwN) designs were then validated by the original participants in a 3rd workshop. We call this 3-phase approach, a co-design process for coasts (d’Hont, 2019). It produces negotiated pathways to preferred futures (that work in local/regional contexts).

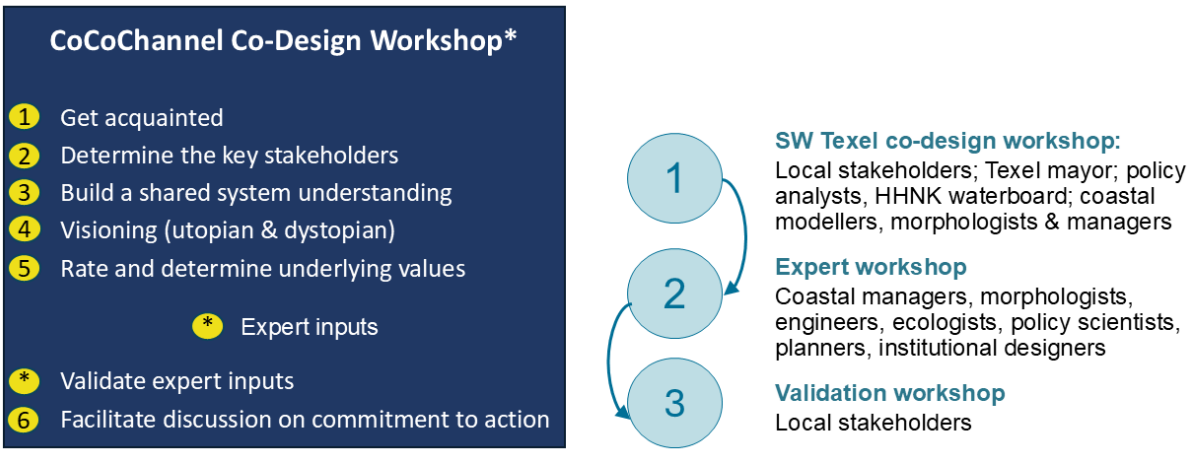

Figure 6: The 3-phased co-design approach applied in the CoCoChannel project on Texel

But what does such co-design look like? Figure 7 displays some images of the first and third workshop on Texel. The paper sheets stuck on the windows are the visions and their accompanying expert designs. We drew upon policy analysis problem structuring and game theory principles to design this co-creation intervention (Cunningham et al., 2014; Ackermann, 2012; Checkland and Winter, 2006; Montero and Kapinga, 2019). And, we rigorously evaluated it at each stage (see d'Hont, 2019; d'Hont and Slinger, 2023). We want to understand who learnt what, and when, so that we can advance in designing societal interventions to enhance water and coastal policy. In essence we were seeking to learn and develop the science of transdisciplinary policy development in a polyphonic context.

Figure 7: Visioning during the first co-design workshop (upper left); validating the visions and associated expert designs during the third workshop (upper right and bottom)

So, what are the effects of this engagement process? The direct societal impacts included the formation of a space for listening and learning about the long-term dynamics of the coast and how this relates to flood risk. Participants also learnt about each other and developed a shared system understanding (d'Hont and Slinger, 2023). In developing potential pathways to new futures they re-defined the erosion issue as an institutional problem. They were willing to forgo nourishments and accept erosion (under the understanding that the ebb tidal delta attachment would resolve this eventually) provided that financial compensation was forthcoming. The explanation of the waterboard that they could not treat two pavilion owners on Texel differently, allowing one to experience erosion (with compensation) and continuing to protect the other, was not understood and viewed by the islanders as an institutional issue. Another effect was the knock-on to the nearby Prins Hendrik Zanddijk. This was a little unexpected. The enhanced communication and trust between local residents, the waterboard and national authorities meant that a different approach could be taken to the Prins Hendrik Dike strengthening - a nature-based approach. So, there was an indirect effect in an adjacent policy arena.

The research impacts are more straightforward. They included advances in integrative knowledge on coastal modelling, connecting to beach and dune dynamics, and to multi-level governance (Wijnberg et al., 2015; Wijnberg et al., 2023). Also, two co-design journal articles (d'Hont and Slinger, 2023; Slinger et al., 2024), a PhD on the design and application of co-design (d'Hont, 2019), with Texel as primary case study, AND a textbook on "Complex Coastal Systems. Transdisciplinary learning on international case studies" (Slinger et al., 2022). But more importantly, we developed and applied a rigorous evaluation method (see McEvoy, 2018; d'Hont, 2019). We found that our method of selecting stakeholders who are normally not involved in policy processes worked. We succeeded in configuring a safe space for listening and learning, where scientific experts were not unduly dominant. People valued the scientific insights they received and the shared system story they developed. They also appreciated our return to the island for the validation workshop.

So, what could we have done better. We could have taken a delegation of local people to the expert workshop to act as a help desk there and prevent potential misinterpretations of the visions. I took this learning along in designing the next transdisciplinary co-design process in Ghana.

Sustainable Ports in Africa, Ghana

In the Sustainable Ports in Africa project, which we undertook in collaboration with partners in the Netherlands and Ghana, we learnt from Texel and placed more emphasis on building a shared system story of the evolution of the Port of Tema (Figure 8). The co-design workshop there was attended by 55 people and as in all the other co-design workshops was nested within a wider transdisciplinary engagement process (Slinger et al., 2018). In this case, and in other projects like Breaching Barriers to Policy Implementation in South Africa, undertaken with Rhodes University, we distinguish local societal impacts, and substantial research impacts, as well network impacts. In Ghana these were at the Pan-African scale involving port developers in west and Southeast Africa (Vreugdenhil et al., 2018).

Figure 8: Visioning (left) and building the system story (right) during the co-design workshop in Tema, Ghana

So, each of these initiatives undertook transdisciplinary research, developing and refining a co-design method for engaging local communities in envisioning the application of nature-based solutions or 'Building with Nature' options in their environment. They drew in many community members, as well as MSc students, PhD's and post-docs and provided a rich training ground in conducting scientifically sound yet societally apt, transdisciplinary research.

Besides establishing the co-design method and the many scientific publications, it is the capacity-building effects and the engagement of the public with environmentally relevant and accessible information that is most encouraging. It is the configuring of a space for multiple voices to be heard that is significant – the voices of people and nature. These are captured and shared in a series of books and booklets. In Ghana we published and circulated a book "Voices on Sustainable Ports in Africa. Stories from Tema Port, Ghana" (Kothuis and Slinger, 2018), with inputs from locals living in and around Tema, public authorities, the port director and the University of Ghana, amongst others. In Texel we communicated via booklets, and in the South Africa we wrote "The story of the Great Brak: Water and Society" (Slinger et al., 2012). This booklet has been printed tens of thousands of times on the request of residents and visitors to the town's museum.

The capacity to engage effectively with local and regional authorities and articulate the relevance of diverse voices and values in these spaces increased, in all cases. In our evaluations, we discovered that people learned about solution options, from and about each other and at the network level, also about longer term ecosystem dynamics and effects. Indeed, McEvoy (2018) found evidence that the learning from a well-structured tool-based intervention workshop could persist for 1,5 years and be used constructively in new initiatives. All in all, this has led to a repertoire of intervention-based research methods that take system complexity, multiple independent voices and values and our fundamental dependence on nature seriously. And, in this new field of transdisciplinary policy development, we are pioneering in the development of methods for including the voice of nature both in teaching and research.

Teaching and research: two sides of the same coin

This is best exemplified in the teaching on Building with Nature. Building with Nature is an ecosystem-based approach that uses interactions and materials present in nature in striving for a flexible integration of land in water and water in land (after Waterman 2010). Together with a team of people, I have developed 2 Massive Open Online Courses (MOOCs) and an

accompanying open textbook, Building with Nature & Beyond (Slinger, 2022). Indeed, these MOOCs have run successfully for a number of years, reaching over 25 000 people. The material is in use in on-campus teaching in Brazil, Vietnam and Indonesia and in recent years also in Delft. It is currently being exported to 4 universities in South Africa and Senegal. The overall aim is to develop a new generation of engineers who can apply ecosystem-based, stakeholder-inclusive design principles and who can do this in a transdisciplinary fashion.

In recent years the concept of Nature-based Solutions has gained ground. This is a broader concept than Building with Nature as it aims for human well-being and biodiversity benefits through a range of ecosystem-based approaches (IUCN, 2020). For example, via restoration, protection, and management activities. For the long-term, large scale water and coastal issues that are my focus, the natural infrastructure category of NbS and Building with Nature align well. That is how they are covered in the open textbook and the MOOCs.

The MOOCs have educated over 25 000 people regarding the Engineering, Ecological and Social Design Principles to be applied in designing and implementing Building with Nature solutions. Here, I would like to highlight that the Ecological Design Principles articulate the intrinsic character and functioning of the ecosystem. It is important that these principles are used in designing potential solutions, so that the breadth of the design space is maintained, rather than narrowed (cf. Montero, Kapinga, 2019). The concept of ecosystem services – the value of nature for humans – is used in the evaluation of the design for people, so in the social use aspects (Slinger, 2022). And it is in the social aspects of these nature based solutions that we are making the most significant steps both in teaching and research. Indeed, in the first part, course participants learn the importance of collaborating across disciplinary divides. In the second part designing for transdisciplinary engagement and coalition building are taught.

4-Layer social-technical-environmental system

An integral component of my vision is to educate young people internationally to design for nature and people. I truly believe that by viewing the space in which they are designing and developing policy in terms of 4-layers:

- The Biophysical layer - ecosystem dynamics, water & coastal systems
- The infrastructure and technology layer – mediating the influence of humans on the environment
- The social use layer - direct, livelihood interactions on the biophysical layer in the developing world
- The values layer - do policies deliver the envisaged values?

They will be equipped to engage with society in developing and designing locally relevant, nature-friendly, place-based solutions that draw on scientific rigour in their conceptualisation as well as in the social process applied in their design and implementation. Indeed, it is the aspect of designing for an appropriate coalition of stakeholders that is taught in the second MOOC (Slinger, 2022).

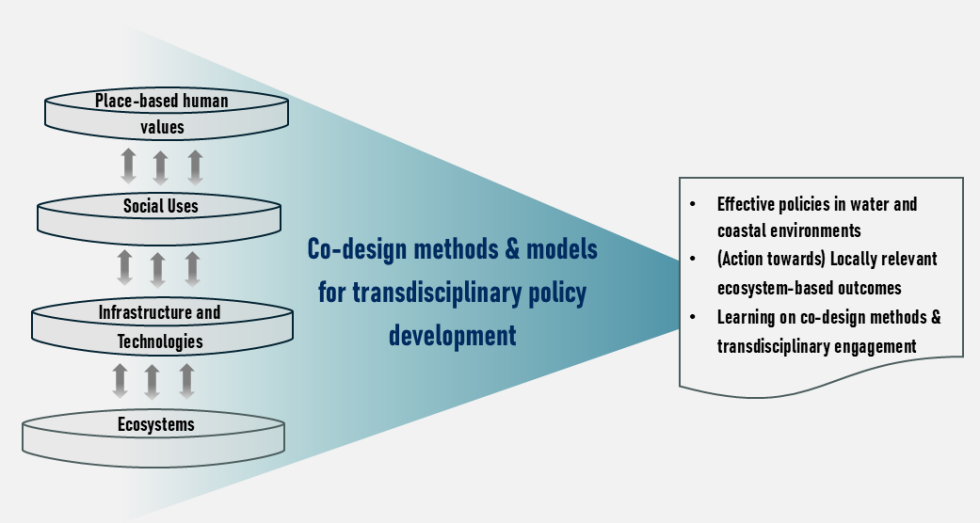

Figure 9: The 4-layer social-technical-environmental system view underpinning the co-design approach to transdisciplinary policy development

Research and Teaching Vision

These are the types of research and teaching that I do, but what is my research vision for the coming time? My overarching research goal is to deepen and formalize knowledge on transdisciplinary engagement in co-designing policy in coastal and water environments, particularly related to Nature-based Solutions.

There are 3 lines of enquiry, that then constitute a transformative agenda in transdisciplinary policy development. These are (1) Theoretical promise vs empirical reality, (2) Methods & tools that configure multiple voices, and (3) Conceptualising co-design. I will highlight a few examples of these investigative lines, which all take as given the complex, contentious polyphonic world in which we live:

- The use of narratives in polyphonic policy contexts
- Upscaling NbS/BwN into policy, particularly by addressing the financing gap in NbS
- Deepening insight into the role of conceptual models in navigating the science-policy divide, and
- Transdisciplinary teaching & research.

Narratives

Narratives or storytelling are receiving increasing attention as an integrative tool in transdisciplinary research. If used skilfully they can capture and express multiple voices and diverse argumentation lines. In policy, they can also compete to become the dominant story, as Dr. Lotte Bontje found in studying the decision making process of the Sand Engine (Bontje and Slinger, 2017) – a classic example of polyphonic policy research! Together, we developed a narrative model for policy change in which the role of competing stories in determining and influencing policy change is explicated (Bontje, 2018). This led to invitations to attend the workshop “Scientific Polyphony: How science narratives configure many ‘voices’” organised by the Narrative Science project of the European Research Council in 2019 - and the realisation that we were invited then as the only scholars applying narrative analysis models in the field of

engineering in Europe at that time (see Bontje and Slinger, 2019). Formalising this theoretical contribution to our field will receive attention in the coming period.

Upscaling Nature-based Solutions

Similarly, the upscaling / mainstreaming/ institutionalisation of NbS/BwN requires attention. Last year I was invited to attend the 1st National Policy Forum on Nature-based Solutions at the National Academy of Science in Washington, D.C. (Slinger, 2024a). There I realised first that we have already found some unusual ways of organising the implementation of BwN/NbS projects in the Netherlands, but have not yet distilled the essence of these approaches so that others can learn from our governance arrangements. Second, I came to understand that is the Netherlands that will need to lead in making eco-engineering standards for NbS as components of flood defences. Third, I understood that the work on the financing gap for NbS is crucial.

Here, I wish to highlight the strides made by Lieke Hüsken regarding barriers to NbS financing and funding. She has linked these barriers to a systemic misalignment between the characteristics of NbS and the characteristics of our existing institutions (Hüsken et al., 2024). These misalignments occur through different institutional mechanisms, with all mechanisms influencing the occurrence of public and private funding and financing gaps, and the cost structure of NbS, in particular transaction costs. Accordingly, attention will go to deepening understanding of the institutional and project-based settings/conditions required for supporting NbS as an ecosystem-based approach to adaptation; so that we can include NbS/BwN as routine options in policy decision making in future.

Role of conceptual models in policy development

Moreover, in a recent PhD study of Dr. Quirijn Lodder, we identified that conceptual models of the ecosystem-based functioning of the Dutch coast acted as linking pins in connecting across the science-policy-practice divide (Lodder, 2024). As scientist, we are used to thinking that simulation models, data or system understanding have this role, but Quirijn found differently. It is through explicating and then questioning the conceptual models underlying our coastal policy that the Coastal Genesis 2 Programme was able to develop more robust strategies for maintaining the Dutch coast (Lodder et. al., 2023). Exploring the extent to which this is valid for other cases, and/or its applicability for coastal and delta management worldwide will also receive attention.

Transdisciplinary Lab for Learning and Research

And, most importantly, in the Transdisciplinary Lab for Learning and Research at TPM, we will devote attention to cross-comparing methods, cases and model-use, so that we can derive rigorous lessons on what works, where, how and why, when one undertakes societal and teaching interventions.

In line with this, at TPM, we envisage including (and researching the application of) more transdisciplinary methods in our teaching, equipping our students to hear multiple voices, apply model- and ecosystem-based co-design concepts and so use and advance this field of transdisciplinary policy development (e.g. Klaassen et al., 2021; Slinger and Kothuis, 2022). We do this in association with interested partners within Europe and Africa via the African Water Resources Mobility Network (AWARMN), the African Research Universities Alliance, and more particularly the Nature-based Solutions for African Resilience (NbS4AfrRes) project, in which we are exchanging teaching material between 3 European universities, 2 Senegalese and 2 South African universities.

Concluding

All of this requires a meta-design competence (in 4-layer social-environmental systems), analytical, modelling and listening skills, but also involves personal development and reflection on your own values.

When you engage with society, with individuals and communities, you have to be present as an authentic person. You have to be able to say when you do not know something, when some expected influence is beyond you. In essence you have to be the opposite of a politician – no false promises, no unfounded hope, only incomplete knowledge and a commitment to explore, learn and grow together as authentically and humbly as possible. This is the foundation for socially relevant and co-creative science AND it is the path of a transdisciplinary policy analyst committed to engage with polyphony in society.

It is this type of mindset and series of skills (Mejía et al., 2023) that we have teach our students, in addition to technical and scientific prowess, to equip then to undertake science for people and nature.

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Let us continue to embrace polyphony in the world around us.

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References

Ackermann, F. (2012) Problem structuring methods 'in the dock': arguing the case for soft O.R. *European Journal of Operations Research* 219(3):652–658.

Augsburg, T. (2014). Becoming Transdisciplinary: The Emergence of the Transdisciplinary Individual. *World Futures* 70:3-4, 233-247.

Bergmann, M., & Jahn, T. (2008). CITY: mobil: a model for integration in sustainability research. *Handbook of Transdisciplinary Research*, 89-102.

Bontje, L.E. (2017). Narrative perspectives on the development of coastal pilot projects. PhD dissertation, TU Delft, Delft, NL.

Bontje, L..E., Slinger, J.H. (2017). A narrative method for learning from innovative coastal projects - biographies of the Sand Engine. *Ocean and Coastal Management* 142: 186-197.

Bontje, L.E., Slinger, J.H. (2019). On narrative competition in coastal policy development, presented at Scientific Polyphony: How science narratives configure many 'voices', Narrative Science project of the European Research Council in 2019, coordinated by the London school of Economics and Political Science

Clifford Holmes, J. K., Slinger, J. H., Palmer, C. G. (2017). Using System Dynamics modelling in South African water management and planning. In: A Brent and T Simelane (eds.*). System Dynamics Models for Africa's Developmental Planning*. Africa Institute of South Africa, Pretoria, SA.

Cunningham, S.C., Hermans, L.M., Slinger, J.H. (2014). A review and participatory extension of game structuring methods. *EURO Journal on Decision Processes* 2(3-4): 173–193.

d'Hont, F.M. (2022). Co-design in the coastal context. PhD Dissertation, Delft University of Technology, Delft, Netherlands.

d'Hont, F.M., Slinger, J.H. (2022). Including local knowledge in coastal policy innovation: comparing three Dutch case studies. *Local Environment. The International Journal of Justice and Sustainability* 27(7): 897–914.

Elias E.P.L, van der Spek A.J.F. (2017). Dynamic preservation of Texel Inlet, the Netherlands: understanding the interaction of an ebb-tidal delta with its adjacent coast. *Netherlands Journal of Geosciences* 96(4):293-317.

Enserink, B., Bots, P., Van Dalen, E., Hermans, L., Kortmann, R., Koppenjan, J., Kwakkel, J., Ruijgh, T., Slinger, J., Thissen, W. (2022). *Policy Analysis of Multi-Actor Systems* (Second Edition). TU Delft Open/Eleven, The Hague. ISBN 978-94-6366-575-9.

European Commission (2000). Directive 2000/60/EC of the European Parliament and of the Council of 23 October 2000 establishing a framework for community action in the field of water policy. *Official Journal of the European Communities*, *327*(43), 1-72.

Gregory, R.D., Bridle, J., Wilson, J.D. (2024). What is the role of scientists in meeting the environmental challenges of the twenty-first century? *Royal Society Open Science* 11:240498

Heiberg, J., Truffer, B. (2022). Overcoming the harmony fallacy: How values shape the course of innovation systems. *Environmental Innovation and Societal Transitions* 42: 411-428.

Hesjedal, M.B., Åm, H., Sørensen, K.H., Strand, R. (2020). Transforming scientists' understanding of science–Society relations. Stimulating double-loop learning when teaching RRI. *Science and Engineering Ethics* 26, 1633–1653

Hevner, A.R. (2007). A three cycle view of design science research. *Scandinavian Journal of Information Systems*, 19(2): 4.

Hüsken, L., Slinger, J., Vreugdenhil, H., Altamirano, M. (2024). Money talks. A systems perspective on funding and financing barriers to Nature-based Solutions. *Nature-Based Solutions* 6: 100200.

IUCN. (2020). Global standard for nature-based solutions. A user-friendly framework for the verification, design and scaling up of NbS. First edition. Gland, Switzerland: IUCN.

Klaassen, R. Kothuis, B., Slinger, J. (2021). Engineering roles in Building with Nature interdisciplinary design: Educational experiences. *Research in Urbanism Series*, 7, 73-98.

Checkland, P., Winter, M.C. (2006). Process and content: two ways of using SSM. *Journal of the Operations Research Society* 57(12):1435–1441.

Kothuis, B., Slinger, J. (2018). *Voices on sustainable ports in Africa. Stories from Tema Port, Ghana.* Delft University Publishers, Delft, Netherlands. ISBN 978-94-6186-945-6. 76pp.

Lodder, Q.J. (2024). Connecting science and policy in Dutch coastal management. The role of system understanding and conceptual models. PhD Dissertation, Delft University of Technology, Delft, Netherlands.

Lodder, Q.J., Slinger, J.H., Wang, Z.B., van der Spek, A.J.F., Hijma, M., Taal, M., van Gelder-Maas, C., de Looff, H., Litjens, J., Schipper, C.A., Löffler, M., Nolte, A., van Oeveren, C., van der Werf, J.J., Grasmeijer, B.T., Elias E.P.L., Holzhauer, H. (2023). The Coastal Genesis 2 research programme: Outputs, Outcomes and Impact. *Ocean and Coastal Management* 237: 106499.

LTV. (2001a). Langetermijnvisie Schelde-estuarium (in Dutch). Dutch Ministry of Transport, Public Works and Water Management. Directorate Zeeland, Netherlands.
LTV. (2001b). Toelichting bij de Langetermijnvisie Schelde-estuarium (in Dutch). Dutch Ministry of Transport, Public Works and Water Management. Directorate Zeeland, Netherlands.
Mach, K.J., Lemos, M.C., Meadow, A.M., Wyborn, C., Klenk, N., Arnott, J.C., Ardoin, N.M., Fieseler, C., Moss, R.H., Nichols, L., Stults, M., Vaughan, C., Wong-Parodi, G. (2020). Actionable knowledge and the art of engagement. *Current Opinion in Environmental Sustainability* 42: 30-37.
Mayer, I.S., van Daalen, C.E., Bots, P.W.G. (2004). Perspectives on policy analyses: a framework for understanding and design. *International Journal of Technology, Policy and Management* 4(2): 169-191.
Max-Neef, M.A. (2005). Foundations of Transdisciplinarity. *Ecological Economics* 53: 5-16.
Meadows, D. H. (2008). *Thinking in systems: a primer.* (ed.) D. Wright, Ed. White River, USA.
Mejía GM, Henriksen D, Xie Y, García-Topete A, Malina RF, Jung K. (2023). From researching to making futures: a design mindset for transdisciplinary collaboration. *Interdisciplinary Science Reviews* 48(1):77-108.
Miao, Q., Nduneseokwu, C. (2024). Global Environmental Leadership: Addressing the Triple Planetary Crisis. In: *Environmental Leadership in a VUCA Era*. Springer, Singapore
Montero, C.S., Kapinga, A.F. (2019). Design science research strengthened: Integrating co-creation and co-design. In: P. Nielsen and H. C. Kimaro (Eds.), ICT4D 2019, International Federation for Information Processing 2019, IFIP AICT 551: 486–495. Springer Nature, Switzerland.
Neal, J.W., Neal, Z., Brutzman, B. (2022). Defining brokers, intermediaries, and boundary spanners: a systematic review, *Evidence & Policy* 18(1): 7–24.
Raworth, K. (2017). A Doughnut for the Anthropocene: humanity's compass in the 21st century. The Lancet Planetary Health 1(2): e48 - e49
RSA (Republic of South Africa.) (1998). National Water Act 36 of 1998. *Government Gazette* 19182. Government Printer, Cape Town, South Africa.
Slinger, J.H. (2017). Hydro-morphological modelling of small, wave-dominated estuaries. *Estuarine, Coastal and Shelf Science* 198: 583-596
Slinger, J.H. (2022). *Building with Nature & Beyond. Principles for designing nature based engineering solutions*. TU Delft Open Publishing, Delft, Netherlands. ISBN 978-94-6366-457-8. 428pp.
Slinger, J.H. (2023). Developing the transboundary Long Term Vision of the Scheldt Estuary – an untold story. *Water International* 48(8): 1046-1067
Slinger, J.H. (2024a). NbS in the Netherlands: from pilot to policy and practice. Presented at 1st National Policy Forum on Nature-based Solutions, 8 February 2024, National Academy of Sciences, Washington D.C., USA.
Slinger, J.H. (2024b). Water renewal and stratification modelling in small estuaries. *Estuarine, Coastal and Shelf Science* 300, May 2024, 108720
Slinger, J.H., Breen, C.M. (1995). Integrated research into estuarine management. *Water Science and Technology* 32 (5-6), 79-86.
Slinger, J.H., Cunningham, S.C., Hermans, L.M., Linnane, S.M., Palmer, C.E. (2014). A Game Structuring Approach Applied to Estuary Management in South Africa. *EURO Journal on Decision Processes* 2(3-4): 341–363.
Slinger, J.H., Cunningham, S.C., Kothuis, B.L.M. (2023). A co-design method for including stakeholder perspectives in nature based flood risk management. *Natural Hazards,* 1 September 2023.
Slinger, J.H., Kothuis, B. (2022). A specific transdisciplinary co-design workshop-model to teach a multi-perspective problem approach for integrated nature-based design. In: (eds. S. Brody, Y. Lee, B. Kothuis*) Coastal Flood Risk Reduction: Comparisons from the Netherlands and the U.S. Upper Texas Coast*. Elsevier, Amsterdam, Netherlands. ISBN: 97803-2385-2524
Slinger, J., Linnane, S., Taljaard, S., Palmer, C., Hermans, L., Cunningham, S., van Niekerk, L., van den Hurk, M., Greter, S., Clifford-Holmes, J. (2012). From policy to practice: enhancing implementation of water policies for sustainable development. The Story of the Great Brak: Water and Society. Delft University of Technology, Delft. CSIR and Groot Brak Museum, South Africa.
Slinger, J.H., Muller, M., Hendriks, M. (2007). Exploring local knowledge of the flooding risk of the Scheldt Estuary. *Water Science and Technology* 56(4), 79-86.
Slinger J.H., Taljaard, S. & Largier, J.L. (2017). Modes of water renewal and flushing in a small intermittently closed estuary. *Estuarine, Coastal and Shelf Science* 196: 346-359.
Slinger, J. H., Taljaard, S., D'Hont, F.M. (eds.) (2020). *Complex Coastal Systems. Transdisciplinary insights from international case studies*. Delft Academic Press, Delft, Netherlands. ISBN: 97890-6562-4437
Slinger, J., P. Taneja, B. Kothuis, H. Vreugdenhil, W.P. de Boer, A. Kanger, M. Koetse, L. Hagedoorn, C. van Dorsser, E. Mahu, B. Amisigo, K. Appeaning Addo, T. Vellinga. (2018). Designing for stakeholder values in port development in Africa. Presented at 34th PIANC World Congress, 7-12 May 2018, Panama.

Taljaard, S., van Niekerk, L., Slinger, J.H. (2017). A screening model for assessing water quality in small, dynamic estuaries. *Ocean and Coastal Management* 146: 1-14.

Thissen, W.A.H., Twaalhoven, P.G.J. (2001). Towards a conceptual structure for evaluating policy analytic activities. *European Journal of Operational Research* 129 (2001) 627-649.

Thissen, W.A.H., Walker, W.E. (2013). *Public Policy Analysis. New Developments*. International Series in Operations Research and Management Science, Volume 179. ISBN: 978-1-4614-4601-9.

Vreugdenhil, H.S.I. (2010). Pilot projects in water management. Practising change and changing practice. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Vreugdenhil, H., Slinger,J., Thissen, W., Ker Rault, P. (2010). Pilot projects in water management. *Ecology and Society* 15(3).

Vreugdenhil, H., Taneja, P., Slinger, J., de Boer, W., Kangeri, A. (2018). Operationalizing the concept of sustainability for Sustainable Port Design. Case of Port of Tema, Ghana. Presented at WCTRS SIGA2 2018 Maritime and Ports Conference, 2-4 May 2018, Antwerp, Belgium.

Waterman, R. E. (2010). Integrated coastal policy via Building with Nature. PhD Dissertation, Delft University of Technology. Drukkelijk Banda, Netherlands.

Wijnberg, K., Mulder, J., Slinger, J., van der Wegen, M., and van der Spek, A. (2015). Challenges in developing 'Building with Nature' solutions near tidal inlets. Presented at the Coastal Sediments '15 conference, Understanding and Working with Nature, May 11 – 15, 2015, San Diego, CA, USA.

Wijnberg, K., Poppema , D., Mulder, J., van Bergen, J., Campmans, G., Galiforni-Silva, F., Hulscher, S. J. M. H., & Pourteimouri , P. (2021). Beach-dune modelling in support of Building with Nature for an integrated spatial design of urbanized sandy shores. *Research in Urbanism Series*, 7: 241-259.

Supervised PhD Theses

Lodder, Q.J. (2024). Connecting science and policy in Dutch coastal management. The role of system understanding and conceptual models. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Antwi, S.H. (2023). Water Governance and Management Practices in the Republic of Ireland: Past, Present and the Future. PhD dissertation, Dundalk Institute of Technology, Dundalk, Republic of Ireland.

Owusu, A.G. (2022). The implementation and effects of environmental flows downstream of large dams. PhD dissertation, Delft University of Technology, Delft, Netherlands.

d'Hont, F.M. (2019). Co-design in the Coastal Context. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Finca, A. (2019). Social history of collective rangeland management and its impact on the well-being of rural communities in the Eastern Cape, South Africa. PhD dissertation, Dundalk Institute of Technology, Dundalk, Republic of Ireland.

McEvoy, S. (2018). Participatory policy analysis for urban climate adaptation. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Bontje, L.E. (2017). Narrative perspectives on the development of coastal pilot projects. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Clifford-Holmes, J.K. (2015). Fire and water: A transdisciplinary investigation of water governance in the Lower Sundays River Valley, South Africa. PhD dissertation, Rhodes University, Makhanda, South Africa.

Kaspersma, J.M. (2013). Postgraduate studies as mechanism for the development of knowledge and capacities in the water sector. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Taljaard, S. (2011). An implementation model for integrated coastal management in South Africa – from legislation to practice. PhD dissertation, University of Stellenbosch, Stellenbosch, South Africa.

Vreugdenhil, H.S.I. (2010). Pilot projects in water management. Practising change and changing practice. PhD dissertation, Delft University of Technology, Delft, Netherlands.

Marchand, M. (2009). Modelling coastal vulnerability. Design and evaluation of a vulnerability model for tropical storms and floods. PhD dissertation, Delft University of Technology, Delft, Netherlands.

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