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The role of 'Building with Nature' in water management – theoretical aspiration and practical implementation of the new approach

With two case studies from Germany and The Netherlands

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Abstract

Water managers are increasingly challenged by rapid global changes and fast-changing boundary conditions in the complex human-nature systems they seek to manage. Since traditional engineering approaches turned out as incapable to integrate social and ecological interests, or to deal with high levels of uncertainty, new strategies are urgently needed. The Dutch 'Building with Nature' (BwN) approach therefore seeks to facilitate more sustainable, adaptable and multi-functional solutions in water management. However, the international uptake of BwN is currently hampered due to scepticism about its actual feasibility and outcomes. This thesis analyses the basic principles and ambitions that underlie the approach and presents a conceptual framework that is used to assess two BwN projects in Hamburg (Germany) and Delfzijl (The Netherlands). The framework describes BwN as a learning-based and nature-inclusive approach that combines 'Ecological Engineering'-techniques with 'Resilience-thinking' and the idea of 'Social-Ecological Systems'. During the research, some conceptual weaknesses and loopholes are revealed that allow traditional water management regimes to modify or instrumentalize BwN for 'greenwashing' their long-standing perceptions and practices. To reduce this misuse and to positively contribute to water management in the future, the BwN community should sharpen the approach's conceptual profile whilst generating more business cases. Nonetheless, the pre-condition for a major BwN uptake is a fundamental regime reconfiguration on the basis of a paradigm that emphasizes learning and integration.

Keywords

Building with Nature | Water Management | Social-Ecological Systems | Estuary Management
Resilience | Sustainable Development | Ecological Engineering | Paradigm Shift | Adaptive Management

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List of Abbreviations

BUE	Authority for the Environment and Energy *(Behörde für Umwelt und Energie)*
BwN	Building with Nature
CAS	Complex Adaptive System
CWSS	Common Wadden Sea Secretariat
EDD	Eco-Dynamic Design
EE	Ecological Engineering
ES	Ecosystem Services
HPA	Hamburg Port Authority
LKN-SH	Schleswig-Holstein Agency for Coastal Defence, National Park and Marine Protection *(Landesbetrieb für Küstenschutz, Nationalpark und Meeresschutz Schleswig Holstein)*
NIOZ	Royal Netherlands Institute for Sea Research
NLWKN	Lower Saxony Water Management, Coastal Defence and Nature Conservation Agency *(Niedersächsischer Landesbetrieb für Wasserwirtschaft, Küsten- und Naturschutz)*
PIANC	World Association for Waterborne Transport Infrastructure
RWS	Rijkswaterstraat (Part of the Dutch Ministry of Infrastructure and the Environment)
SES	Social-Ecological System
SD	Sustainable Development
WSV	Federal Waterways and Shipping Administration *(Wasser- und Schiffahrtsverwaltung des Bundes)*

1 Introduction

1.1 Water management – quo vadis?

Around 40% of the world's growing population is concentrated along coastal zones, and particularly near deltas or estuaries (Figure 1). These 'transitional waters' provide favourable conditions for urban growth, industrial production and extensive agriculture (IPCC, 2014, Adger et al., 2005, Elliott and Whitfield, 2011). Historically, the increasing concentration of people and assets in these areas has caused high demands for different kinds of water infrastructures. Flood defence, navigability, freshwater supply and land reclamation were of prime importance (Pahl-Wostl et al., 2010). Hence, since the 18th Century, transitional waters became largely shaped by channelled streams, drained floodplains and fortified shores (Pahl-Wostl, 2006, Van Raalte et al., 2011).

Transitional water systems form complex ecological borderzones between land and water; they deliver valuable and partly unique 'ecosystem services' (ES) to human societies, such as climate regulation, water purification or food production (Fidélis and Carvalho, 2014). However, the vast human modifications, combined with intense usage, soon interfered with their functioning and morphology (Nemec et al., 2014). They are among the most degraded natural systems worldwide at present (Barbier et al., 2010). German estuaries for instance suffer particularly from habitat losses, raised tidal gauges and oxygen depletion (Schuchardt, 2013). Consequently, *"the capacity of coastal ecosystems to regenerate after disasters and to continue to produce resources and services for human livelihoods can no longer be taken for granted."* (Adger et al., 2005, p.1039). Although mankind benefited from this development for over two centuries, recent and future generations must deal with the social-ecological consequences (Serrat-Capdevila et al., 2009).

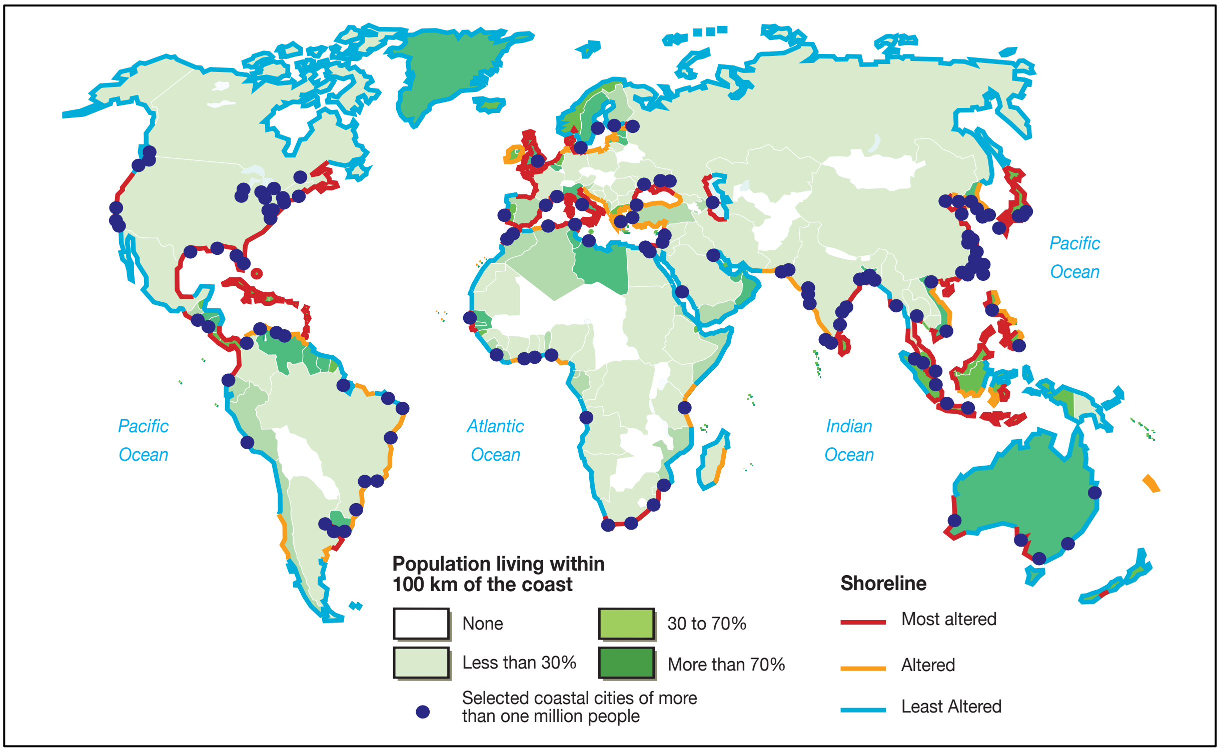

Figure 1: Map showing the global estimations of coastal populations and shoreline degradation. Areas with the greatest coastal population densities have also the most degraded shorelines (Rekacewicz, 2006).

Recent efforts to restore the ecological functionality of transitional waters remain dominated by economic interests like shipping or agriculture (Pahl-Wostl, 2015, Fidélis and Carvalho, 2014). The situation is getting worse, since urban growth and economic activity intensifies along most transitional waters (Van Raalte et al., 2011). Human-driven shifts on global level, such as sea-level rise (IPCC, 2014), biodiversity loss or globalization (Millenium Ecosystem Assessment, 2005), add additional pressure. Their impact on ecosystems, economic assets and critical infrastructures is not fully understood yet, which imposes a major challenge for water management (Pahl-Wostl, 2006). Since 'sustainable development' became a major policy interest in the 1990s, these problems gained explicit attention for the first time (Pahl-Wostl et al., 2008). Scientists and practitioners have started to question the traditional perception of the human-nature relationship, the assumed predictability of future system behaviour, and the adequacy of conventional management practices (Halliday and Glaser, 2011, Gunderson et al., 2006). As a consequence, the last two decades have seen a radical shift in the perception of and research on human-water systems (Vörösmarty et al., 2013).

Emerging approaches for sustainable water management

Motivated by these developments, alternative approaches to water management occur globally (Borsje et al., 2011, Huitema et al., 2009). Their commonality is the insight that *"the pressing problems in this field have to be tackled from an integrated perspective taking into account environmental, human and technological factors and in particular their interdependence."* (Pahl-Wostl, 2006, p.49). In other words: the emphasis is shifting from rigid engineering-only solutions to flexible and more integrated strategies (Pahl-Wostl, 2015).

This thesis focuses on the 'Building with Nature' (BwN) approach. It emerged within the Dutch research programme of the same name[a] and has been initiated by Ecoshape, a consortium of Dutch maritime businesses, research organisations and public institutions. Simply speaking, BwN seeks to utilize natural processes in the design of water infrastructures (*'use the force'*), and/or to generate opportunities for nature development (*'let it grow'*, Figure 2). The overall aim is to combine environmental improvements and social-economic goals in so-called 'win-win' solutions (Van Eekelen et al., 2016). BwN projects include for instance the re-use of dredged material or the utilization of vegetation for flood protection. The approach has proven its general feasibility in several pilot-projects, mostly in the Netherlands, and is now internationally advocated as new water management 'best-practice' (De Vriend and van Koningsveld, 2012, NSR, 2016).

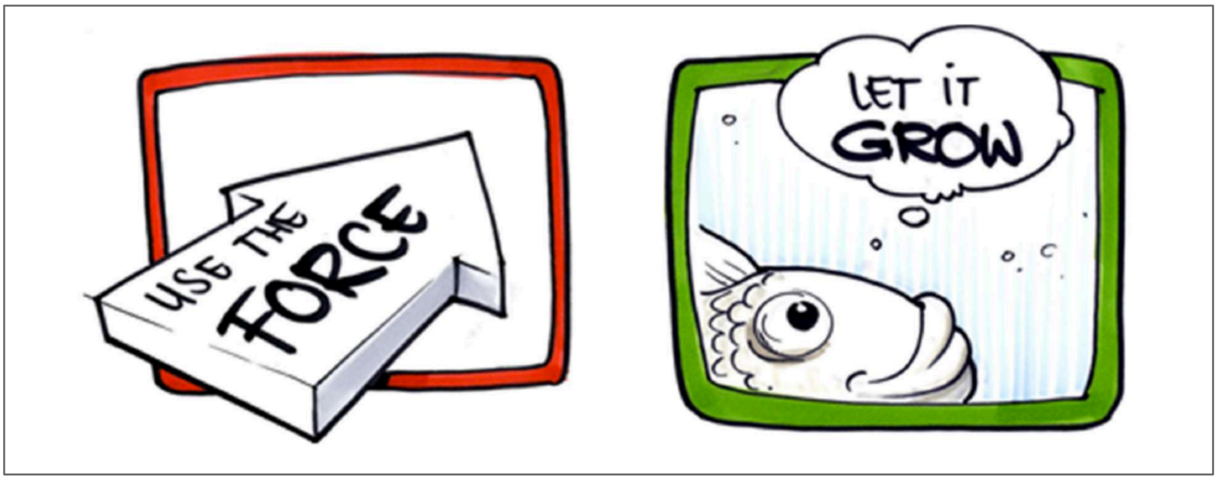

Figure 2: The two basic BwN methods 'use the force' and 'let it grow' (Van Eekelen et al., 2016).

[a] The term 'Building with Nature' denotes three different issues in this thesis. To avoid confusion, **'BwN'** is used to refer to the water management approach. **'Building with Nature programme'** names the research programme. The **'*building with nature*'** paradigm (introduced in chapter 2) is written in italics for the remainder of this thesis.

Research focus: the role of BwN in theory and practice
Above all, this thesis aims to analyse and better understand the conceptual roots of BwN. They can be located in the discourses on 'Social-Ecological Systems (SES)', 'resilience' and 'ecological engineering (EE)'. These three pillars are investigated from the perspective of water management. On that basis, a conceptual BwN framework is developed. It provides a systematic overview of the aspirations and principles that underlie BwN, and allows for a qualitative analysis of real-life BwN projects. The second half of the thesis therefore consists of two case studies (Figure 3): The Spadenlander Busch in Hamburg (Germany), and Marconi Buitendijks in Delfzijl (The Netherlands). The findings of the research shed a new light on the role of BwN in contemporary water management.

Figure 3: Overview map showing the locations of the two cases (map adapted from Bing Maps).

1.2 Concept of this research

Problem statement and research objective
The starting point for this thesis is the aforementioned shift in water management. The emphasis turns from an engineering- to a system perspective and from the oppression of natural forces to their purposeful inclusion (Pahl-Wostl et al., 2010, de Vriend et al., 2015). This requires the careful integration of ecology, sociology and engineering, which constitutes a considerable challenge (Mitsch, 2014, Kamphuis, 2006, Perkins et al., 2015). Several corresponding approaches are developed or tested at present. Their feasibility and effectiveness remains to be seen though, also for BwN: *"the performance of BwN solutions is uncertain and hampers wider uptake across the Noth Sea Region."* (NSR, 2016, p.1).

Accordingly, Ecoshape tries to constantly improve the approach and to deliver additional 'success stories'. Their focus thereby lies on operational aspects, such as legal hurdles (e.g. Vikolainen et al., 2014) or improved techniques (e.g. Temmerman et al., 2013). What seems to be missing is a critical analysis of the conceptual foundations of BwN. The BwN literature sometimes appears vague or even biased in this regard, for example in the understanding of 'participation' or 'resilience'. There is evidence from other fields, like climate change adaption, that these conceptual inaccuracies can significantly hamper the practical implementation of novel management approaches (e.g. White and O'Hare, 2014). Correspondingly, the development of a conceptual framework would make a great advancement for BwN research and practice and marks the first objective of this thesis.

The second objective concerns the performance of real-world BwN projects, and more specifically, the review of so-called 'success stories'. An objective rating of their actual performance and impacts on water management requires a critical investigation. Hence, two 'flagship' projects will be examined in this thesis (Figure 3), *inter alia* by means of the proposed ideal-typical BwN framework.

Research questions

Following the previous line of argumentation, the main question of this thesis is the following:

Main question: How can the BwN approach contribute to the solution of contemporary water management problems?

Three research questions form the main structure of the empirical part. The findings to these questions will add up to give a sufficient answer to the main question:

Question 1 (Q1): What are the aspirations and principles underlying the BwN approach, and how can they be conceptualized into a comprehensive framework?

Question 2 (Q2): How and to what extent has the BwN approach been translated into the case projects in regards to the conceptual BwN framework?

Question 3 (Q3): Do the projects stimulate any lasting changes in the related water management regimes[b]?

Research Design

Figure 4 illustrates the structure of this thesis. While this chapter provides a general introduction and the research questions, chapter 2 assembles the broader theoretical frame. It describes the development from traditional water management to BwN and leads to a conceptual model. Chapter 3 outlines the applied methodology and methods, whereas in chapter 4, the results are presented and discussed. This chapter also includes a brief case introduction. Afterwards, the final conclusions are drawn in chapter 5 with regard to the conceptual model. The thesis closes with suggestions for future research and a critical reflection on the research process itself in chapter 6.

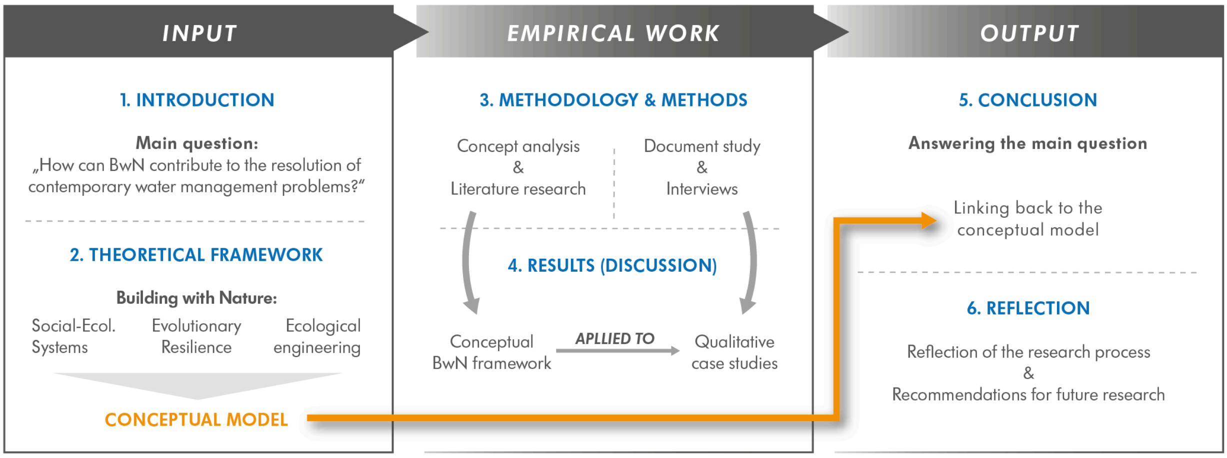

Figure 4: The research design of this thesis (own figure).

[b] The term 'water management regime' and its understanding within this thesis is explained in section 2.2.1.

SPADENLANDER BUSCH

View from the South to the construction site with the new water inlet on the right.

Photo: M. Martens, 2017

2 Literature Review

This chapter investigates the progresses made in the field of water management. It assembles the theoretical frame for this thesis and closes with the conceptual model. The central theme is the paradigmatic shift from *"doing not too bad [building **in** nature], via doing no wrong [building **of** nature], to doing good [building **with** nature]."* (Deltares and Ecoshape, 2016, n.p.).

2.1 The narrative of men and water – from Building *in* to Building *with* Nature

The relationship of society and water systems has a long history of conceptualizations (Davidson-Hunt and Berkes, 2003). Recently, traditional perceptions (2.1.1) become increasingly questioned, since many water problems turned out to be much more challenging than assumed. A fundamentally new and non-anthropocentric paradigm is emerging currently (2.1.2). It draws on insights made from the fields of SES (2.1.3) and resilience (2.1.4) and is termed *'building **with** nature'* (2.1.5).

2.1.1 Traditional perceptions and approaches

Building in Nature

During the 19th Century, natural water systems gained a pivotal role in the industrialization of the western countries, for instance for transportation or food production (Molle, 2009). Due to the scientism of that time, these systems were seen as fully predictable and controllable entities in strict separation from society. Accordingly, engineers were commissioned with their exploitation by means of technical 'blueprint' interventions and with little concern for ecological interferences (Pahl-Wostl, 2015, Cheong et al., 2013). This 'hydraulic mission' is reflected in the paradigm of *'building **in** nature'* (Figure 5). The majority of present-day river modifications, coastal fortifications or wetland drainages originate from that period (Pahl-Wostl, 2006). However, the increasingly poor conditions of the water system became evident during the environmental movements in the 1970s (Molle, 2009). Managers and scientists started to recognize the actual fragility of aquatic ecosystems and the diverse impacts of human interventions. The period between the 1970s and 1990s was therefore characterized by a variety of post-damage repairs, such as impact mitigation (Aarninkhof et al., 2010, Pahl-Wostl, 2006).

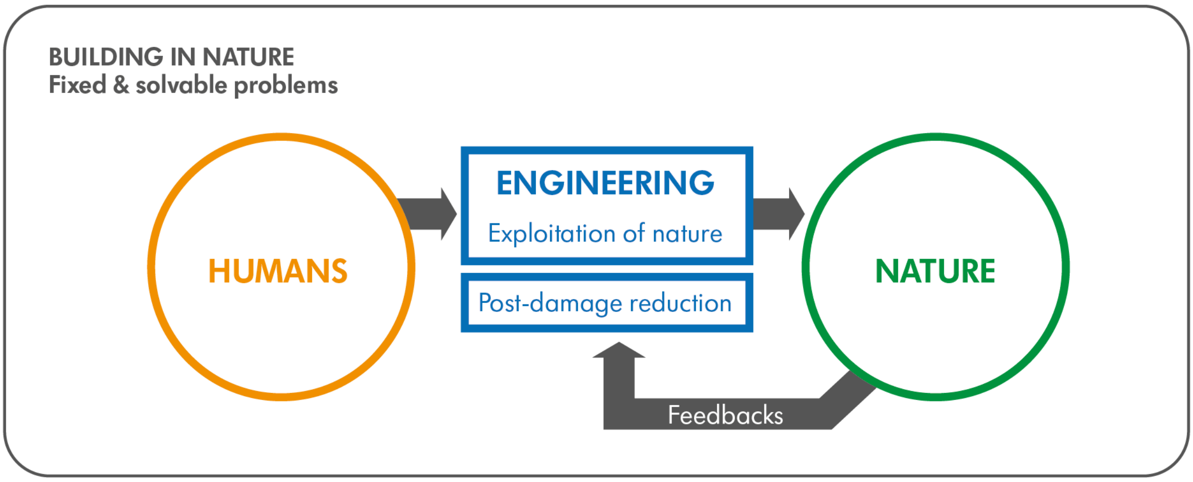

Figure 5: The 'building in nature' paradigm. Humans commission engineers to tame and exploit nature, while potential ecological damages are reduced in retrospect (own figure).

Building of Nature

Despite the growing efforts made for damage reduction, the degradation of water systems proceeded. This issue gained attention again in the early 1990s, when sustainability and the notion of ES became popular in science and policy-speak (Palmer and Nursey-Bray, 2007, Costanza et al., 1998). ES are denoted as *"the benefits people obtain from ecosystems [...]"* (Millenium Ecosystem Assessment, 2005, n.p.). Table 1 lists some ES examples. Societies are existentially endangered if those services further decline or even collapse (Biggs et al., 2012). Simple damage repairs became therefore accompanied by preventive measures, such as ecological restoration or compensation for potential environmental damages. Consequently, water management now resorted to a *'building **of** nature'* paradigm (Figure 6) (Van den Hoek et al., 2012, Van Raalte et al., 2011). This new perspective triggered various approaches and policies, such as 'Integrated River Basin Management' (Molle, 2009) or the 'Agenda 21' by the UN (Millenium Ecosystem Assessment, 2005). Nonetheless, many novel attempts towards sustainability remained political rhetoric or were poorly applied to practice (Pahl-Wostl, 2006).

ES type	Examples from salt marshes	Examples from sand beaches and dunes
Provisioning services	Raw materials *(provision of fodder for livestock farming)*	Raw material *(provision of sand of particular grain size and mineral proportion)*
Regulating services	Water purification *(nutrient and pollution uptake, particle deposition)*	Coastal protection *(wave attenuation and reduction of flood impacts)*
Supporting services	Soil formation *(accumulation and stabilization of sediment)*	Maintenance of wildlife *(provision of habitats for animal and plant species)*
Cultural services	Education and research *(provision of shelter for endangered species)*	Tourism *(provision of unique and aesthetic landscapes)*

Table 1: Examples of four different ES Types from salt marshes and sand beaches or dunes (categorization based on Millenium Ecosystem Assessment, 2005, examples from Barbier et al., 2010).

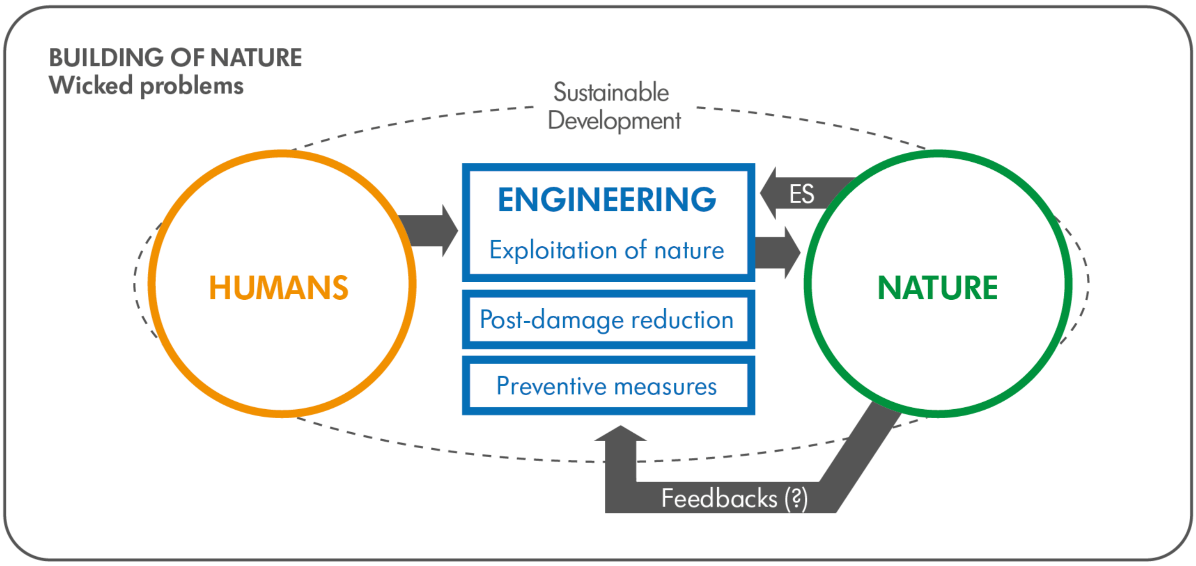

Figure 6: The 'building of nature' paradigm. Humans still exploit nature, but try to prevent ecological damages and reduce those that seem unavoidable. The ES that people obtain from nature are recognized and sustainable management practices become implemented (own figure).

2.1.2 The rise of a new water management paradigm

Although water management has made significant progress, aquatic ecosystems remain seriously damaged (Barbier et al., 2010), and new challenges are on the rise. These are climate change, and particularly for estuaries, sea-level rise, globalization, urban growth, and biodiversity loss (IPCC, 2014, Aarninkhof et al., 2010). These issues raised awareness of the real complexity of human-nature systems, the uncertainties connected to their management, and the incapability of traditional approaches to deal with them. Accordingly, many voices advocate a radical shift of perspectives (e.g. Pahl-Wostl, 2015).

Persistent water problems

Rittel and Webber (1973) coined the notion of 'wicked problems' to describe issues of high social complexity. Various authors describe present management problems as even more complex, as they have consolidated in various domains and over different levels of society; these are 'persistent problems' (Van der Brugge et al., 2005, Loorbach, 2010). Water issues make a prime example here. Water has many forms, such a fresh-, ground- or wastewater. It manifests itself in various issues, like scarcity or pollution, and is connected to several functions, for instance navigation, recreation and ecological health. Consequently, water problems concern a multitude of actors with diverging stakes, perspectives and empowerment, and many of them only indirectly (Van der Brugge et al., 2005). The problem causes often lie outside the traditional water sector, for instance in agriculture, and have impacts on, others, like spatial quality or ecological health. Further complication arises from temporal delays and spatial distances between problem causes and their effects (Jänicke and Jörgens, 2004).

These persistent water problems are inseparable linked to the 'network society' (Castells, 1996). The term describes the present social reality, which is characterized by globalization, diversification, and shifts from government to governance (Jänicke and Jörgens, 2004, Innes and Booher, 2004). The latter means that the 'governing role' is increasingly shared between the state, the civil society and various market parties. This shift goes hand in hand with the diversification of responsibilities over different levels, ranging from the municipality to international administrations (Duit and Galaz, 2008, Brondizio et al., 2009). In other words, the 'network society' links different communities, economies and ecosystems across time, geographical scales and organizational levels (Van Slobbe and Lulofs, 2011, Loorbach, 2010).

Water management paradigms

The nature of persistent problems undermines the basic assumptions on which traditional water management builds (Pahl-Wostl et al., 2007, 2010). The plethora of issues, connections and dynamics does not allow for simplifications or technical fixes (Halliday and Glaser, 2011). Instead, managers are urged to acknowledge the complex and unpredictable nature of the systems they seek to manage. Therefore water management requires a 'paradigm shift' (e.g. Pahl-Wostl, 2015, Gedan et al., 2010, Huitema and Meijerink, 2010a). Following Pahl-Wostl et al. (2010), a paradigm constitutes the 'worldview' that underlies a specific domain. It is assembled by

> *"[...] a set of basic assumptions about the nature of the system to be managed, the goals of managing the system and the ways in which these goals can be achieved. The paradigm is shared by an epistemic community of actors involved in the generation and use of relevant knowledge."* (p.840)

The paradigm determines the societal function of water management; as outlined before, this function is currently shifting from 'controlling the water' with technical measures, to 'living with water' in a more farsighted and sustainable manner (e.g. Huitema and Meijerink, 2010a, Fidélis and Carvalho, 2014, Restemeyer et al., 2015). 'Sustainability' refers to a state in which social welfare, economic prosperity, and the functional integrity of ecosystems is in a lasting balance (Figure 7) (Walker and Salt, 2006).

The principles and processes aiming at this ultimate target come together as 'sustainable development' (SD), which basically constitutes an organizing principle *"that meets the needs of the present without compromising the ability of future generations to meet their own needs."* (Brundtland Commission, 1987, p.41). Nonetheless, striving for sustainability in the face of persistent problems requires rather abstract reasoning, constant self-reflection and a holistic, non-anthropocentric system perspective (Halbe et al., 2015). Thus, the concepts of 'Social-Ecological Systems' (SES) and 'resilience' gained popularity recently (Cumming, 2011).

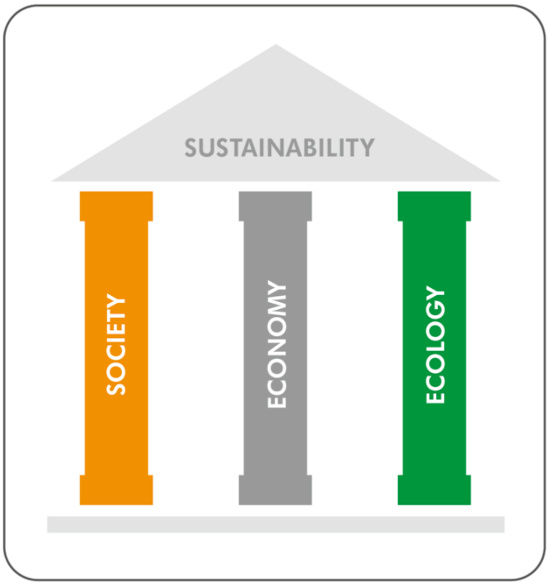

Figure 7: The three-pillar model of sustainability (adapted from Brundtland Commission, 1987).

2.1.3 Social-ecological systems

Natural water systems are more than ever affected by social organization nowadays (Brondizio et al., 2009). Humans, in return, rely on natural resources and ecosystem services. Hence, society and the environment are increasingly perceived as highly interlinked systems, rather than as isolated entities (Halliday and Glaser, 2011). Berkes and Folke (1998) have proposed the notion of SES in that regard. The SES model reassembles elements from various disciplines and creates a promising new body of integrated theory to assess the human-nature relationship (Cumming, 2011). SES can be defined as complex compositions of interacting societal and ecological sub-systems in a spatially defined geophysical context (Halliday and Glaser, 2011, Gallopin, 2006). A basic SES consists of at least four core subsystems: The resource system, its resource units, the users, and a related governance system. They interact with each other as well as with their surroundings and thereby produce system-specific outcomes (Ostrom, 2009). Figure 8 provides an exemplary impression of this highly simplified understanding.

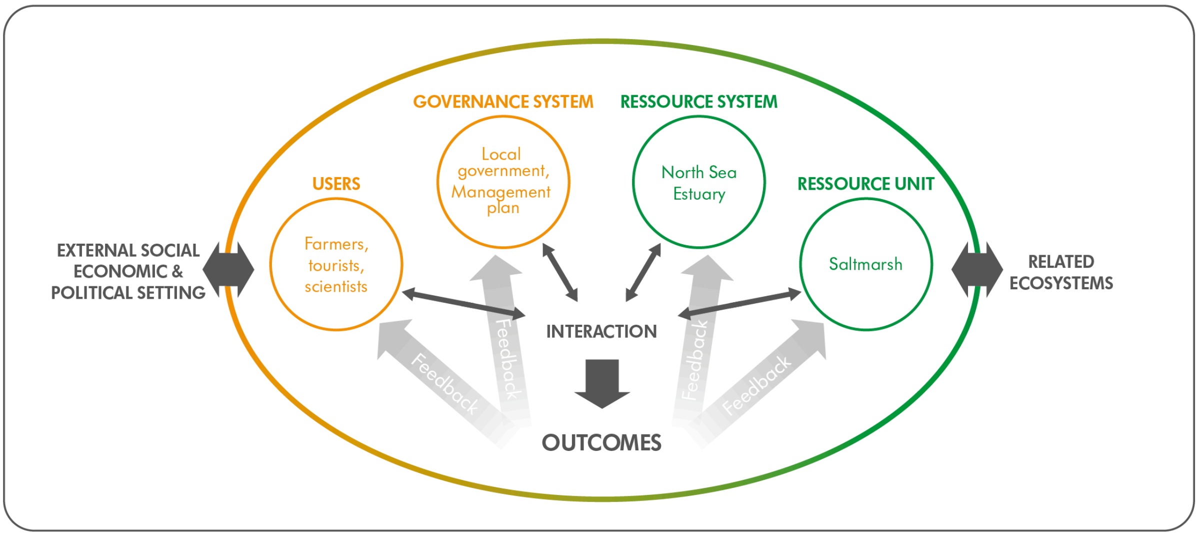

Figure 8: Basic SES model with exemplary first-level subsystems. Each sub-system consists of several sub-level-systems that interact with each other and their 'external' environment (based on Ostrom, 2009).

SES studies draw heavily on complex system theory. The latter portrays systems *"not as deterministic, predictable and mechanistic, but as process-dependent organic ones with feedbacks among multiple scales that allow these systems to self-organize."* (Folke, 2006, p.257) This is because complex systems inhere non-linear processes and thresholds, which can lead to unpredictable behaviours. The implication is that such a system is not explainable from the sum of its parts alone, but must be understood as a whole (Halliday and Glaser, 2011, Berkes and Folke, 1998). Complex *adaptive* systems differ from other complex systems through the interactions between its agents; these interactions facilitate novelty and learning, which allow those systems to adapt and to evolve. SES are both *complex* and *adaptive* (Cumming, 2011). However, what makes SES theory unique is the fact that it considers people and nature as fully integrated (Cumming et al., 2015). Correspondingly, SES cover some important social aspects that other, rather 'a-political' system perspectives tend to oversee or ignore, such as intentionality, willingness or power (Davoudi, 2012).

2.1.4 Evolutionary resilience

When SES thinking gained cross-disciplinary attention, another concept became of interest – 'resilience' (Davoudi, 2012). Resilience generally describes the capacity of a system to deal with perturbations or to anticipate change (Adger et al., 2005, Young et al., 2006). Despite its roots in physics and ecology, the concept is increasingly popular within the social sciences and the realm of policy-making. Resilience is particularly appealing for SES scholars, as it provides an explanation for the unpredictable and often non-linear behaviour of complex adaptive systems (Halliday and Glaser, 2011, Gallopin, 2006). Three main interpretations can be distinguished from the variety of existing foci and applications – 'Engineering', 'Ecological' and 'Evolutionary' resilience.

C.S. Holling (1973, 1996) firstly defined the level of resilience as the time disturbed ecosystems need to return to their initial state, hence to 'bounce back' to their former equilibrium – the 'engineering resilience' (Walker et al., 2004). The more sophisticated 'ecological resilience' describes systems that either 'bounce back' to former states, or 'bounce forward' to new ones (Gallopin, 2006). Here, resilience is understood as *"the capacity of a system to absorb disturbances and reorganize while undergoing change so as to still retain essentially the same function, structure, identity and feedbacks [...]"* (Walker et al., 2004, p.2). These equilibrium-based definitions fit well with modernist planning ideals of 'preserving the existing' and 'recovering to the normal' (Davoudi, 2012). However, they are called into question by the discovery of systemic thresholds, for instance the 'tipping points of climate change', the observation of sudden system shifts, like collapsing fish stocks, as well as unexpected fluctuations, such as the El Niño phenomenon (Adger et al., 2005, Porter and Davoudi, 2012). It appears as if systems are in a constant flux, with or without external disturbances, and despite some seemingly stable periods (Walker et al., 2004, Davoudi, 2012). This interpretation of evolutionary resilience discards former equilibrium-thinking and instead considers transformational changes as the new normality (Porter and Davoudi, 2012). Hence, rather than being a scale for the return to steady-states, resilience is now understood as the ability to either resist, adapt, or crucially transform (Carpenter et al., 2005): "*It is also about the opportunities that disturbance opens up in terms of recombination of evolved structures and processes, renewal of the system and emergence of new trajectories."* (Folke, 2006, p.259). The sources of disturbance can thereby lie outside or inside the system, which marks another difference to former interpretations (Davoudi, 2012). Following Galderisi et al. (2010) and Davoudi (2012), this thesis understands resilience therefore as 'robustness', 'adaptability', and 'transformability'.

'Robustness' relates to the capacity of structures, processes or entities to resist or absorb disturbances without suffering losses or failure – basically to 'bounce back' (Galderisi et al., 2010). This capacity is limited though, and major disturbances may exceed it (Restemeyer et al., 2015, Walker et al., 2004).

Therefore 'adaptability' is important. It describes the capacity to reduce vulnerabilities, to take advantage of opportunities, and to adjust to internal pressures or changing environments (Gallopin, 2006, Walker and Salt, 2006). In human-dominated SES, adaptability roots primarily in the social domain (Serrat-Capdevila et al., 2009, Gunderson et al., 2006, Folke, 2006). While robustness and adaptability are about sustaining the essential characteristics of a system, there might be situations that require a change of the system itself (Restemeyer et al., 2015, Olsson et al., 2014). 'Transformability' therefore marks the capacity to create fundamentally new systems "*when ecological, economic, or social conditions make the existing system untenable.*" (Walker et al., 2004, p.3). This includes the ability to turn crisis or disasters into 'windows of opportunity' for radical system reconfigurations (Galderisi et al., 2010).

2.1.5 Synthesis

To synthesize the former findings, one can describe SD in a resilient SES as an evolutionary process of improvements, adaptions and transformations on the basis of learning (Bagheri and Hjorth, 2006). A corresponding water management paradigm should emphasize the following aspects therefore:

- Participatory and collaborative decision-making,
- increased integration of issues and sectors,
- explicit inclusion of environmental goals,
- management of problem sources not effects,
- decentralized and more flexible approaches,
- more attention to the social dimension,
- open and shared information sources,
- incorporation of iterative learning cycles (adapted from Pahl-Wostl, 2006, 2015)

Many voices advocate a radical shift towards such a paradigm, either from a normative (*it should happen*) or a descriptive (*it happens right now*) perspective (Pahl-Wostl et al., 2010). This new paradigm is termed 'building ***with*** nature' in this thesis and is schematized in Figure 9.

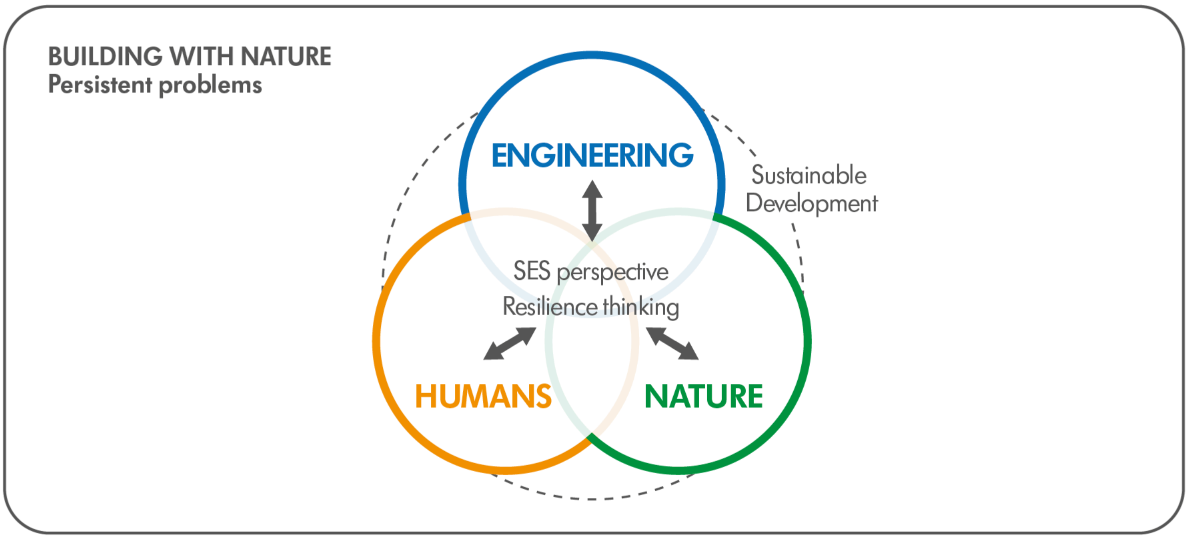

Figure 9: The new 'building with nature' paradigm. Humans, nature and technology are fully integrated in a resilient SES. The guiding management principle is sustainable development (own figure).

MARCONI BUITENDIJKS

Information sign for the upcoming construction site ‚Kwelderlandschap' (saltmarshes).

Photo: M. Martens, 2016

2.2 Building with Nature

The previous sections revealed the complicated task of water managers; they strive for sustainability, deal with persistent problems, and intervene in complex systems that are rarely understood, and whose behaviour is hard to predict. Accordingly, the aspiration to translate the new '*building **with** nature*' paradigm into practice grows (2.2.1). Ecoshape presents the BwN approach in this hindsight (2.2.3) by drawing heavily on 'Ecological Engineering' techniques (2.2.2).

2.2.1 From aspiration to practice

The term 'management' describes *"the planned and purposeful act or practice of exerting influence on a system and steering it in a certain direction."* (Pahl-Wostl et al., 2010) The traditional paradigms of *'building **in** nature'* and *'building **of** nature'* (2.1.1) have led to management approaches that seek to control water systems through detailed plans, rigid interventions, and fixed goals (Pahl-Wostl, 2015). However, these attempts failed to deal with non-linear and unpredictable system dynamics, which characterize most transitional waters. Based on recent insights from SES and resilience research, more integrated and adaptive approaches emerged lately. Prominent examples are 'Managed Realignment' (Esteves, 2014) or 'Ecological Restoration' (Mitsch and Jørgensen, 2004). Generally speaking, these account for a spectrum of issues and actors, and combine some steering with flexible goals. Learning plays a major role and facilitates constant improvements of the applied strategies and practices (Pahl-Wostl, 2006, 2010). The literature mostly refers to 'adaptive management' in this context (e.g. Johnson, 1999, Olsson et al., 2004).

To understand the translation of paradigms to the operational level, the dominant management structures and procedures also play an important role – the so-called regimes (Figure 10). Regimes are the aggregation of procedures, norms, and organizational forms that emerge around a societal function (2.1.2). They are the real-life manifestation of a paradigm and determine how it is translated into practice (Pahl-Wostl et al., 2007). To illustrate: the traditional societal function is 'controlling the water', which implies rigorous flood defence measures. Accordingly, the water management regimes were optimized to shield human settlements from the sea through diking and damming. Authorities, companies and other organizations have specialized on the planning, building and maintenance of these structures. Hence, the paradigm has materialized in physical structures, customized institutional arrangements, and high societal investments (Huitema and Meijerink, 2010b).

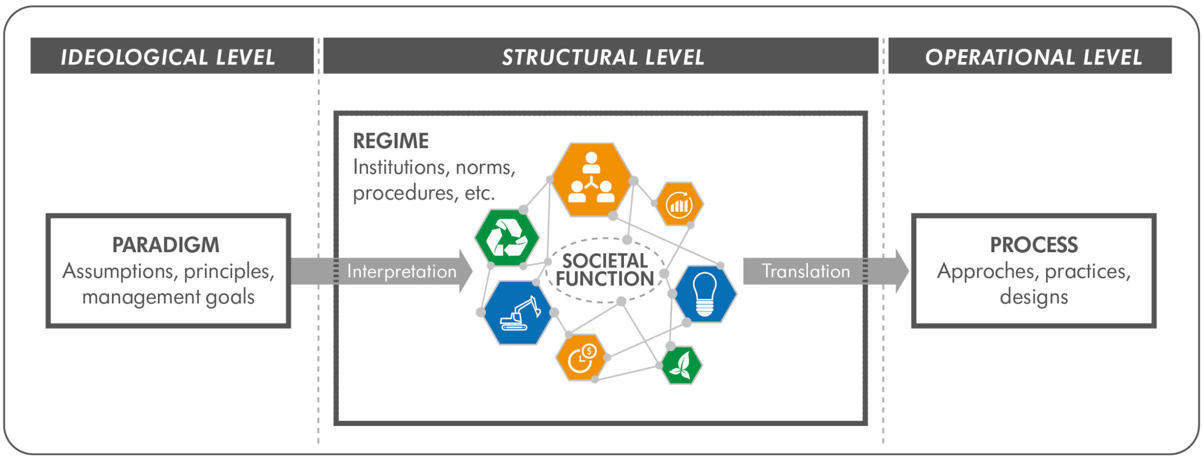

Figure 10: The relationship of paradigms, regimes and management processes. Regimes are displayed as tightly connected assemblage of institutions, norms and procedures that emerge around a societal function (the coloured tiles are random and just for visualization). This function is based on the dominant paradigm. The regime translates this function to the operational level in form of suitable management processes (own figure).

The example shows how regimes inhere rather inflexible, interdependent and mutually stabilizing elements. This guarantees a smooth workflow, but also impedes their reconfiguration when the underlying paradigm radically changes (Loorbach, 2010, Rotmans et al., 2001). Pahl-Wostl et al. (2010) put it this way: *"Paradigm shifts are often disastrous for individual careers and present uncomfortable challenges to institutions and governance systems."* (p.841). Correspondingly, paradigm shifts may take decades and are often accompanied by strong resistances or even ignorance from the affected regime community. This can seriously hamper or prevent the operationalization of novel management approaches (Van der Brugge et al., 2005, Pahl-Wostl et al., 2010, Huitema and Meijerink, 2010a).

2.2.2 Ecological Engineering

One approach that gains popularity in water management recently is 'Ecological Engineering' (EE). It aims to replace traditional engineering strategies, which often lead to severe ecological impacts. Flood hazards for instance were successfully lowered through dams and dikes, but these massive structures frequently initiated the erosion of local and adjacent ecosystems, and led to harmful changes in morphology and hydrodynamics (Cheong et al., 2013). Hence, a rethinking has started; many scientists and practitioners now assume that the proactive involvement of nature can create both social security and ecological benefits, while being less rigid and harmful. Thus, the EE approach is much in line with SES-thinking and has the potential to increase local resilience (Van Raalte et al., 2011, Mitsch, 2014, Borsje et al., 2011). Figure 11 provides an example for the added values of EE solutions.

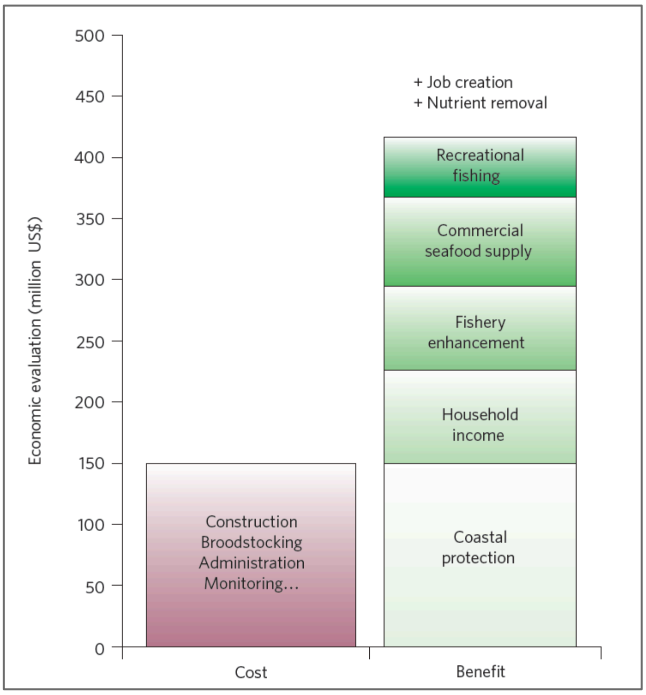

Figure 11: Evaluation of an estuary oyster reef restoration project. The series of reefs has a total length of 100 miles. The benefits are estimated for a 10-year period. Job creation and nutrient removal (as well as other ecological co-benefits) are not included (Cheong et al., 2013).

EE is based on two emerging discourses: first, maritime and coastal ecosystems became recognized as important sources of ES (Pinto and Marques, 2015). The demand for climate and flood regulation, freshwater provision and recreational space for example constantly grows (Borsje et al., 2011, Perkins et al., 2015). At the same time, human activities have substantially eroded the ability of water ecosystems to provide these services (Barbier et al., 2010, Gunderson et al., 2006, Aarninkhof et al., 2010). Hence, their protection and maintenance became a major policy interest (Millenium Ecosystem Assessment, 2005). Second, ecological synergies and other natural interactions are increasingly emphasized in the fields of ecological conservation and restoration (Cheong et al., 2013, Simenstad et al., 2006). Seagrass meadows combined with mussels for instance raise the fixation rate of atmospheric carbon in the soil (Van der Heide, 2012).

EE tries to combine these ecological interactions with the maintenance of essential ES (Mitsch and Jørgensen, 2004). The idea is to generate self-sustaining, cost-effective and multi-purpose solutions to pressing water problems (Cheong et al., 2013). Hence, EE projects have been initiated worldwide in recent years (Mitsch, 2014), although their total number is still scarce (Temmerman et al., 2013). The most frequent application is the creation of coastal wetlands. These protect dikes from wave impact, provide resting areas for birds, and grow along with sea-level rise through sedimentation. Engineering can support their stability and growth with soft engineering structures, such as oyster domes or brushwood fences, or by supportive measures, like plantations or periodical nourishments (Gedan et al., 2010, Mitsch and Jørgensen, 2004).

2.2.3 The Building with Nature innovation programme

Despite its advantages, EE is not without critics. Mitsch (2014) for instance notes how EE is too often *"done by practitioners who have little experience in design [...] and by engineers who do not appreciate the capabilities of ecosystems to self-design [...]"* (p.13). Cheong et al. (2013) add that the approach widely ignores the societal dimension. Several other authors stress that EE and similar approaches must join forces with related lines of research to sufficiently deal with the systems in which they intervene (e.g. Elliott et al., 2016, Van Slobbe et al., 2013, Gedan et al., 2010). This is what the Dutch innovation programme 'Building with Nature' claims to do.

Background

The BwN approach was initially developed by the engineer J.N. Svašek in 1979, and got connected to water management by R.E. Waterman (2007). Two Dutch dredging companies adopted and extended the idea in 2008. They formed the Ecoshape Consortium (Table 2) and proposed a 'Building with Nature' research programme to a national innovation fund. After approval, they received 30 million Euro as funding and started the first phase of the programme (2008-2012). It had three objectives: the development of basic BwN knowledge, its testing in real-life projects, and a lasting impact on the Dutch water management sector (Ecoshape, 2016b, Van Slobbe et al., 2013).

The Ecoshape Consortium

Core partners		**Network**	
SUPERVISORY BOARD:		Dordrecht	*Municipal government*
Boskalis	*Dredging*	Port of Rotterdam	*Port authority*
Van Oord	*Dredging*	It Fryske Gea	*Dutch NGO*
Deltares	*Research (engineering)*	Provincie Zuid Holland	*Provincial government*
Witteveen+Bos	*Engineering/consultancy*	Gemeente Harlingen	*Municipal ministry*
Wageningen University	*Research (life sciences)*	Climatebuffers	*Dutch NGO coalition*
Arcadis	*Engineering/consultancy*	TU Delft	*Research (engineering)*
Royal HaskoningDHV	*Engineering/consultancy*	Unie van Waterschappen	*Water board association*
HKV Consultants	*Engineering/consultancy*	Nioz	*Research (marine sciences)*
Wetlands international	*International NGO*	European Union	*International government*
IHC Merwede	*Maritime equipment (e.g. dredging vessels)*	University of Twente	*Research (engineering/ social sciences)*
Vereniging van Waterbouwers	*Dutch hydraulic engineering association*	Ministry of Infrastructure and the Env. (RWS)	*National ministry*

Table 2: The core partners and network members of the Ecoshape Consortium(Ecoshape, 2016b). Colours indicate the type of organization: engineering/dredging (blue), governments (orange), environmental sciences (green) and others (grey).

BwN basically draws on EE, but widens it's scope by involving ecologists, sociologists and policy makers as well. The core aim of the approach is the development of sustainable water infrastructures with a strong focus on the proactive involvement of nature. In other words: BwN is about finding social-, economic- and ecologic win-win solutions (Wesselink and De Vriend, 2009, De Vriend et al., 2014, 2015). The approach accounts for three dimensions and their interactions (Ecoshape, 2016b):

- **Nature:** The abiotic (hydro-morphological processes, e.g. sedimentation) and biotic (ecological processes, e.g. nutrient-cycling) environment;
- **Humans:** Formal (e.g. laws, authorities) and informal (e.g. power, networks) aspects of governance;
- **Engineering:** Human interventions that aim to influence the natural system (e.g. diking, restoration).

Activities and future prospects of the programme

According to Lulofs and Smit (2012), phase I 'showed that it works'. A number of pilot-projects delivered first insights on water governance, ecosystem functioning, and the diverse effects of human interventions on aquatic ecosystems (Figure 12). The research results have been assembled in the freely accessible 'Building with Nature Design Guidelines'[c] (Deltares and Ecoshape, 2016). Further, the 'Eco-Dynamic Design' (EDD) technique was developed and successfully tested. It constitutes a step-by-step guide for practitioners to create nature-inclusive designs (de Vriend et al., 2015):

- **Step 1:** Understand the system (including ES, values and interests).
- **Step 2:** Identify realistic alternatives that use and/or provide ES.
- **Step 3:** Evaluate the qualities of each alternative and preselect an integral solution.
- **Step 4:** Fine-tune the selected solution (practical restrictions and governance context)
- **Step 5:** Prepare the solution for implementation (approval, contracting, funding etc.)

By now, BwN is embraced in the national Dutch 'Delta Programme'. Other European countries increasingly adopt BwN or apply similar approaches (adapted from De Vriend and van Koningsveld, 2012, p.161f). Furthermore, several BwN-like projects have been conducted in Asia, Africa and the USA (Waterman, 2007, de Vriend et al., 2015). However, BwN turned out to be contested by many politicians, authorities and project developers (Van den Hoek et al., 2012). Resistances and pitfalls are, *"if not technical or ecological, then contractual, societal, or legal, or associated with unnecessary conservatism among professionals."* (De Vriend, 2014, p.36). 'Conservatism' in this context relates to traditional mentalities (*'building **in** nature'*), which seem incompatible with the idea of including natural forces and accepting higher levels of uncertainty (De Vriend, 2014, Van den Hoek et al., 2014). Accordingly, phase II of the programme (2014-2019) aims to improve the approach and to reduce governance hurdles towards its further practical application on international scale (Deltares and Ecoshape, 2016). Current BwN projects concern nature-based flood defences, sustainable ports, resilient delta cities, and the restoration of river ecosystems (Ecoshape, 2016b). In addition to phase II, Ecoshape initiated an international BwN project under the auspices of the EU 'Interreg North Sea Region programme', starting in late 2016 (CWSS, 2015).

In parallel to BwN, several similar concepts emerged, such as 'Working with Nature' (PIANC, 2011), 'Engineering with Nature' (Bridges et al., 2014) and 'Flanders Bays 2100'. These concepts build on the same assumptions and scientific insights and are congruent in their attempts and principles (Bridges et al., 2014, Vikolainen et al., 2014).

[c] The BwN Design Guideline is accessible under: *https://publicwiki.deltares.nl/display/BWN1/Building+with+Nature*

Figure 12: BwN project examples (above: Ecoshape, 2016, left: M. Martens, 2016, right: de Vriend et al., 2014).

2.3 Conceptual model

Figure 13 shows the conceptual model for this thesis. It assembles the key findings and concepts of this chapter and serves as intellectual frame for the subsequent empirical work. It basically denotes who and what will be involved, and describes the present and assumed connections (after Baxter and Jack, 2008).

The model follows the division into an ideological-, structural- and operational level as done in Figure 10 already. The red circles locate the three research questions (1.2). The basic assumption is that a paradigm change sets place in water management. Question one (Q1) is about how BwN conceptualizes the new paradigm. Q2 assesses how BwN is applied to the case study projects. The motivations for the initial adoption of BwN, as well as the impact that BwN has on the local water management regime, is what Q3 is about.

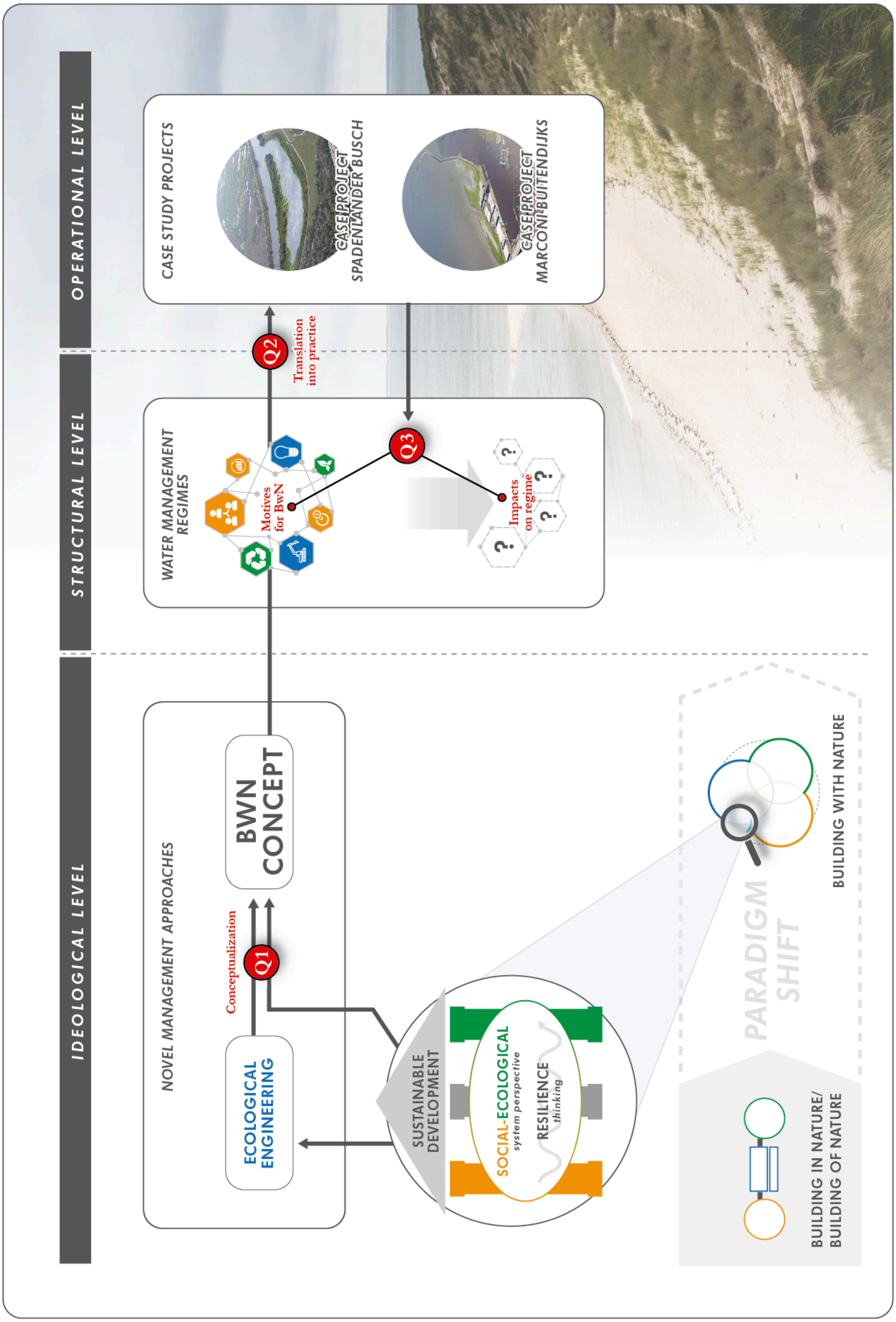

Figure 13: Conceptual model of this thesis (own figure).

SPADENLANDER BUSCH

↑ View from the North to the project site, next to the project information board.

↓ Panorama of the construction site, taken from the main dike.

Photos: M. Martens, 2017

3 Methodology

The objectives of this research are twofold: First, to assemble a conceptual framework of BwN, and second, to assess the performance of BwN in practice. This chapter describes the deployed methodologies and methods, and explains how the collected data was analyzed and evaluated.

3.1 Conceptualization of a BwN framework

Q1 aims to identify the aspirations and principles behind BwN, and to conceptualize them into a comprehensive framework. Frameworks can help to make sense of complex ideas by identifying, organizing and simplifying their most relevant factors (Pickett et al., 2007). To gather the relevant data, a concept analysis was applied upon BwN, followed by a systematic research of the related scientific literature.

3.1.1 Concept analysis

Concept analysis is a method to reflect upon the theoretical content of concepts that are applied in a specific domain and are held by a relatively small community (Risjord, 2008). The method suits BwN well, as it operates mainly in the water domain and roots in the relatively small community of practice. The analysis drew on the following sources:

- Ecoshape website (www.ecoshape.nl),
- the BwN Book by Ecoshape (De Vriend and van Koningsveld, 2012),
- 13 peer-reviewed articles and six conference proceedings (Table 3).

List of analysed articles and proceedings	
Author/year	**Type**
Aarninkhof et al. (2010)	Conf. Proc.
De Vriend (2014)	Article
de Vriend et al. (2015)	Article
de Vries et al. (2016)	Conf. Proc.
Lulofs and Smit (2012)	Conf. Proc.
van Slobbe/Lulofs (2011)	Article
van Slobbe et al. (2012)	Article
van Slobbe et al. (2013)	Article
Stive et al. (2013)	Article
Temmerman et al. (2013)	Article
Van den Hoek (2011)	Conf. Proc.
van den Hoek et al. (2012)	Article
Van den Hoek et al. (2014)	Article
Van der Meulen et al. (2015)	Article
van Raalte et al. (2011)	Conf. Proc.
Vikolainen et al. (2013)	Article
Vikolainen et al. (2014)	Article
Waterman (2007)	Article
Wessellink/de Vriend (2009)	Conf. Proc.

Table 3: List of articles and conference proceedings used in the concept analysis.

To generate the pool of articles and proceedings, 'Building with Nature' was used as search term in scientific electronic databases, as well as for a Google-search. Further, the references listed on the website and in the BwN book were scanned. All detectable articles and proceedings were checked for their relevance considering the aim of the concept analysis. Some were excluded due to their specific focus, for example on certain species, or because they did not provide any new insights to the analysis.

Afterwards, the selected sources were systematically investigated for goals, principles, approaches or concepts that are generally associated with BwN. This included single terms, such as 'integration', as well as paraphrases, like 'the ability to react to future changes or surprises'. The computer programme MAXQDA was used to set and apply inductive codes to the above listed sources (see in Appendix D).

3.1.2 Systematic literature research

In the next step, the findings of the concept analysis had to be classified and put into context. For that purpose, a systematic literature research was conducted. Here, the findings of the concept analysis were compared to the literature on SES, resilience and EE, which was used for chapter 2 already. This step helped to clarify basic terms and their relationships, and to link paraphrases with scientific terminology. Waterman (2007, p.8) for instance wrote that BwN *"takes into account the present geomorphology and the historic development of these coastal and delta areas [...], flora & fauna, and ecosystems [...]"*. This statement was framed as 'ecological memory' in the course of the literature research.

After a basic framework structure was set up, a more detailed investigation was conducted. Search terms were derived for each element individually; inputs made from one source thereby helped to identify others. This 'evolutionary' type of literature research continued until all framework elements seemed sufficiently addressed and their mutual relationships became clear. The literature research involved about 80 contributions in total; they cover system studies, water management and engineering, adaptive co-management, environmental sciences, governance and sustainability studies.

3.2 Qualitative case studies

For Q2 and Q3, a qualitative case study approach was adopted. Case studies are reasonable when contextual conditions affect the phenomenon under study (Yin, 2003); this is an appropriate choice for studying the BwN concept. The study of multiple cases thereby generates more robust and reliable results than single case studies (Baxter and Jack, 2008).

Case screening and selection

To avoid an unreasonable expansion of scope, Yin (2003) suggests to bind case studies by context. Hence, the thesis focuses on projects from estuarine environments. Berkes and Seixas (2005) denote estuaries as good real-world laboratories to explore the relationship of humans and nature, as they are intensively used, human-dominated, and geographically bounded. In addition, estuaries are among the most common environments for BwN projects; findings made from estuarine contexts might therefore particularly contribute to future BwN research and practice.

Two projects were chosen: the 'Spadenlander Busch' in Hamburg (GER) in the Elbe estuary, and 'Marconi Buitendijks' in Delfzijl (NL) in the Eems-Dollard estuary. A detailed introduction follows in chapter 4.2. The selection was based on three criteria:

1. **BwN:** Cases should be in accordance with BwN or with similar concepts (compare 2.2.3).
2. **Content/context:** The projects should differ in location (preferably not the same estuary), and key actors or organizations should not overlap.
3. **Data availability:** Relevant project information should be available and accessible in sufficient quality and quantity, both in terms of documents and corresponding interviewees.

To gain a better overview of the field, the selection process drew on an initial screening phase. It involved quick document reviews and first consultations of the 'BwN community' (RWS, NIOZ, Van Oord, BwN Facebook-group). Further, the German partners of the upcoming BwN Interreg-programme were contacted (CWSS, NLWKN, LKN-SH, Hamburg Senate Office). The screening resulted in a pre-selection of eligible cases. The final choice then followed the specific research purpose and with hindsight to the limited resources for this research.

Data collection and analysis

The combination of different data collection methods enhances data credibility and broadens the understanding of the case (Bryman, 2003). Hence, two complementary methods were chosen: document study and semi-structured interviews.

The data gathering started with a quick case preparation, using sources such as project websites and reports. Subsequently, contact was established with the two leading authorities 'Hamburg Port Authority' (HPA) and the Municipality of Delfzijl. The responsible project managers were identified and contacted as first interviewees. To ensure broad data coverage, including critics and 'hidden' information, all interviewees were asked to name the actors and documents they assume important for the project. This 'snowball approach' (Atkinson and Flint, 2001) helped to identify the participants and documents that were finally interviewed and analysed, respectively.

Interviews and documents were subsequently coded with MAXQDA. For Q2, a deductive code-tree was derived from the developed BwN framework. For Q3, some inductive codes were added (code tree in Appendix D). This consistent form of coding allowed for the joint analysis of interviews and documents; thus, the collected data is reported as parts of the same 'puzzle' (Baxter and Jack, 2008).

3.2.1 Document study

The study of different document types is a method particularly applicable to qualitative case studies (Bowen, 2009). For this research, documents provided descriptive, or 'formal' information about the projects. Some of the documents were pre-selected during the initial case screenings, while others were identified via the mentioned 'snowball approach'. Table 4 lists all analysed documents. The selection covers for instance official reports, surveys and websites. Nevertheless, to see through the 'bright side' perspective of the project's initiators and advocates, the study aimed to involve critical voices as well. For Hamburg, these were particularly press releases, position papers and websites of nature organizations. For Delfzijl, there was hardly any critical document detectable, apart for some background information on the ecological status of the Eems Dollard.

Documents – Spadenlander Busch (Hamburg)		**Documents – Marconi Buitendijks (Delfzijl**	
Document	**Type (page count)**	**Document**	**Type (page count)**
BUE (2016)	Press release (n.p.)	Bos et al. (2012)	Report (38 p.)
BUND (2009)	Press release (n.p.)	Ecoshape (2016)	Press release (n.p.)
BUND (2010)	Press release (n.p.)	ED2050 (2016)	Report (45 p.)
Freie und Hansestadt Hamburg (2012)	Project approval report (126 p.)	Van Eekelen et al. (2016)	Conf. Proceeding (11 p.)
Gutbrod and Meine (2009)	Conf. Proc. (10 p.)	Dankers et al. (2013)	BwN design study (267 p.)
Hamburg für die Elbe (2015)	Website	DeZwarteHond (2008)	Concept (64 p.)
HPA & WSV (2008)	Concept (39 p.)	Dredging Today (2016)	Press release (n.p.)
HPA (2014)	Press release (n.p.)	Gemeente Delfzijl (2009)	Concept (92 p.)
HPA (2016)	Presentation (19.p)	Gemeente Delfzijl (2015)	Website (n.p.)
IBL Umweltplanung (2010)	Ecol. survey (23 p.)	Gautier et al. (2010)	Report (39 p.)
Knüppel (2012)	Report (13 p.)	De Groot et al. (2012)	Survey (39 p.)
Meine et al. (2012)	Communication concept (10 p.)	Marconi Steering Committee (2012)	Concept (16 p.)
Melchior+Wittpohl (2010)	Survey (85 p.)	Provincie Groningen (2015)	Budget plan (6 p.)
NSG Auenlandschaft Norderelbe (2010)	Directive (7 p.)		
PIANC (2012)	WwN-database (n.p.)		
Rettet die Elbe e.V. (2011)	Position paper (39 p.)		
Rettet die Elbe e.V. (2016)	Press release (n.p.)		
Tideelbe (2015)	Report (175 p.)		
Studio Urbane Landschaften (2009)	Design study (15 p.)		

Table 4: List of analysed documents from both cases.

3.2.2 Semi-structured interviews

Descriptive information from documents alone is insufficient to address actual real-world operations (Bowen, 2009). Hence, semi-structured interviews were conducted to reveal the 'informal' stories behind the cases. 'Semi-structured' refers to a combination of prepared open-end questions and additional spontaneous questions (Fylan, 2005).

The Guideline

The prepared questions are laid down the interview guideline (Appendix C). It was developed on the basis of the document study and the BwN framework (which is presented in section 4). The guideline comprises four parts:

1. Introduction of the research (objectives etc.), and of the interviewee (background, role, etc.)
2. The project background (goals, organization, etc.)
3. Involvement of the BwN concept (intended role, opportunities and problems, etc.)
4. Closure (including the 'snowball-approach')

The guideline's content is linked to Q2 and Q3. It became slightly sophisticated during the empirical process. Due to the different roles and backgrounds of the interviewees, not all of the prepared questions could be addressed in each interview.

The interviews – preparation, realization and follow-up

The selection of interviewees followed the initial case screening and the previously introduced 'snowball approach'. Table 5 lists the interviewees. The aim was to cover both the initiators and the critics of the projects. Nevertheless, the number of interviewees was strongly limited by the objective of this thesis, which seeks for insights about the role of BwN; therefore the interviewees must have been directly involved in the adoption and implementation of BwN. That was mainly the HPA in Hamburg, and the municipality of Delfzijl for the Marconi Buitendijks project.

After appointments were made, the interviewees received a preparatory note via E-Mail, which included a short introduction of the thesis as well as ethical issues (Appendix B). The interviews were conducted face-to-face following the prepared guideline. They have been recorded and were transcribed afterwards (Appendix F).

Interviewees – Spadenlander Busch (Hamburg)			
Interviewee *(acronym)*	**Organisation**	**Organization's role in the project**	**Date *(type)***
Project manager *(HPA manager)*	Hamburg Port Authority (HPA)	Initiator and sole responsibility for project planning and implementation.	08-12-2016 *(face-to-face)*
Nature conservation specialist *(BUE specialist)*	Authority for the Environment and Energy (BUE)	Involved in conservation issues during project planning.	08-12-2016 *(face-to-face)*
Water conservation specialist *(NABU specialist)*	Naturschutzbund (NABU) Hamburg	Local environmental association that was consulted during approval.	08-12-2016 *(face-to-face)*
Interviewees – Marconi Buitendijks (Delfzijl)			
Interviewee *(acronym)*	**Organisation**	**Organization's role in the project**	**Date**
Marconi project manager *(Marconi manager)*	Municipality of Delfzijl	Initiator of the project and founder of the steering committee.	05-12-2016 *(face-to-face)*
Nature conservation advisor *(Conservation advisor)*	Het Groninger Landschap	Regional environmental association, advising role and site management after completion (presumably).	07-12-2016 *(face-to-face)*

Table 5: List of interviewees from both cases.

MARCONI BUITENDIJKS

↑ View along the ‚Schermdijk' jetty, where the saltmarshes will be located.

↓ Dike relocation works for the beach enlargement as part of Marconi.

Photos: M. Martens, 2016

4 Results

One problem for doing research on BwN is the lack of a coherent and differentiated conceptualization of the approach. Thus, the empirical part of this thesis starts with the assembly of a conceptual BwN framework (4.1). The second part consists of the two case studies (4.2) in which the framework is applied to practice (4.3). Each part is followed by a short discussion (4.1.4 & 4.3.6).

4.1 A conceptual BwN framework

The findings from the concept analysis and the subsequent literature research assemble the threefold structure of the framework: the SES-, evolutionary resilience- and EE dimension (Table 6). Each dimension involves one or more key goals, which relate to twelve interlinked principles. Within the text, colour codes are used to highlight these linkages: ***Purple*** *(*principles of the SES dimension), ***Red*** (principles of the evolutionary resilience dimension), and ***Cyan*** (principles of the EE dimension). All principles are outlined and discussed in the next three sections.

BwN Framework			
SOCIAL-ECOLOGICAL SYSTEM DIMENSION (section 4.1.1)			
Goals	**Principles**	**Key literature**	**Synopsis**
Incorporating complexity	**Integration of sectors/disciplines**	Zaucha et al., 2016 Jänicke and Jörgens, 2004	*Cross-sectoral and -disciplinary coordination of problem analysis and response strategies.*
	Participation	Arnstein, 1969 Oen et al., 2016	*Redistribution of decision-making power to the public in authentic project coalitions.*
Incorporating uncertainty	**Generation of shared knowledge**	Pahl-Wostl et al., 2010 Halliday and Glaser, 2011	*Harmonization of knowledge frames and generation of a shared system understanding.*
	Long-term focus	Hughes et al., 2013 Walker and Salt, 2006	*Far-sighted project evaluation and consideration of slow system changes.*
EVOLUTIONARY RESILIENCE DIMENSION (section 4.1.1)			
Goals	**Principles**	**Key literature**	**Synopsis**
Enhancing Robustness	**Resistance**	Galderisi et al., 2010 Restemeyer et al., 2015	*Build capacities to resist or absorb threats.*
Enhancing Adaptability	**Diversity and redundancy**	Biggs et al., 2012 Stirling, 2007	*Built capacities to transfer or substitute system functions and to maintain responsiveness.*
	Self-organization and feedbacks	Walker and Salt, 2006 Biggs et al., 2012	*Strengthening processes of self-organization through the careful management of feedbacks.*
	Social learning	Cundill a. Fabricius, 2009 Pahl-Wostl et al., 2006	*Collective adjustment or improvement of system understanding and problem framing.*
Enhancing Transformability	**Room for innovation**	Holling, 2001 Olsson et al., 2014	*Generation and implementation of novelty when system conditions become untenable.*
ECOLOGICAL ENGINEERING DIMENSION (section 4.1.3)			
Goals	**Principles**	**Key literature**	**Synopsis**
Integration of nature	**Ecosystem-service approach**	Biggs et al., 2012 Barbier et al., 2010	*Equal valuation and balanced implementation of societal and natural development.*
	Proactive creation and utilization	Perki et al., 2015 Borsje et al., 2011	*Making use of natural processes or materials for the creation of self-sustaining structures.*
	Ecological memory	Bengtsson et al., 2003 Sterk et al., 2016	*Nurturing natural heterogeneity and connectivity within the wider landscape.*

Table 6: The BwN framework is divided in three lenses, their main goals and related principles. Key literature is listed for each principle together with a brief synopsis.

4.1.1 The SES Dimension

The previously described characteristics of SES (2.1.3) confront water managers with high levels of complexity and a spectrum of uncertainties arising thereof (Pahl-Wostl et al., 2007, Walker, 2002). Many of the conventional approaches turned out to be *"hopelessly impotent"* (Duit et al., 2010, p.367) in coping with, for instance, long-term thresholds (Hughes et al., 2013), cross-scale feedbacks (Barbier et al., 2010), or unexpected social opposition (Van Slobbe and Lulofs, 2011). Various water projects that have been delayed, cancelled, or simply failed due to their unforeseen development support this observation (e.g. Mink et al., 2007, Van Hooydonk, 2006, Van Vuren et al., 2015). Hence, BwN accounts for the inherent levels of complexity and uncertainty within projects, rather than ignoring it. The framework comprises four related principle for this dimension.

Integration of sectors and disciplines

The attempt to dissect, control, or even eliminate complexity has largely failed (Pahl-Wostl et al., 2007, Duit et al., 2010). Complexity should be understood as non-reducible system component instead (Berkes and Folke, 1998, Ostrom, 2009). Persistent water problems often concern several sectors, like agriculture or tourism, and relate to different disciplines, such as climatology and ecology; effective problem analysis requires the integration of these disciplines and sectors (Jänicke and Jörgens, 2004). Zaucha et al. (2016) suggest 'boundary-spanning activities' as starting point for such an integrated approach. These activities refer to the generation of 'boundary objects', like reports or experiments. These provide a *"framework that allows different groups to work together without necessarily achieving consensus."* (p.692). Integration is in mutual dependence with the ***generation of shared knowledge*** and an important pre-condition for most of the other framework principles.

Participation

Participation refers to the engagement of stakeholders (including citizens) in different stages of decision-making processes (Biggs et al., 2012). It is a basic democratic right that safeguards the inclusion of social values or preferences in project planning and management (Rydin and Pennington, 2000). Hence, participation is relevant for the legitimacy of any management activity (Oen et al., 2016, Innes, 2007). Besides that, it can improve plans or projects by widening the scope of problem detection, its understanding and potential solutions (Biggs et al., 2012). Innes and Booher (2004) note:

> *"[...] that when the conditions for authentic dialogue are met, genuine learning takes place; trust and social capital[d] can be built; the quality, understanding and acceptance of information can be increased; jointly developed objectives and solutions with joint gain can emerge, and innovative approaches to seemingly intractable problems can be developed." (p.429)*

The kind of participation is thereby essential for its outcomes. Arnstein (1969) noted how *"participation without redistribution of power is an empty and frustrating process for the powerless"* (p.216). Accordingly, her 'Ladder of Citizen Participation' distinguishes eight degrees of actor interaction in relation to their decision-making power (Figure 14). 'Real' participation in this concept always comprises some power for the participating parties. Accordingly, managers should assure that decision-making power is shared among the concerned parties (Oen et al., 2016, de Vriend et al., 2015). Because participation is a complex and resource-intensive process, it requires tailored procedures, agreed rules, and ***shared knowledge*** about the system to be managed (Zaucha et al., 2016, Innes and Booher, 2004). The purposes, limitations and expected outcomes of every participatory process should be well communicated in advance. This can avoid ambiguity among the actors or dissatisfaction about the outcomes (Few et al., 2007).

[d] Social capital refers to the structure of relationships between actors that encourages productive and collective action. Important components are trust, rules and sanctions, networks and leadership (Walker and Salt, 2006).

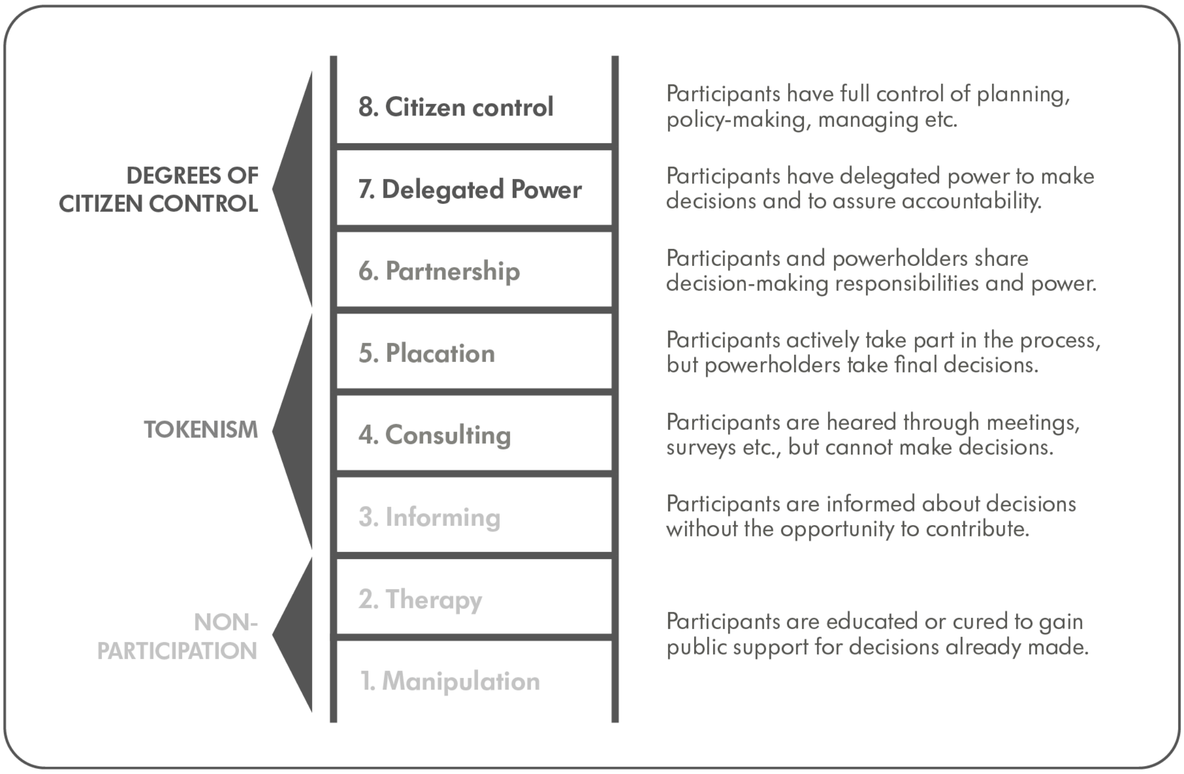

Figure 14: The ladder of citizen participation. Eight degrees are distinguished, whereas only the last three are seen as real participation (adapted from Arnstein, 1969).

Generation of shared knowledge

Including social aspects into water management means to consider a variety of different 'knowledge frames' (Halliday and Glaser, 2011). These constitute the selective framing processes that emerge from individual or collective backgrounds, perspectives and belief systems (Pahl-Wostl et al., 2010). Hence, people not necessarily mean the same, although they use the same words, and they might draw different, but in itself valid conclusions from the very same information. This also implies that the understanding of a system or problem can significantly differ within a project coalition (Halliday and Glaser, 2011, Ostrom, 2009). The ways in which actors collect information and process them into knowledge should be harmonized for that reason. Merging various, in itself restricted knowledge frames, is assumed to reduce individual biases (Pahl-Wostl et al., 2010), to generate a better system understanding (Zaucha et al., 2016), and to foster *"more grounded and pragmatic approaches to environment and development."* (Fabinyi et al., 2014). This particularly requires a common language among stakeholders. The generation of shared knowledge should therefore start with an open discussion about present values, perceptions and understandings (Zaucha et al., 2016). This ambition is tightly entangled with ***integration*** as well as with ***participation*** (Fabinyi et al., 2014).

Long-term focus

Some (sub-)systems of SES exhibit thresholds or tipping points that respond to rather slow, gradual or cumulative changes in their key drivers. Subsequent system shifts, even critical ones, can unfold likewise gentle (Hughes et al., 2013). The slow but steady retreat of glaciers for example followed gradual global warming. Although it will take decades, their loss constitutes an inevitable global crisis. More local phenomena are species invasion or coastal retreat. These slow system 'drifts' tend to be overlooked or ignored by focussing on rapid changes and their short-term consequences (Van Slobbe et al., 2013, Hughes et al., 2013). Because even small-scale crisis have the potential to spread or upscale, as for instance described by Lorenz' 'butterfly effect' (1963), these drifts pose a strongly underestimated threat to SES (Walker and Salt, 2006). A long-term focus in system analysis and decision-making is therefore essential for the identification and understanding of drift phenomena, their drivers, and potential future effects (Hughes et al., 2013, Walker, 2002). Thresholds and tipping points should be explicitly addressed in decision-making, and long-term strategies should prevail over emergency responses (Davoudi, 2012, Walker and Salt, 2006). Continual monitoring programs and experimental testing of future scenarios, as elements of ***social learning***, are supportive measures in this respect (Allen et al., 2014, Cundill and Fabricius, 2009, Johnson, 1999).

4.1.2 The Evolutionary Resilience Dimension

Managing system resilience (2.1.4) in the face of high uncertainty is a completely different endeavour than simply improving present system conditions (Walker et al., 2006). Small-scale disturbances for example can upscale to major crisis, while large-scale interventions do not necessarily result in major effects – if any (Davoudi, 2012). Moreover, the non-linear behaviour of systems makes future predictions through the interpolation of past events unfeasible (Duit et al., 2010). Water management must therefore abandon the traditional attempt of optimizing and protecting the 'existing'; instead, it should maintain capacities to properly deal with, or even anticipate change (Johnson, 1999). Disturbances and change should be taken as an opportunity for adjustments, innovation and development, rather than as fully avertable threat (Pahl-Wostl, 2015, Adger et al., 2005, Folke, 2006). Correspondingly, BwN aspires to enhance the system's robustness, adaptability and transformability.

Resistance

SES should be able to resist or absorb a certain level of pressure or disturbance without suffering major functional damages (Restemeyer et al., 2015). The capacity for resistance arises from strength and rigidity in the built environment, in social institutions, and in ecological structures, or from their ability to 'bounce back'. The latter relates to buffer capacities. Resistance is highly dependent from ***diversity and redundancy***, for example in technical systems, as it allows to spread the impact of a disturbance (Galderisi et al., 2010, Walker et al., 2004). Resistance in social systems can be described by the degree of institutionalization, for instance of procedures (Olsen, 2009, Westley et al., 2013). Resistance should be designed at appropriate scale and with a ***long-term focus*** (Pahl-Wostl et al., 2007). Too high levels may frustrate the possibility for quick decisions, adaptions or transformations in the face of unexpected events (Galderisi et al., 2010). Duit and Galaz (2008) point at the dilemma of 'institutional stability vs. flexibility' here. Thus, resistance should be carefully balanced with, particularly, ***room for innovation***.

Diversity and redundancy

Persistent problems assemble a multitude of issues; effective and tailored responses require an at least likewise broad 'arsenal' of options (*diversity hypothesis*, Duit et al., 2010). These emerge from diversity and redundancy (Gupta et al., 2010, Zaucha et al., 2016, Adger et al., 2005). Stirling (2007) depicts diversity as a function of variety (how many different elements), balance (how much of each element type) and disparity (how much do they differ). This understanding applies for instance to biodiversity, spatial heterogeneity, and governance networks. Diversity allows for the transfer of functions as adjustment to change or disturbance (Biggs et al., 2012, Galderisi et al., 2010). High biodiversity for example enables ecosystems to sustain their functionality even when some species get lost (Bengtsson et al., 2003). Unlike diversity, redundancy refers to the substitutability of functions through replications; it provides a 'functional insurance' to compensate for losses or failure. Examples are technical backups or repetitive habitat patches (Walker and Salt, 2006, Duit et al., 2010). Diversity and redundancy should be promoted and sustained in all their social-economic and ecological forms (Olsson et al., 2014, Whaley and Weatherhead, 2016). However, Biggs et al. (2012) stress how high levels might also lead to stagnation, for instance when decision-making suffers from a too diverse spectrum of interests. Hence, diversity and redundancy should be carefully balanced between system fragility (low levels) and stagnation (high levels). Diversity and redundancy are a pre-condition for ***self-organization***; self-organizing processes, in return, are the basis for response diversity and functional redundancy.

Self-organization and feedbacks

Self-organization describes the generation of systemic order through local interactions and without any central coordination[e]. It emerges from spontaneous or random behaviour of local system units, which trigger amplifying or stabilizing feedbacks from other parts. This leads to a constant and dynamic process of mutual adjustments (Resilience Alliance, 2010, Duit and Galaz, 2008). In practice, self-organization enables for instance markets to react to the global economy, or plants to recolonize disturbed areas. It is also the reason why salt marshes retreat when humans alter the natural feedbacks along the coast, for instance by cutting of sediment supply. Accordingly, managers should aim to strengthen beneficial feedbacks, while minimizing negative ones. For ecosystems, this often means to avoid or to reduce human interferences and to restore natural dynamics (Biggs et al., 2012, Galderisi et al., 2010). In doing so, one should carefully balance between tight feedbacks on the one hand, and a certain degree of modularity on the other. The latter refers to semi-isolated subunits, such as protected natural sites or locally organized actor networks. Modularity accounts for the fact that 'over-connected' systems transmit shocks or disturbances rather rapidly (Walker and Salt, 2006). Dealing with feedbacks, particularly with unintended or rarely understood ones, is a challenging task though. The ability to detect, understand and influence systemic feedbacks requires a ***long-term focus***, ***shared knowledge*** and ***integration***, and above all, ***social learning*** (Larrosa et al., 2016, Walker et al., 2004).

Social learning

Repetitive cycles of social action, reflection, and adjustments facilitate social learning (Berkes et al., 2003, Cundill and Fabricius, 2009). It means to constantly revise the collective understanding of human-nature interactions by modifying existing or gathering new knowledge (Gunderson and Holling, 2002). Social learning arises from social interactions, either intentionally or unnoticed. Hence, it bases on ***participation, integration***, and ***shared knowledge*** (Biggs et al., 2012, Pahl-Wostl et al., 2010). As learning enables adjustments to, or the preparation for change and disturbance, it is essential to navigate SES into more sustainable trajectories (Whaley and Weatherhead, 2016, Pahl-Wostl, 2006, Olsson et al., 2004).

Learning comprises several complementary categories (Gupta et al., 2010). Technical or 'single-loop learning' refers to the improvement of existing skills or routines on the basis of new information (Williams and Brown, 2016). When the basic assumptions that underlie these routines are questioned, for instance the understanding of a problem, one speaks about institutional or 'double-loop learning' (Figure 15). In this regard, learning also provides ***room for innovation*** (Gupta et al., 2010, Gunderson et al., 2006). Two important elements of learning are monitoring and experimentation (Biggs et al., 2012, Cumming, 2011). Monitoring is the practical mean for constant reflection on what has been 'learned', and on the process of learning itself (Figure 15); it entails a repetitive cycle of data collection and evaluation, for instance to assess a project's performance (Cundill and Fabricius, 2009). Experiments are the means to test model predictions or lab results under real-life conditions. They help to identify tipping-points, to enhance scenarios, or to improve management strategies in a controlled way of 'learning-by-doing' (Johnson, 1999, Allen et al., 2014). In practice, monitoring and experiments frequently suffer from budgetary and organizational issues, as well as from conflicting interests. These constraints should be cleared out in advance (Cumming, 2011, Walters, 1997).

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[e] It should be noted that self-organization is an autonomous process in its ecological sense, but subject to intentionality when applied to social domains (Davoudi, 2012). Here, the literature distincts between 'community self-organization' (e.g. Olsson et al., 2004), 'self-governance' (e.g. Pahl-Wostl et al., 2015), or 'self-reliance' (e.g. Davoudi, 2012). This section constitutes a strong simplification of 'self-organization' therefore.

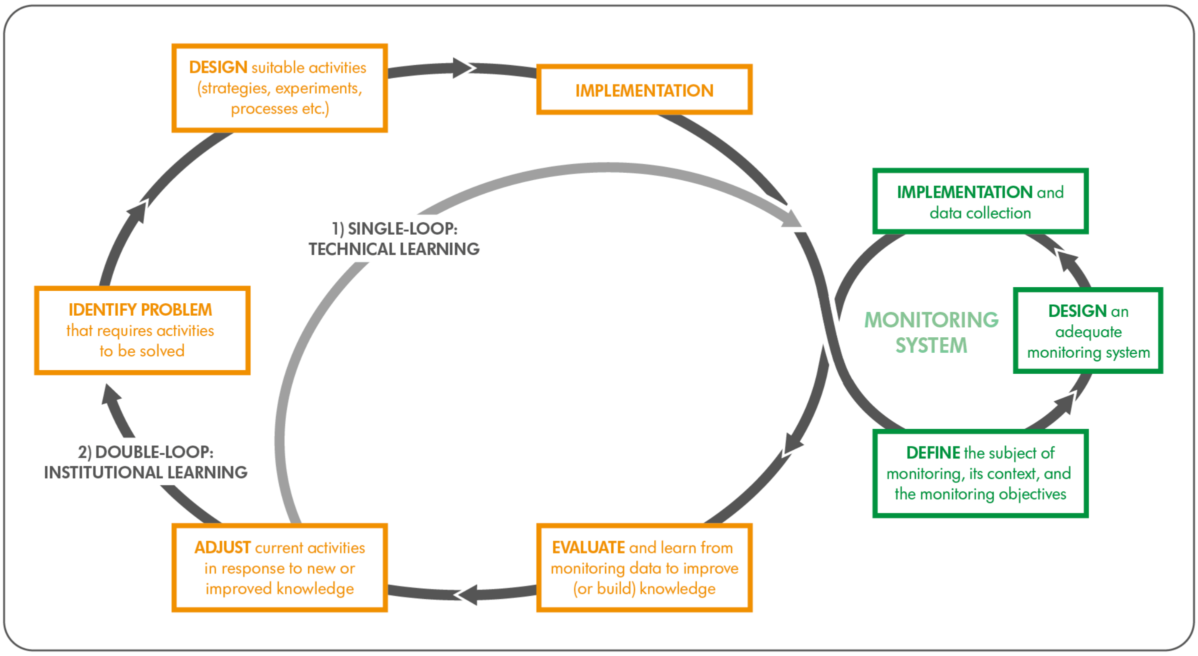

Figure 15: Social learning as iterative cycles. At first, responses to identified problems become designed and implemented. A tailored monitoring system checks their performance. The monitoring data is evaluated and used to 1) constantly improve the existing activities ('technical learning' as nested cycle), or to 2) reframe the initial problem and consequently, rework the responses ('institutional learning'). Typically several iterations of the single-loop cycle are periodically followed by a complete institutional restart, the double-loop cycle (modified after Williams and Brown, 2016, Cundill and Fabricius, 2009).

Room for innovation

Shifts into undesirable system states can create uncertainty, confusion and crisis, but also room for novelty and innovation. These are the means to fundamentally reconfigure a system (Berkes et al., 2003, Walker et al., 2004). The term novelty describes the occurrence of new things, processes or structures. Examples are technical inventions or the immigration of neobiota (Allen et al., 2014). Innovations mark the deliberate implementation of novelty with extensive and long-lasting effects on a greater system (Man, 2001). Innovations often rely on 'windows of opportunity', such as a political crisis or a disastrous events, *"when uncertainty is great, potential is high, and controls are weak [...]"* (Holling, 2001, p.396). After being tested and gaining support, innovations eventually consolidate over time. They can sit in technologies, governance models, species distribution, and virtually every other aspect of SES (Olsson et al., 2014). Hence, in case undesirable developments become apparent, experimental space (***social learning***) and 'windows of opportunity' should be provided or created, respectively (Walker et al., 2004, Walker and Salt, 2006). The number of suitable 'access points' for innovations should be increases by nurturing ***diversity and redundancy*** within governance- or management-systems. ***Participation*** as well as ***integration*** can broaden the spectrum of potential supporters (Westley et al., 2013, Huitema and Meijerink, 2010b). Various contributions underscore the key role of 'innovation leaders' in this context, meaning individuals or organizations with the abilities and willingness to initiate and lead innovations; these should be assisted and supported (Walker and Salt, 2006, Loorbach, 2010, Olsson et al., 2014).

4.1.3 The Ecological Engineering Dimension

Ecological engineering (2.2.2) is assumed to generate more sustainable management strategies than traditional approaches. Rather than working against nature, EE involves the natural system in various forms. The aim is to overcome engineering-only practices and to utilize self-sustaining and highly responsive ecosystems for the creation of multi-functional infrastructures (Borsje et al., 2011, Perkins et al., 2015). However, EE faces some practical hurdles; the proper evaluation of nature-inclusive designs, a conceptual gap between engineers and ecologists, and little respect for natural processes on landscape level (Cheong et al., 2013). The BwN framework therefore involves three corresponding principles in the Ecological engineering-dimension.

Ecosystem-service (ES) approach

Sustainable water management builds on a balance between socio-economic and natural development. This requires the evaluation and comparison of strategies and measures. However, nature-inclusive designs and social-ecological interactions are difficult to quantify (Cheong et al., 2013). Traditional cost-benefit analysis with its focus on short-term outcomes and structural effectiveness seems inappropriate here (Van den Hoek et al., 2012). Several contributions therefore suggest ES as 'currency' for their valuation (e.g. Costanza et al., 2014, Pinto and Marques, 2015, Granek et al., 2010). This ES-approach assesses the impacts of human action on ecosystem functioning, and the corresponding feedbacks back on human wellbeing (Figure 16). Hence, it shows the 'price' of ecological degradation, while highlighting the social-economic benefits of healthy ecosystems (Barbier et al., 2010).

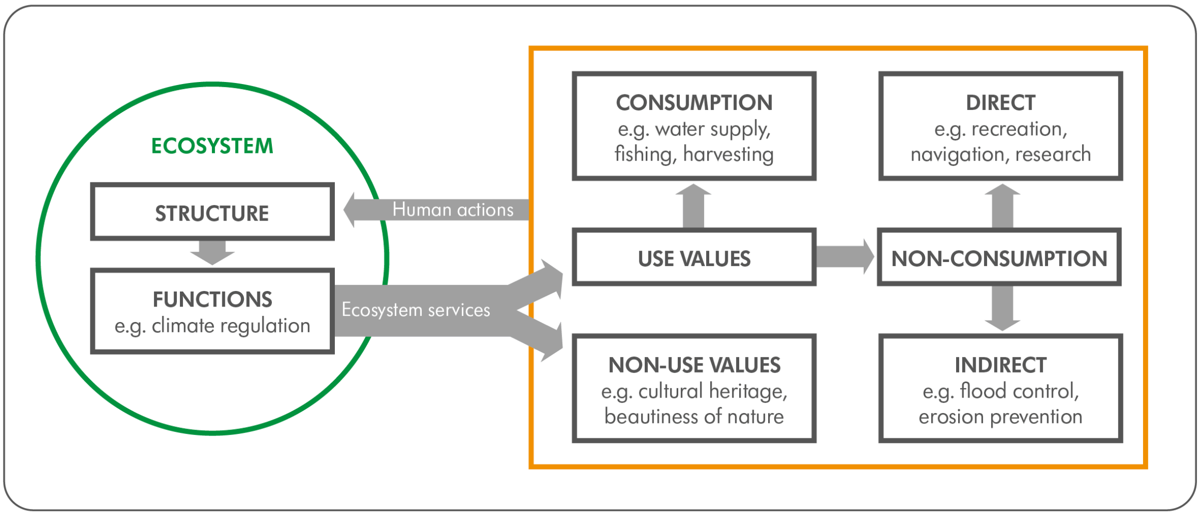

Figure 16: Basic valuation scheme for ES (adapted from National Research Council, 2005, modified after Barbier et al., 2010).

However, ES valuation stays a challenging task. Proper assessment is often limited by gaps in the understanding of ecosystem functioning (Biggs et al., 2012) or restricted predictability of their behaviour (Barbier et al., 2010). Moreover, the relationship between many ES remains unclear. Another concern relates to the expression of ES in monetary terms. This 'economic approach' tends to underestimate or oversee rather abstract ES, as well as potential long-term effects (Pinto and Marques, 2015). Nonetheless, valuation is critical to document the benefits of nature-inclusive solutions and to justify their implementation (Cheong et al., 2013). ES valuation should therefore build on holistic approaches with a ***long-term focus***. These should account for monetary as well as non-monetary values and rely on ***integration***, ***participation***, ***shared knowledge***, and ***social learning*** (Granek et al., 2010, Barbier et al., 2010, Hutchison et al., 2013, Biggs et al., 2012).

Proactive creation and utilization

Most current EE projects involve ecological restoration (Vikolainen, 2012, Temmerman et al., 2013). It means to actively restore ecosystems that were historically present at a certain location, or to allow for their passive recovery. Though, defining adequate historic conditions is challenging, and it remains questionable whether they can be achieved at all (Uprety et al., 2012, Elliott et al., 2007, Benayas et al., 2009). Hence, many claim that ecosystems should be created or enhanced also without historic references, but in the most beneficial way regarding present conditions; this implies that existing ecosystems are not necessarily conserved, but may be enhanced or even replaced by others (e.g. Mossman et al., 2012, Mitsch, 2014, Cooke, 2005). Oyster reefs for instance can serve coastal protection and fishery also in regions, where oysters have not been native before (Temmerman et al., 2013, Borsje et al., 2011). By combining conventional restoration with this approach of purposeful creation, nature can be effectively utilized by managers (Figure 17). The use of 'soft engineering'[f] produces no- or low-regret interventions, which are particularly useful with hindsight to the uncertain progress of climate change and sea-level rise (Perkins et al., 2015, Cheong et al., 2013).

Nevertheless, designing and utilizing natural systems relies on sound system understanding and the careful translation into practice, which remains a challenge (Van Slobbe et al., 2013). Hence, engineers should become more open for experimentation and adaptive solutions, while ecologist should abandon their strict focus on conservation and restoration (Mitsch, 2014, Cheong et al., 2013). Their practices should converge into a 'nature-inclusive' approach, drawing on ***integration***, ***shared knowledge***, and ***social learning***. Designs should be based on the ***ES-approach*** and must consider ***ecological memory*** (Temmerman et al., 2013). Corresponding projects contribute to ***resistance*** and create room for both ***innovation*** and ***self-organization***. The high degree of uncertainty related to the inclusion of natural dynamics requires a ***long-term focus*** though (Elliott et al., 2007).

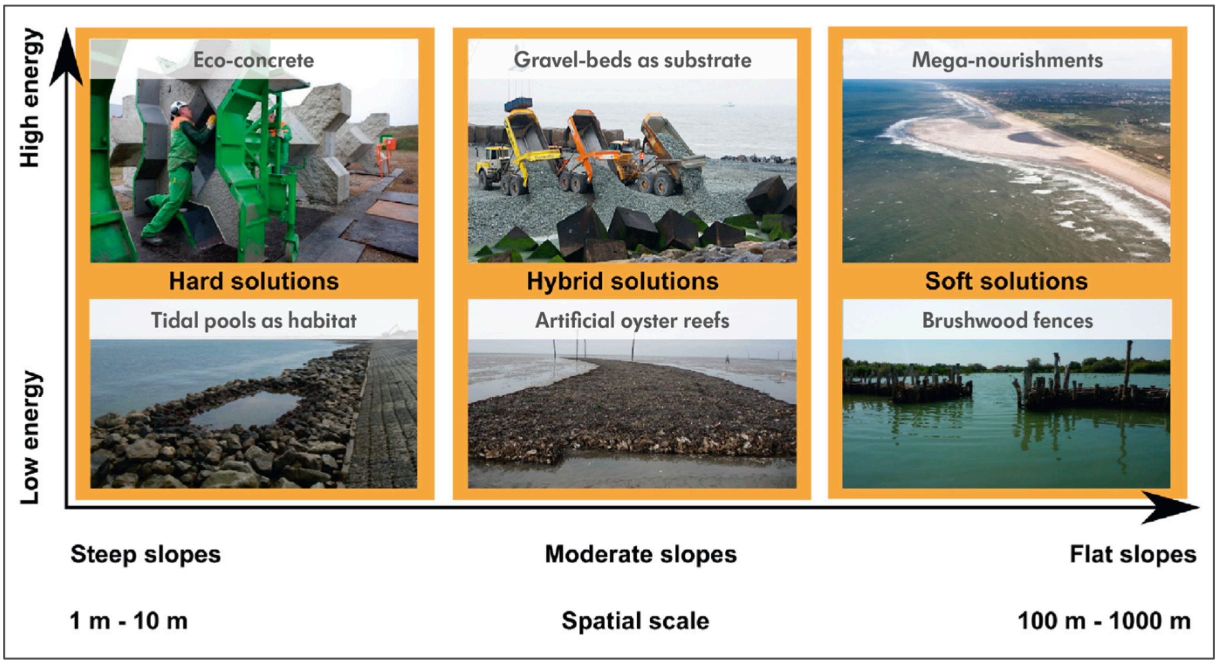

Figure 17: Examples of nature-inclusive designs in coastal protection. Determining key parameters are coastal slope and hydrodynamic energy (modified after de Vriend et al., 2015).

[f] Soft engineering has similar goals to massive 'hard engineering' structures, such as sea-walls, but draws on more nature-like and multi-functional structures for that purpose (Perkins et al., 2015).

Ecological memory

The composition of species, interactions and structures within an ecosystem is shaped by its ecological memory (Bengtsson et al., 2003). Ecological memory comprises an internal and an external component. The internal one enables the reorganization of disturbed areas on the basis of biological and geographical legacies, such as seeds or accumulated nutrients (Sterk et al., 2016). The external memory refers to the capacities for re-colonisation from the surroundings (Bengtsson et al., 2003). This capacity depends on the biological conditions within the adjacent areas, as well as on their proximity and connectivity to the disturbed one (Cumming, 2011). To utilize or maintain much of an area's memory, managers should think in larger spatial and temporal scales. Natural areas should be perceived as interacting parts within dynamic and evolving landscapes (Allen et al., 2014). Hence, managers should replace their 'site-focus' and related practices of "*ad-hoc gardening*" (Simenstad et al., 2006, p.37) by a 'landscape approach' with a ***long-term focus*** (Sterk et al., 2016). A newly created floodplain area for instance can only prosper, when soil conditions are adequate (internal memory), and adjacent sites provide seedlings (external memory). Thus, ecological memory is an essential factor for the integration of nature into management. This requires ***shared knowledge*** and ***social learning*** (Berkes and Seixas, 2005). Ecological memory thereby arises from, but also facilitates ***diversity***, ***self-organizing processes and feedbacks*** (Allen et al., 2014, Bengtsson et al., 2003).

4.1.4 Discussion

The first objective of this thesis was to assemble a conceptual BwN framework. Therefore an extensive and systematic concept analysis was conducted to get grip on the approach (see also Appendix E). It revealed two noteworthy issues. First, most of the analysed BwN sources repetitively refer to 'elastic buzzwords' (Davoudi, 2012). The understanding of 'sustainability' is never clarified for instance, although it is the ultimate goal of BwN (De Vriend, 2014). The same applies to 'public participation' and 'stakeholder involvement'; while these principles are constantly stressed within the literature, the pitfalls in creating such engagement remain largely unrecognized. These conceptual weaknesses led to visible shortcomings in practice. Van den Hoek et al. (2014) for example conclude that most of the recent BwN projects stick to 'information' or 'consultation' strategies, hence the lowest forms of participation (*sensu* Arnstein, 1969). Altogether, the analysis suggests that BwN is no exception in the *"uncritical acceptance of terms and concepts that are often unhinged from their philosophical or disciplinary lineages and used in slippery ways."* (Porter and Davoudi, 2012, p.329).

The concept analysis also revealed that a strong engineering perspective dominates the BwN literature. This seems logical, considering that Ecoshape roots in the field of hydraulic engineering (compare Table 2). Hence, despite its interdisciplinary and holistic aspiration, BwN tends to fall back to what Bagheri and Hjorth (2006) denote as *"cornerstones of modern science"* (p.144). The approach is for instance frequently associated with the 'correct interpretation' of ecosystems and 'optimal design solutions' (de Vriend et al., 2015). Lulofs and Smit (2012) add to this line of though by writing *"that dynamics in eco-systems are controllable and amendable [...]"* (p.16). This engineering bias is symptomatic for many of the studied sources. Accordingly, De Vriend (2014) concludes that BwN in its current understanding has a blind eye for non-technical hurdles and pitfalls. In addition to that, the reviewed BwN case studies suggest that economic goals remain the key drivers behind many BwN designs. This goes at the expense of ecological or societal targets and weakens the ambitions of SD.

With these conceptual shortcomings in mind, the second part of the research entailed the assembly of an ideal-typical BwN framework. Therefore a systematic literature research was performed on the basis of the previous concept analysis. The resulting framework displays BwN as a holistic planning and management approach that combines the SES perspective with resilience-thinking and EE techniques (compare Table 6). Clearly, it covers a multitude of complex issues, which are not fully elaborated here. However, frameworks constitute reasonable simplifications of complex phenomena that otherwise evade a comprehensive understanding (Pickett et al., 2007). Therefore this framework's strength is not its depth of detail, but its holistic, interdisciplinary, and differentiated view on BwN. It covers all elements that seem important to the approach, structures them in a reasonable way, and highlights their relationships. Thus, the framework represents a workable compromise between the need to portray holistic approaches in their entire bandwidth (*sensu* Cumming et al., 2015), while being practicable for case studies with limited time and resources (*sensu* Nemec et al., 2014).

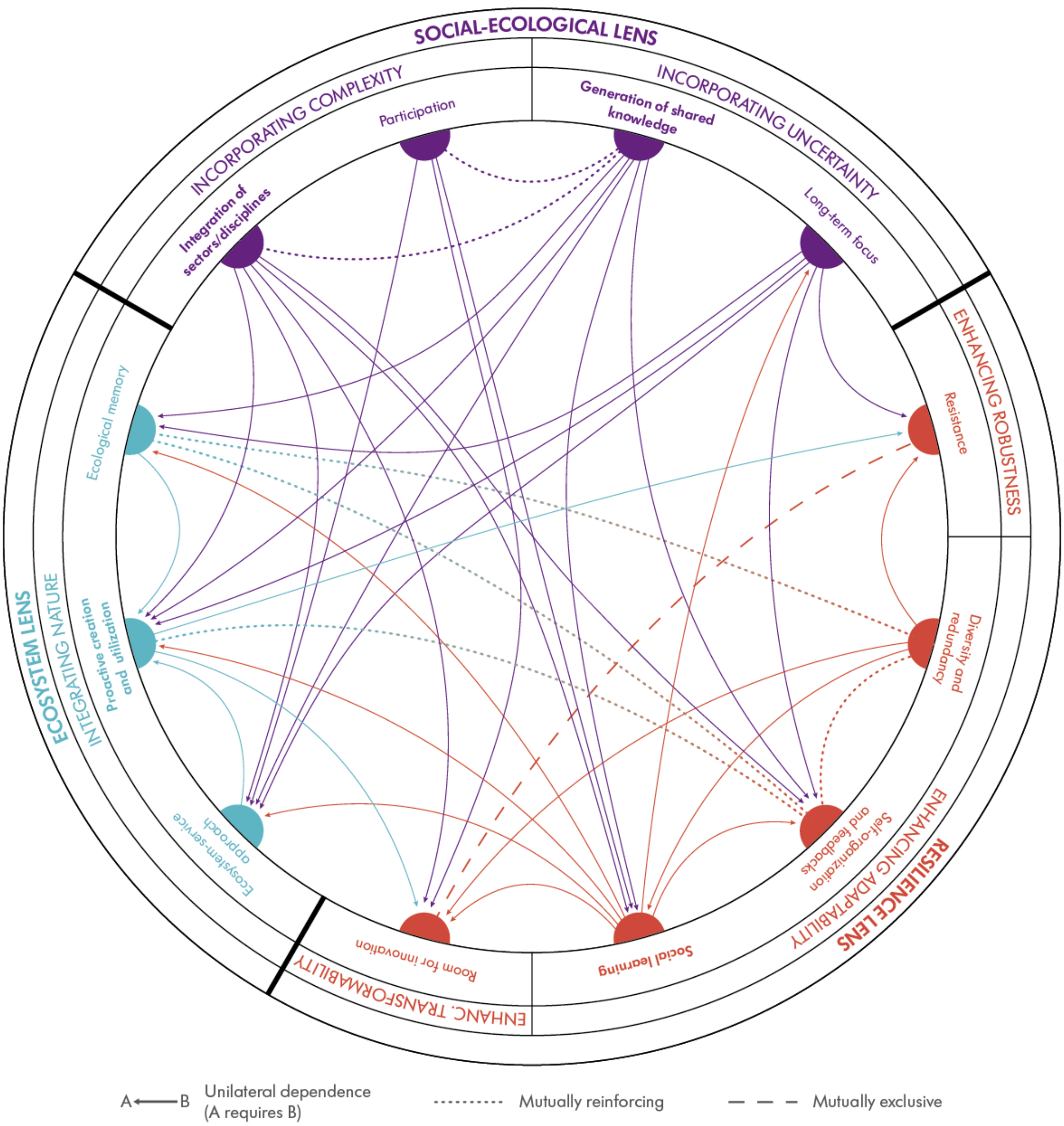

Figure 18: Circular diagram illustrating the connections between the principles of the BwN framework. Most principles rely on others (unilateral dependence). Some are either in a synergetic (mutually reinforcing) or conflicting (mutually exclusive) relationship with each other (own figure).

After assembling the framework, the linkages between the principles (highlighted in the text) were illustrated in a circle diagram (Figure 18). The number of linkages gave an impression which principles are most relevant to BwN:

- **Generation of shared knowledge**
- **Integration of sectors and disciplines**
- **Social learning**
- **Proactive creation and utilization**

Important here is that these four principles reflect the very essential claims of the reviewed SES-, resilience- and EE-literature. They simultaneously fit De Vriend's (2015) brief synopsis of BwN: *"a different way of thinking* (shared knowledge and learning), *acting* (creation and utilization) *and interacting* (integration)." (p.160) Thus, it seems appropriate that projects have to meet these key principles to be conform with BwN. The relevance of the other eight principles might vary though. 'Room for innovation' for example seems less important in small restoration projects, while being imperative to urban resilience projects.

It is worth mentioning that the framework entails a number of normative issues. 'Resilience' for instance entails the questions of resilience for whom, of what to what, and to what ends when applied to the social realm (Walker, 2002). Answers to these questions will be driven by interests and power in any case, wherefore trade-offs seem unavoidable in resilience management (Davoudi, 2012, Carpenter et al., 2001). Another normative challenge is the decision of 'what' should be involved in water management (integration), and 'who' has a say in the process (participation) (Pahl-Wostl et al., 2010). While a limited focus might rule out some relevant aspects, an extended focus implies an exponential increase of complexity with every additional aspect (Cumming, 2011). Hence, the choice about boundaries and scales of analysis should be well-considered, as it is crucial for the legitimacy and effectiveness of any management activity (Few et al., 2007).

4.2 Case introduction

After BwN has been conceptualized in the last section, the remainder of this thesis focuses on the case projects, which are introduced here. A fact sheet (Table 7) summarizes the relevant key facts.

	CASE FACT SHEET	
	Spadenlander Busch	**Marconi Buitendijks**
Location	Hamburg, Germany Upper Elbe estuary	Delfzijl, The Netherlands Outer Eems-Dollard estuary
Main goal *(Co-benefits)*	• Reduction of 'tidal pumping' through the creation of addition tidal volume. • *Creation of a public 'tidal park' for recreation and education.* • *Enhanced ecological quality.*	• Improving spatial quality through the creation of a new waterfront. • *Enhanced touristic attractiveness and re-use of dredged material.* • *Enhanced ecological quality.*
Responsibility	Hamburg Port Authority (HPA)	Municipality of Delfzijl
Status	Under construction since 2012 (- approx. 2019)	Construction starts in late 2017 (- approx. 2019)
Extent	Single site of 47 ha (30 ha water, 17 ha land) as part of an estuary management concept.	Two salt marsh areas (20 and 37 ha), as part of a larger spatial program with other projects in parallel.
Costs	Approx. 63.3 million Euro	Approx. 10 million Euro

Table 7: Fact sheet of the cases Marconi Buitendijks and Spadenlander Busch.

4.2.1 Spadenlander Busch

Background

In 2008, the HPA and the Federal Waterways and Shipping Administration (WSV) developed the 'Elbe River Engineering and Sediment Management Concept' (RESMC). It is a response to the disadvantageous sediment situation in the Elbe estuary, which result from human stream modifications as well as from natural dynamics. A particular problem is the so-called 'tidal-pumping' effect: the incoming high tide became stronger and faster than the ebb flow over the years, which results in a net upstream transport of sediments (HPA and WSV, 2008). Consequently, the dredging necessity in the waterway and the port area significantly increased (Gutbrod and Meine, 2009). The RESMC therefore aims to lower the dredging quantities and related ecological impacts, while safeguarding the accessibility of the port. The Spadenlander Busch project is the first large-scale measure in this context (Knüppel, 2012). It is in line with the 'Working with Nature' (WwN) approach of the PIANC (compare 2.2.3). Constructions have begun with a one-year delay in 2012. The costs are estimated with about 63.3 million Euro (Bürgerschaft der freien und Hansestadt Hamburg, 2014).

Project design

The project covers a site of 47 ha on a former spoil-area for dredging material. Here, about 30 ha of shallow waters are created (Figure 19 and Figure 20). This additional one million m^3 of tidal volume functions like a 'sponge' and will reduce the tidal amplitude by 1-2 centimetres. This is expected to the weaken the tidal pumping (Freie und Hansestadt Hamburg, 2012). Two million m^3 of partly contaminated soil have to be removed therefore. The remaining 17 ha of the site consist of natural floodplain forests, reeds and other valuable wetland habitats. While these areas are restricted, the 'tidal park' concept (Figure 19) contains some publicly accessible park elements as well. The project also serves as test site for comparable measures in the future (Gutbrod and Meine, 2009, Knüppel, 2012).

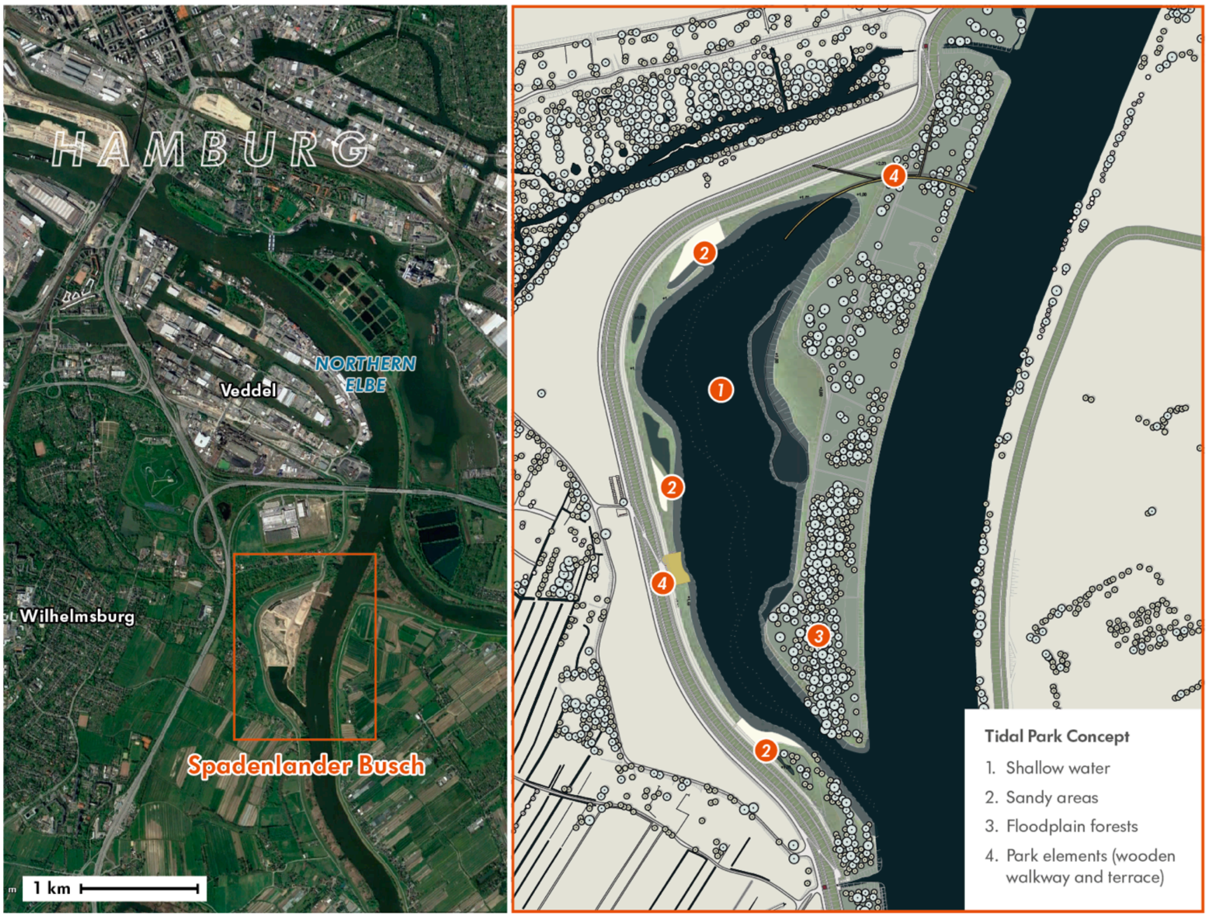

Figure 19: The location of the Spadenlander Busch (left). The aerial photo (adapted from Google Maps) shows the construction site in October 2016. The Tidal Park Concept (right) envisages natural zones and park elements (adapted from Studio Urbane Landschaften, 2009).

Figure 20: Aerial view of the Spadenlander Busch before implementation (above) and visualization of the expected look after completion (below) (Knüppel, 2012).

4.2.2 Marconi Buitendijks

Background

The Marconi programme aims to strengthen the maritime character of Delfzijl through revitalizing the city centre and by reconnecting it to the coast (Gemeente Delfzijl, 2015). It is a response to several socio-spatial problems the city encounters – most notably, a strong population decline, a lack of attractiveness, limited recreational opportunities, and growing flood risks (de Groot and van Duin, 2013). The sub-programme Marconi Buitendijks ('outside the dike') concerns the development of a new waterfront (Figure 21 and Figure 22). This thesis focuses on one of the five related projects: the creation of saltmarshes by Ecoshape (Dankers et al., 2013). Contractors were signed recently and construction is expected to start in 2017 (Dredging Today, 2016). The expected costs sum up to 10 million Euro (Provincie Groningen, 2015).

Figure 21: Aerial photo of Delfzijl showing the locations of the Marconi Buitendijks sub-projects along the waterfront (adapted from Google Earth).

Figure 22: Visualization of the Marconi Buitendijks programme with its sub-projects (adapted from Gemeente Groningen, 2016).

Project design
The project envisages the creation of 57 ha of saltmarshes along the quayside and the harbour jetty, the so-called 'Schermdijk'. The marshes are divided in a publically accessible 'saltmarsh-park' (20 ha), and a non-accessible pioneer saltmarsh zone (37 ha). The area includes a bird-resting island of 4 ha. Dredged material from the port of Delfzijl and the estuary will be used for construction and periodical nourishments (de Groot and van Duin, 2013, Van Eekelen et al., 2016). The marshes are expected to raise the spatial quality along the waterfront, to enhance the ecological value of the area, and to offer a possibility for the 'smart use' of dredged material (Provincie Groningen, 2015). Moreover, Ecoshape will use the pioneer saltmarsh zone for experimentation. The idea is to gain knowledge for the creation or restoration of saltmarshes in the future (Ecoshape, 2016b).

Two other Marconi Buitendijks projects are nearby (Figure 22): the enlargement of the city's beach, which has started recently, and the 'Griesberg', an old offshore soda dump, which will be removed soon. Another project, the creation of a new freshwater outlet with an estuarine gradient, is still in an early planning stage (de Groot and van Duin, 2013, Van Eekelen et al., 2016, De Vriend, 2014).

4.3 Implementation and impact of BwN in the case projects

As outlined earlier, the two case projects were tested against the previously developed BwN framework. The following sections present the findings in a thematic structure. English translations for the German quotes can be found in Appendix A.

4.3.1 Political pressures as catalyst of change – motives for the adoption of BwN

Spadenlander Busch

After the last Elbe channel deepening in 1999, tidal pumping has increased significantly (HPA and WSV, 2008). Dredging quantities grew from an annual average of 2 million m^3 to over 8 million m^3 in 2004 (Gutbrod and Meine, 2009). Since 2005, most of the dredged material had to be dumped offshore in the waters of the federal state of Schleswig-Holstein ('Buoy E3', Figure 23). The state has linked this consent with the obligation to reduce the dredging quantities as soon as possible. Additional pressure on Hamburg arises from European environmental directives[g], which increasingly restrict the dredging and dumping activities and demands for ecological improvements along the estuary (TIDEELBE, 2015). Correspondingly, the responsible authorities HPA (port areas) and WSV (channels) developed the RESMC. Despite its clear economic purpose, the concept acknowledges that:

> *"Lasting action in line with the requirements of European standards requires integrated solutions. Seeking them at local level, as it was done in the past, is no longer possible [...] As a consequence, in a tidal estuary like the Elbe with its diverse uses, demands and special characteristics, new options [...] will have to be implemented on a permanent basis."* (HPA and WSV, 2008, p.2ff):

This recognition of the need for new strategies forced the HPA to promptly implement first measures:

> *"Das war sozusagen auch mit eine gewisse äußere Veranlassung, dass Schleswig-Holstein gesagt hat, tut was. Und dann haben wir gesagt, ok wir tun was. Wir machen den ersten Schritt zur Umsetzung des Konzepts."* (HPA manager)

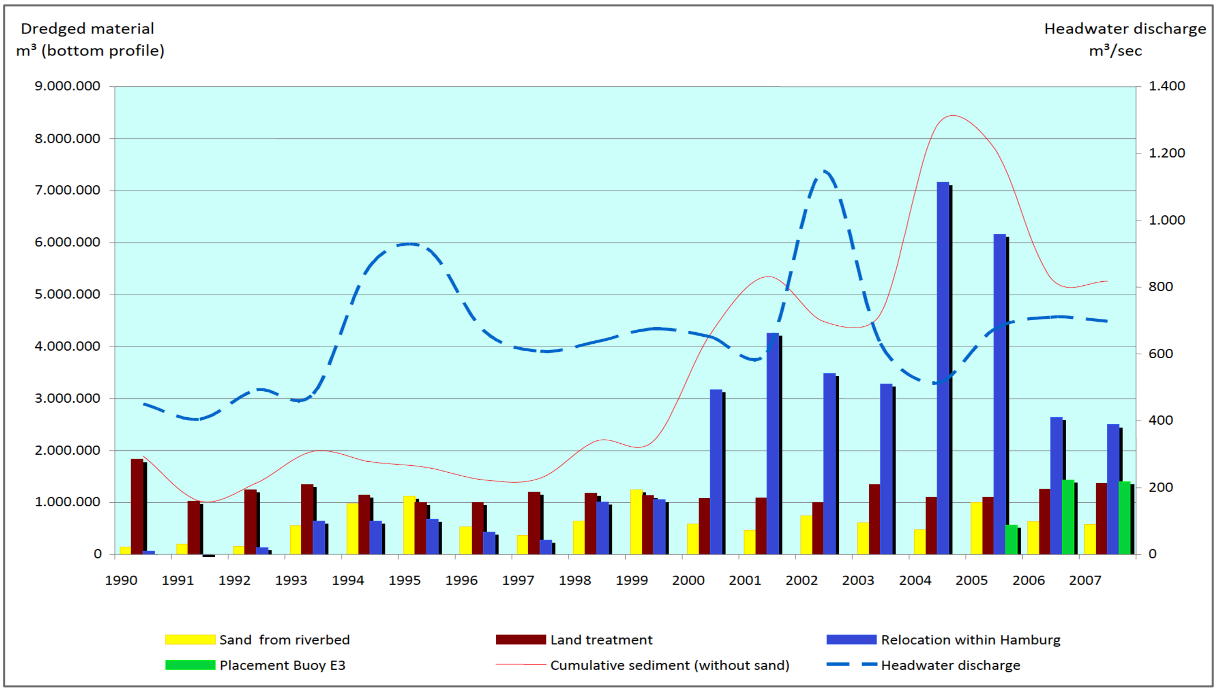

Figure 23: The evolution of dredging quantities by the HPA in the period 1990 - 2007, combined with headwater discharge (HPA and WSV, 2008).

[g] Important in this context are the Water Framework Directive (WFD), the Marine Strategy Framework Directive (MSFD), and the Birds- and Habitat Directive (FFH). The latter forms the European protection network Natura 2000.

The decision fell on the Spadenlander Busch project. It had been proposed in the preliminary 'Tidal Elbe Concept' from 2006 already, and extensive hydrological calculations existed (HPA and WSV, 2008). Moreover, despite its mono-functional purpose, the design provided opportunities for nature conservation and leisure as well (Freie und Hansestadt Hamburg, 2012). A representative of the Environmental authority (BUE) puts it this way:

> *"Eine Fläche die auf den Naturschutz bezogen vollkommen wertlos war, wird durch so eine Maßnahme, die der HPA zur Absenkung des Tidenhubs der Elbe quasi aus strombaulicher Sicht dient, gleichzeitig dem Naturschutz dienlich. Und das muss man sagen, das kommt hier in fast idealer Weise zusammen und kommt eben selten so vor."* (BUE specialist)

Furthermore, the city owned the dedicated 'Kreetsand' area and the main dike was already relocated. These favourable conditions promised a fast implementation without considerable administrative or regulatory problems. Figure 25 shows the project's historic development (TIDEELBE, 2015).

Marconi Buitendijks

Delfzijl suffers from a bad image in terms of attractiveness and liveability. The number of inhabitants is expected to decrease by 31% until 2040 (Dankers et al., 2013). Part of the problem is the city's spatial situation. A comprehensive development vision was missing until now, which resulted in a 'technical patchwork' structure and a lack of 'maritime flair'. Figure 24 gives an impression (Marconi steering committee, 2012). The project manager says:

> *"Hier ist eine ganz kleine Stadt mit einer Stahlwand drum herum, also ganz mit dem Rücken zur Wasserseite gebaut. Wenn man hier ein bisschen rum läuft, hat man überhaupt nicht mehr das Gefühl, dass es eine Hafenstadt ist. Es ist komplett abgeschnitten."* (Marconi manager)

Currently, due to sea-level-rise and land subsidence, Delfzijl must upgrade its flood defences. Heightening the inner-city seawalls would even intensify their spatial barrier effect (Van Eekelen et al., 2016). In 2009, the Marconi programme was initiated to solve these social, spatial and technical challenges. Figure 25 provides an historic overview (Gemeente Delfzijl, 2009). Together with their partners, the municipality developed a 40-year spatial vision – the 'Maritime Zone of Delfzijl' (Gemeente Delfzijl, 2015). It states that *"de sleutel tot verandering ligt in kwaliteitsverbetering van de recreatieve mogelijkheden in het* ***buitendijkse gebied*** *en op de binnenflank van de keringen."* (Marconi steering committee, 2012, p.8) Hence, the development of a new waterfront and its re-connection to the city was given priority; it led to the sub-programme Marconi Buitendijks (Provincie Groningen, 2015). This prioritization also followed the demands of the involved nature organizations to address the ecological problems of the Eems-Dollard estuary (ED2050, 2016, Bos et al., 2012), says the representative of Het Groninger Landschap:

> *"Our organization said, if you want our support than you also have to do something for nature. [...] In the beginning it was more a restructuring process of the city, then it got developed and became also a nature inclusive project."* (Conservation advisor)

Figure 24: Impression of the sea wall in the inner city of Delfzijl and its 'barrier effect' between the city and the waterfront behind (DeZwarteHond, 2008).

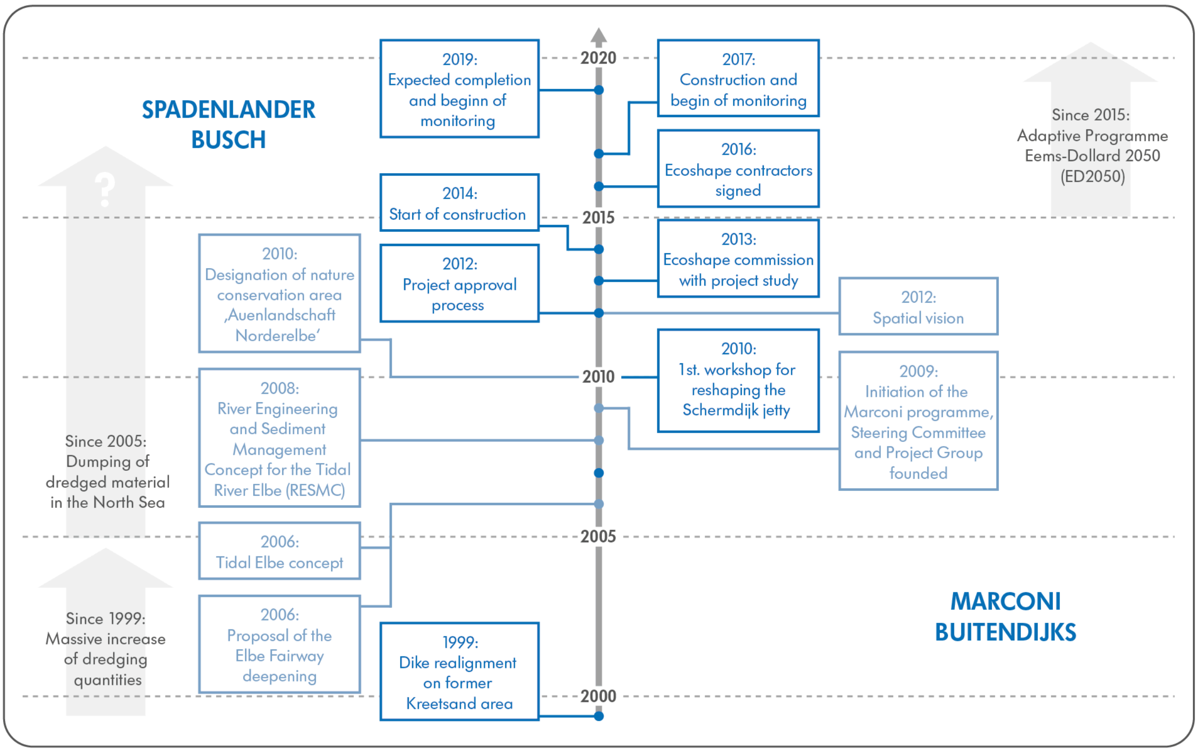

Figure 25: Timelines of the two cases. The blue elements relate directly to the projects, the light blue elements illustrate overarching developments. The grey arrows indicate important processes in the wider SES-landscape (own figure).

How BwN became involved

The PIANC[h] encourages water-related organizations to adopt the WwN approach in their projects. In return, the organizations can apply for the official WwN label and award (PIANC, 2011). Based on a questionnaire, a PIANC commission then decides if the WwN criteria were met (Fuchs, 2014). In 2012, the HPA applied with their project and received the 'Certificate of Recognition' one year later (HPA, 2014). The HPA interviewee explains how WwN was considered during project planning:

> *"Wir haben es quasi intuitiv richtig gemacht. Wir haben die Maßnahme begonnen und dann sind wir aufmerksam geworden auf diese WwN Philospohie von Pianc und dass dort eben auch dieser Award dann praktisch ausgelobt wurde. Und dann haben wir uns kurzer Hand beworben und 'aus Versehen' gewonnen."* (HPA manager)

The Spadenlander Busch has won the WwN-Award in 2014, as the best out of seven international water infrastructure projects (HPA, 2014). Since then, the project is listed in the WwN database as best-practice example (PIANC, 2012). The BUE interviewee adds:

> *"Das hat HPA gemacht, um sich damit noch ein bisschen auszuschmücken. Die haben ja auch eine Auszeichnung gekriegt für dieses Projekt und das ist eben ein Aushängeschild [...]."* (BUE specialist)

[h] As mentioned earlier, the Spadenlander Busch project adopted the WwN concept (PIANC), while Marconi Buitendijks is a BwN project (Ecoshape). The concepts are considered as similar (2.2.3), and will be treated as such in this research.

It worked different in Delfzijl. Here, several workshops were organized to identify concepts for a multi-functional waterfront and a social-ecological 'win-win' situation (DeZwarteHond, 2008, Gautier et al., 2010, Dankers et al., 2013). In 2012, the focus was put on a new beach and the creation of saltmarshes (de Groot and van Duin, 2013). Therefore an experienced partner was needed:

> *"Daraufhin haben wir damals Ecoshape gefragt, weil die an diesem Hafenprojekt[i] [...] schon beteiligt waren [...]. Und daraufhin haben wir mit denen gesprochen und gefragt, ob sie sich denn auch mit Salzwiesen auskennen, und das haben sie bejaht."* (Marconi manager)

Accordingly, Ecoshape was commissioned with a feasibility study in 2013. The preliminary concept by Dankers et al. (2013) was convincing (Provincie Groningen, 2015). The final contract with Ecoshape was signed in November 2016, and construction will start in early 2017 (Dredging Today, 2016). Furthermore, the consortium contributes 180.000 Euro to the total project costs of 10 million Euro (Provincie Groningen, 2015). However, the engagement of Ecoshape was also a logical consequence of the complex circumstances, thinks the representative of the nature organizations:

> *"I guess it was also because plans turned out to be difficult. If you want to do something outside the dike line and in Natura 2000 areas, you must have a good nature story to tell. Otherwise it is not going to happen. I expect it was also a necessity."* (Conservation advisor)

4.3.2 New modes of governance

Integration

In Hamburg, the HPA is sole responsible for the planning and implementation of the Spadenlander Busch project. The only other involved authority was the BUE, which prepared the establishment of the conservation zone 'Auenlandschaft Norderelbe' at that time. As the implementation of the project would have been impossible within a protected area, the HPA made early contact to the BUE (Freie und Hansestadt Hamburg, 2012). Together they managed to include the project in the regulatory decree for the new conservation zone (HmbGVBI, p.207, §2 and §4). The responsible person at the BUE describes the collaboration as follows:

> *"Der Prozess war super, muss ich sagen, weil wir sind eben von Anfang an beteiligt gewesen [...] und durch die Tatsache, dass wir das als Naturschutzgebiet mit diesem Naturschutzzweck ausgewiesen haben, gab es dann auch keine Naturschutzzielkonflikte mehr."* (BUE specialist)

Other potentially concerned authorities or departments were only consulted once to avoid problems during the project approval (Meine et al., 2012). A 'broad planning process' followed (Gutbrod and Meine, 2009). The hydrology department of the HPA worked together with four external companies. These covered the disciplines engineering, geotechnical engineering, biology and hydrology. The hydrological aspects had clear priority when it came to design decisions (Melchior+Wittpohl, 2010). The HPA representative says:

> "*Ja, also an dieser Stelle, Kreetsand, da ist das primär in Zusammenarbeit mit der Hydrologie entwickelt worden."* (HPA manager)

While the HPA draws on vast experience in project planning, the municipality of Delfzijl was rather inexperienced at the beginning (Gemeente Delfzijl, 2009). When the Marconi programme started, the major realized that his administrative capacities were limited:

> *"So kamen wir nicht weiter. Und dann meinte der Bürgermeister, wir müssen da was tun, wir holen uns die Leute mal dazu, denn der Deich ist nicht von uns, die Wasserflächen auch nicht, die Industrie auch nicht – aber wir möchten was machen!"* (Marconi manager)

A new form of organization was required to integrate the various interests, responsibilities and fragmented property rights that the Marconi programme touched on (Gemeente Delfzijl, 2009). Consequently, a steering committee and a related project group were founded (Figure 26). Both

[i] Ecoshape programme 'Ports of the Wadden Sea'.

organizational bodies consist of representatives from the province, the two present water boards, RWS, and the municipalities of Delfzijl and Eemsmond. While the committee makes decisions and guides the process, the project group creates practical concepts and organizes their implementation. The group also makes contact with external stakeholders, for example the German authorities along the Eems-Dollard. On the basis of various meetings, workshops and studies, the committee developed their overall spatial vision in 2012 – the 'Maritime Zone of Delfzijl' (Marconi steering committee, 2012). In 2012, the Groningen Seaports, the responsible port authority, and Het Groninger Landschap, a foundation that represents several regional nature organizations, became advisors of the committee. Moreover, the committee collaborates with various universities, companies, public administrations, interest groups and research organizations, such as Ecoshape (Dankers et al., 2013, Gemeente Delfzijl, 2015, de Groot and van Duin, 2013).

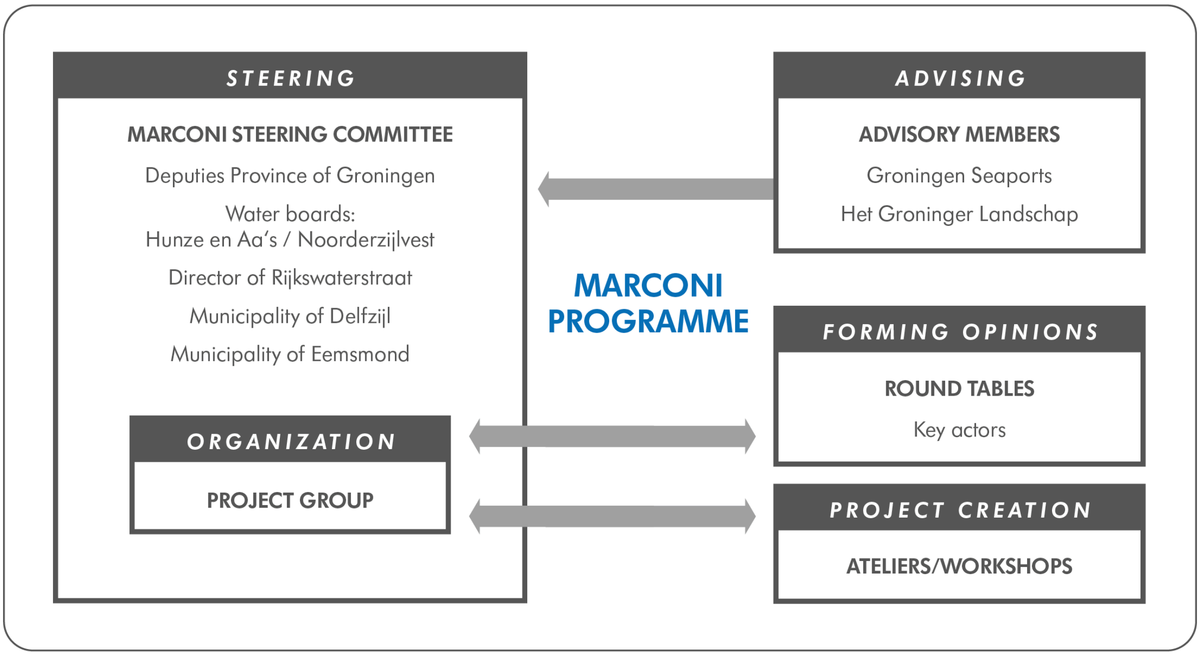

Figure 26: Governance structure of the Marconi programme (adapted from Gemeente Delfzijl, 2015).

Participation

According to Gutbrod and Meine (2009), the Spadenlander Busch project has a 'strong pedagogical purpose' due to its role as first pilot-project of the RESMC concept. A new communication strategy was developed therefore (Meine et al., 2012). This step was voluntarily, as there is no formal obligation to involve locals during the planning process (Freie und Hansestadt Hamburg, 2012). The strategy included the distribution of information leaflets, the establishment of an information pavilion ('Deichbude', Figure 27), and three information meetings with local inhabitants. The aims were to *"present the overall management targets and possible synergies"*, to *"sensitise the people for the aims of the project"*, and to *"become aware of neighbours' wishes and concerns."* (Meine et al., 2012, p.2). The HPA person was asked if local inhabitants had the ambition or chance to actively participate in the design and development of the project during these meetings:

> *"Ne. Dafür waren die nicht kreativ genug."* (HPA manager)

In the remainder of the communication strategy, recommendations are derived from Spadenlander Busch project. In terms of public concerns and acceptance it is stated that:

> *"Very often stakeholders and involved parties are simply lacking information and therefore stick to "professional" opinion leaders who may follow their specific interests. The better you communicate your ideas, rationale and plans the better is your chance to get acceptance by the involved parties."* (Meine et al., 2012p.7)

Right before the request for approval, HPA informally met with several nature organizations. They were asked for their agreement to the final plans. The aim was to avoid opposition in the following approval process, were these organizations are formally asked for their objections (Meine et al., 2012). The representative of the nature organization NABU describes the process as follows:

> *"Wir kriegen Unterlagen, da ist eigentlich schon alles fertig. Das ist die beantragte Bauweise und die Antragssteller hatten nie Lust, noch was Wesentliches zu ändern. Das ist auch halt ein bisschen Frust für uns, weil wir als Verbände eben erst zu einem späten Stadium beteiligt werden müssen bei manchen Sachen [...]. Und dann steht meistens schon fest, was passieren soll."* (NABU specialist)

Although the nature organizations agreed in the informal meeting, one of them still submitted a letter of objection during the subsequent approval phase. However, none of the pleas were accepted (Freie und Hansestadt Hamburg, 2012).

In the Marconi Buitendijks programme, participation is a core element of the planning process, although the organizational structure (Figure 26) stipulates a clear division between 'steering', 'advising' and 'organizing'. However, the interviewee from the advising nature organization says:

> *"So formally, we do not have any decision-making power. But we sit at the same table in the moment decisions were taken. [...]. We are treated as if we have something to say. In this committee it is not about 'voting'. We find consensus about what is the best way and we have an even say in that [...], although not in the formal sense, but this it how it feels."*
>
> *"That is one of the few places where all is about trust and where people can talk open to each other."* (Conservation advisor)

Public engagement is also part of Marconi. Inhabitants of Delfzijl attented for instance the workshops in which the Marconi programme was established (Gemeente Delfzijl, 2009), as well as other meetings or workshops within the programme (Gemeente Delfzijl, 2015). The integrated and participative process in Delfzijl has not only led to mutually agreed concepts and goals; it also helped to overcome financial and legislative barriers:

> *"Dadurch dass wir mit Ecoshape, der Naturorganisation und deutschen Partnern zusammengearbeitet haben, bekamen wir das Ok für dieses Vorhaben. [...] Die Provinz, die viel Gel gegeben hat, sagte das sie das sehr gut findet, dass wir soviel gemeinsam erreicht haben, und darum haben die uns das Geld auch gegeben."* (Marconi manager)

After 2019, it is planned that Het Groninger Landschap, the advising nature organization, will become responsible for the site's management (E-mail communication, R. Reintsema, 02.01.2017).

Figure 27: The 'Deichbude' information pavilion at the Spadenlander Busch site (Photo: M. Martens, 2017).

4.3.3 The projects as large-scale experiments

Innovative concepts with a long-term focus

The RESMC involves several new or untested ideas to handle the sedimentation problems (HPA and WSV, 2008). The creation of additional tidal volume, which is the main goal of the Spadenlander Busch, is one of the most promising approaches:

> *"Man hat diverse Maßnahmen angeguckt [...] und auch mehrere Modellierungen angestellt und hat festgestellt, dass in der Summe ein ziemlich starker Effekt erzielt werden kann."* (HPA manager)

However, due to the complex hydrological and morphological interactions, the RESMC envisages a stepwise implementation of short-, medium- and long-term measures. For several reason (see 4.3.1) the Spadenlander Busch was selected as first short-term measure in this hindsight. Its actual impact on the tidal dynamics will remain marginal, but results of this experiment will serve as basis for similar measures in the upcoming decades (TIDEELBE, 2015, PIANC, 2012). The long-term goal is to change the unfavourable tidal dynamics in the Elbe estuary (HPA and WSV, 2008).

A comparable approach can be found in the Marconi Buitendijks project. The creation of saltmarshes in Delfzijl is part of the Ecoshape programme 'Ports of the Wadden Sea'[j] and contributes to the regional programme 'Vitale Kust'. Their common goal is the sustainable re-use of dredged material (ED2050, 2016, de Groot and van Duin, 2013). Hence, Ecoshape will experiment with different material compositions, sowing techniques and ecological structures in the Delfzijl saltmarshes (Ecoshape, 2016a). The findings might contribute to future saltmarsh projects all over the Wadden Sea (Van Eekelen et al., 2016). Marconi Buitendijks is only the first short-term measure within the overarching Marconi programme, which has a long-term focus of 40 years and does not only focus on the structural problems of Delfzijl, but aims to enhance the ecological quality of the whole Eems-Dollard estuary (Gemeente Delfzijl, 2015).

Social learning

As pilot-projects, both cases involve 'learning' as explicit goals. The insights from the Spadenlander Busch project will serve the improvement of future measures and is sought to educate the public about tidal dynamics and estuarine ecology (Knüppel, 2012). Further, the experiences made in the planning process will eventually feed into future collaborations of this kind (Gutbrod and Meine, 2009). The aim at Marconi Buitendijks is to gain practical experience and knowledge about the creation of saltmarshes (Ecoshape, 2016a). The publically accessible saltmarsh park will also contain an educational component, in which visitors can learn about the ecological features of the estuary (Provincie Groningen, 2015). A certain level of uncertainty can be found thereby in both projects, particularly in terms of their functionality:

> *"Man weiß eben noch nicht [...], funktioniert das wie wir uns das vorgestellt haben oder läuft das ganz anders? Macht die Natur was wir von ihr erwartet haben? Das ist ja gerade an der Elbe in so einem Ästuar hoch komplex und schwer vorhersehbar."* (BUE specialist)

> *The natural dynamics of salt marshes make it only partly possible to predict what the area will look like in the future. [...] The use of the salt marsh by breeding and foraging birds is hard to predict."*
> *(de Groot and van Duin, 2013, p.29)*

Hence, monitoring is an intergral component of both cases. For Marconi, it has two main tasks: first, to assess if the marshes serve their intended mission, such as recreation or bird resting and if ecological features develop as expected. The latter is important, because the permission for this project was based on the prediction that the sites reach a specific ecological quality. If the marshes do not meet them, adaptive measures must be taken (de Groot and van Duin, 2013, Ecoshape, 2016a). Monitoring was also extensively discussed during the approval of the Spadenlander Busch. Here, the

[j] Ecoshape initiated the programme 'Ports of the Wadden Sea' with a pilot case in Harlingen. Here, dredged material is reused to create saltmarshes. Marconi Buitendijks is now part of this BwN programme *(www.ecoshape.org/en/projects/mud-motor).*

HPA will solely monitor the hydrological effectiveness (TIDEELBE, 2015). Ecological aspects will be covered by regularly monitoring for the WFD and Natura 2000, which is regularly done by the BUE (IBL Umweltplanung GmbH, 2010). The plea of several nature organizations to integrate the hydrological and ecological monitoring was not accepted in the approval. It was argued that the HPA is generally not responsible for ecological issues (Freie und Hansestadt Hamburg, 2012).

4.3.4 The challenges of nature-inclusive design

Balanced interests

A preliminary ES analysis was conducted for the Spadenlander Busch (Figure 28). Knüppel (2012) concludes thereof that the project has an overall positive impact, particularly for biodiversity, sediment regulation, cultural values and knowledge development. In other words: the project is expected to equally serve the interests of the port, nature and society (Gutbrod and Meine, 2009, Knüppel, 2012). The former Kreetsand area was a wasteland, partly used for recreational purposes (Freie und Hansestadt Hamburg, 2012). When finalized, the project will provide space for various species communities and rare riparian habitats. As previously mentioned, it will also become part of a local conservation site (IBL Umweltplanung GmbH, 2010). Consequently, *"no trespassing is allowed, but it is planned to establish public footpaths along the new build shore and to establish a set of presentation boards [...]"* (Knüppel, 2012). This 'tidal park' concept (see Figure 19, p.37) serves leisure adn educational purposes (Meine et al., 2012). Anyway, the HPA refused the request by other authorities to make the tidal park obligatory (Freie und Hansestadt Hamburg, 2012). When asked whether the park will be realized or not, the HPA interviewee answered:

> *"Weiß ich nicht. Das ist natürlich für IBA[k] interessant, wir haben auch von uns heraus gesagt, also wenn das ein Pilotprojekt sein soll, dann wollen wir es natürlich es auch nutzen [...]. Und deswegen hatten wir diese Studie noch in Auftrag gegeben. Ich denke, wenn die Maßnahme fertig gestellt wird, dann wird man auch entsprechendes machen."* (HPA manager)

Spadenlander Busch/Kreetsand

Cat.	Ecosystem Service	Score
S	"Biodiversity"	3
R1	Erosion and sedimentation regulation by water bodies	3
R2	Water quality regulation: reduction of excess loads coming from the catchment	1
R3	Water quality regulation: transport of polutants and excess nutriënts	1
R4	Water quantity regulation: drainage of river water	1
R5	Erosion and sedimentation regulation by biological mediation	1
R6	Water quantity regulation: transportation	0
R7	Water quantity regulation: landscape maintenance	1
R8	Climate regulation: Carbon sequestration and burial	1
R9	Water quantity regulation: dissipation of tidal and river energy	1
R10	Regulation extreme events or disturbance: Wave reduction	0
R11	Regulation extreme events or disturbance: Water current reduction	1
R12	Regulation extreme events or disturbance: Flood water storage	1
P1	Water for industrial use	1
P2	Water for navigation	0
P3	Food: Animals	0
C1	Aesthetic information	2
C2	Inspiration for culture, art and design	3
C3	Information for cognitive development	3
C4	Opportunities for recreation & tourism	2

Beneficiaries:	
Direct users	0
Indirect users	2
Future users	3
Local users	2
Regional users	2
Global users	1

X Targeted ES

Legend: expected impact*	
3	very positive
2	positive
1	slightly positive
0	neutral
-1	slightly negative
-2	negative
-3	very negative

*: Indicative screening based on ES-supply surveys and estimated impact of measures on habitat quality and quantity. Quantitative socio-economic conclusions require local supply and demand data to complement this assessment.

Figure 28: ES analysis for the Spadenlander Busch, showing the expected impacts on ES supply at the site, and the expected impacts on different beneficiaries (Knüppel, 2012).

[k] The IBA, the International Building Exhibition, set place in Hamburg in 2013. The IBA is basically a temporarily limited 'urban planning lab'. The Spadenlander Busch was presented as innovative project in this context. See: *www.iba-hamburg.de*

It is worth mentioning that the expected ecological and societal co-benefits of the Spadenlander Busch are 'positive side-effects', and not obligatory. In fact, water infrastructures do not have to be synergetic at all according to Hamburg's regulations (Freie und Hansestadt Hamburg, 2012). Thus, the design is optimized for its hydrological purpose (Melchior+Wittpohl, 2010). Nevertheless, other actors generally welcome the project:

> *"[...] das ist ein HPA Projekt und die HPA macht so keinen Naturschutz, es geht um Hafeninteressen und Hafenbau und das Ziel war hier Flutraum zu schaffen und die Absenkung des Tidenhubs. [...] Und wenn wir es gemacht hätten, hätten wir eben ein paar kleine Sachen eventuell anders gemacht, aber unterm Strich ist das eine super Maßnahme, auch für den Naturschutz."* (BUE specialist)

> *"Den Tidehub zu verringern hat auch einen wirklich positiven ökologischen Effekt. Also es ist erst mal nur ein hydrologischer Faktor, aber auch die Ökologie leidet aufgrund der völlig aus dem Ruder gelaufenen Tidedynamik."* (NABU specialist)

The Marconi partners in Delfzijl repetitively highlighted their ambition to find an integrated solution that does not go at the expense of nature or landscape values. Further, it should not hinder the restoration of the highly degraded Ems-Dollard system; rather, the project should close *"met een (kleine) plus achter te laten."* (Dankers et al., 2013, p.77) Hence, in the feasibility study by Dankers et al. (2013), a valuation cluster was used to assess the different thinkable design variants. The cluster covered the aspects 'morphology', 'ecology', 'coastal defence' and 'spatial quality'. Plusses and minuses were offset against each other. Nevertheless, despite its ecological benefits, there are doubts about the societal value of the project:

> *"Personally I think these saltmarshes aren't going to contribute that much like they hope they will. It will not give Delfzijl the boost that it needs. I don't think people will come to the city because they can walk on saltmarshes. So, it is good for nature [...], but to make Delfzijl more attractive, I have my doubts if this will actually help."* (Conservation advisor)

One of the initial project aims was to integrate the saltmarshes in the upgrading of the city's flood defence system (Van Eekelen et al., 2016). If combined with a rework of the harbour jetty, their wave-attenuating effect could have relieved the primary dike line ('Chemie dijk', Figure 29). In this case, the dike would require only little upgrades. However, the construction costs would have been higher than for a simple dike upgrade (Dankers et al., 2013). The idea was abandoned, and without the flood defence aspect, the project has lost its main engineering component:

> *"Das haben wir versucht, aber damals waren wir einfach noch nicht so weit. Auf der Website gibt es noch so ein Modell, das zeigt, dass das [der Schermdijk] etwa 6 m hoch gebaut werden soll und es auch eine Düne geben soll sowie eine Salzwiese davor. Aber das war so teuer, dass wir gesagt haben wir bauen nur eine Salzwiese."* (Marconi manager)

> *"I think what is missing over here is the link with coastal defense. Initially it was supposed that the salt marshes play a role in coastal defence. Then it would have been Building with Nature. But this one is simply 'Building Nature'."* (Conservation advisor)

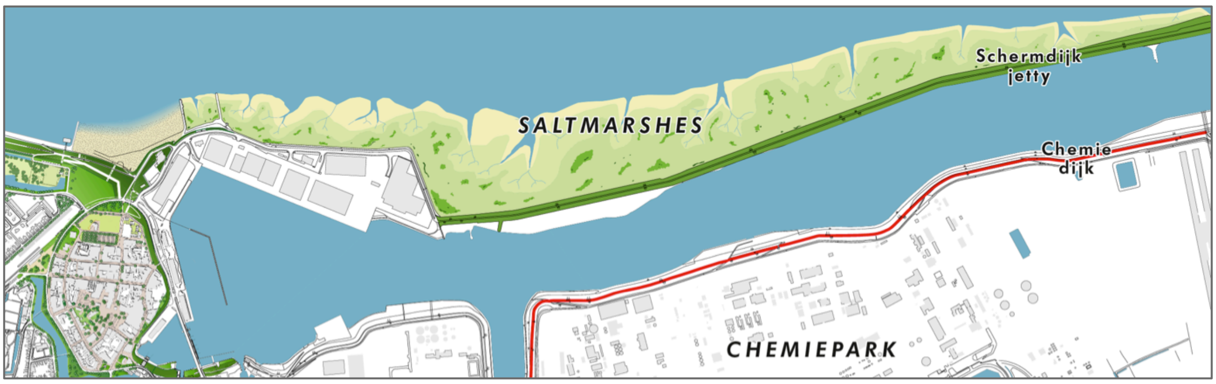

Figure 29: Earlier design of the saltmarshes. Here, the marshes were considered as part of the flood defence system to relieve the 'chemie dijk' (red line) from wave impact (Gemeente Delfzijl, 2015).

Environmental protection or optimization?
A key conflict of BwN exists between conservation and restoration on the one hand, and the creation of new nature with an optimized socio-economic benefit on the other. The Spadenlander Busch area for instance became an exceptional urban retreat, as it lied fallow for over ten years and remained largely unaffected by human activities. Thus, with the project being built, breeding sites for several sensitive bird species get lost. However, the finalized site will involve some other rare habitats, which accommodate some endangered and, in terms of environmental policy, more 'valuable' species, such as the almost extinct 'Elbe Water Dropwort' (*Oenanthe conioides,* Figure 30). In addition, the area will probably have a higher economic usefulness than before when the envisaged hydrological concept works (Freie und Hansestadt Hamburg, 2012, IBL Umweltplanung GmbH, 2010). In Delfzijl, a similar issue emerged in relation to Natura 2000. Just recently, the offshore areas at Delfzijl became part of the Natura 2000 network as habitat type 'estuary' (ED2050, 2016). The reduction of these areas is prohibited. However, the new saltmarshes will advance onto the mudflats, which actually does reduce the estuarine area (de Groot and van Duin, 2013). An exception was constructed:

> *"The thing with Natura 2000 is, if you have good arguments, then you can adjust from these regulations. That's also what could happen if a new project is going to take some habitats, but the benefits in the end are larger than the damages we have in the moment. [...] But it is very difficult."* (Conservation advisor)

In the end, two issues turned the scales. At first, the removal of the 'Griesberg' creates additional 22 ha of mudflats (Figure 22); these partly compensate for the losses (ED2050, 2016). Second, the overall ecological quality of the area is expected to increase, as saltmarshes are assigned a higher ecological value within the Natura 2000 framework than mudflats (Dankers et al., 2013).

Figure 30: The Elbe Water Dropwort (left) and its typical habitat, the tidal floodplain forests along the Elbe estuary (right) (photos by H. Below, DVL, 2010).

4.3.5 The role of the projects in the wider social-ecological context

The previous section revealed the backgrounds and plans of the projects. This section uncovers their existing and expected impacts on the water management regime as a whole. Moreover, main points of criticism are outlined.

Perception and realization of the 'new' water management paradigm
Gutbrod and Meine (2009) note that the implementation of innovative large-scale measures in the future requires a fundamental shift of societal values. It is therefore imperative to *"improve the public understanding of the function of tidal systems and estuaries [...]"* and to *"convince the NGO's of the project's aims and point out the mutual benefits [...]"* (Meine et al., 2012, p.1f). The HPA perceives

itself as innovation leader in this hindsight and denotes the Spadenlander Busch as starting point of a 'paradigm change' (Gutbrod and Meine, 2009). The HPA interviewee was asked what these claims actually mean for the authority itself, for example in terms of planning procedures:

> *"Also wir haben jetzt hier bei uns im Hause nicht durchgesetzt, dass man sagt wir müssten jetzt einen neuen Planungsansatz wählen. Aber im Bereich der Tideelbe-Entwicklung zeigt eben auch dieses Dialogforum Tideelbe*[1]*, dass man erst reden und dann planen muss."* (HPA manager)

The 'Dialogforum Tideelbe' aimed to establish a 'trustful culture of constructive exchange', and to provide a basis for future decision-making. It identified 23 potential measures for the reduction of tidal pumping (TIDEELBE, 2015). The Spadenlander Busch project served as best-practice example:

> *"Kreetsand führen wir natürlich immer als beispielhaft an. So oder so ähnlich könnte es aussehen."* (HPA manager)

In December 2016, the follow-up institution was established – the 'Forum Tideelbe', a so-called estuary partnership between the federal states of Lower Saxony, Schleswig Holstein and Hamburg. The main goal is to study the feasibility of the previously identified measures. The Spadenlander Busch functions as showcase project again (BUE, 2016, TIDEELBE, 2015). The administrative office of the Forum will be manned by the HPA. It is responsible for stakeholder coordination, the organization of meetings, and the commissioning of external expertise. However, there are critics about the credibility of the Forum, and the ambitions of its initiators, namely the BUE, HPA and Hamburg's Ministry of Economy, Transport and Innovation (HPA, 2016). Rettet die Elbe e.V. (2016) for instance notes that only 500.000 Euro/a are allocated to the forum, whereas the HPA receives 100 million Euros annually: *"Welchen Stellenwert die Freie und Hansestadt Hamburg dem Projekt beimisst, macht sich auch an der finanziellen Ausstattung fest [...]." (n.p.).* Other concerns relate to the lack of accountability of the five-year dialogue:

> *"Die Umweltverbände argwöhnen, dass es nur so eine Scheinpartizipation ist und nur eine Scheindiskussion und am Ende wieder nichts bei raus kommt. Dass nur geredet wird, um nicht handeln zu müssen."* (HPA manager)

In contrast, the Marconi partners virtually enacted a paradigm shift by agreeing that the programme has no definite ending point, and that the process must remain adaptive (Gemeente Delfzijl, 2009). Social, economic and ecological goals were integrated in a non-conventional, participative process (Marconi steering committee, 2012). This form of collaboration is seen as great advancement:

> *"Das wichtigste ist, macht es zusammen, das ist ganz wichtig, jeder muss was haben davon, und Offenheit – keine Geheimnisse voreinander. [...]. Zusammenarbeit schafft mehr Synergien, mehr Antriebskraft und Konsens."* (Marconi manager)

Correspondingly, planning in Delfzijl started with several explorative workshops (e.g. Gautier et al., 2010) where different stakeholders and the public were involved from the beginning (Gemeente Delfzijl, 2009). This Marconi governance model (Figure 26) found its way to the province level recently, where the ED2050 programme was set up in 2016. It aims to revitalize the Eems-Dollard region until the year 2050. The sub-programme 'Vitale Kust' involves seven projects at the Eems-Dollard (Figure 31), and Marconi Buitendijks is now one of them (ED2050, 2016):

> *"Also haben wir mit der Provinz überlegt, ob die das [Marconi] Konzept nicht übernehmen können, in das Provinzhaus. Und ab da heißt das dann nicht mehr Marconi, sondern Vitale Kust. Die Arbeitsweise wird eins zu eins übernommen."* (Marconi manager)

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[1] 'Dialogforum Tideelbe' is the short version for 'Forum Strombau- und Sedimentmanagement Tideelbe'. This was a stakeholder dialogue that involved about 40 actors that are concerned by the future development of the Elbe estuary. It set place between 2013 and 2015 and was initiated by the HPA and WSV. Its establishment was a condition made by the state of Schleswig-Holstein to the city of Hamburg (TIDEELBE, 2015).

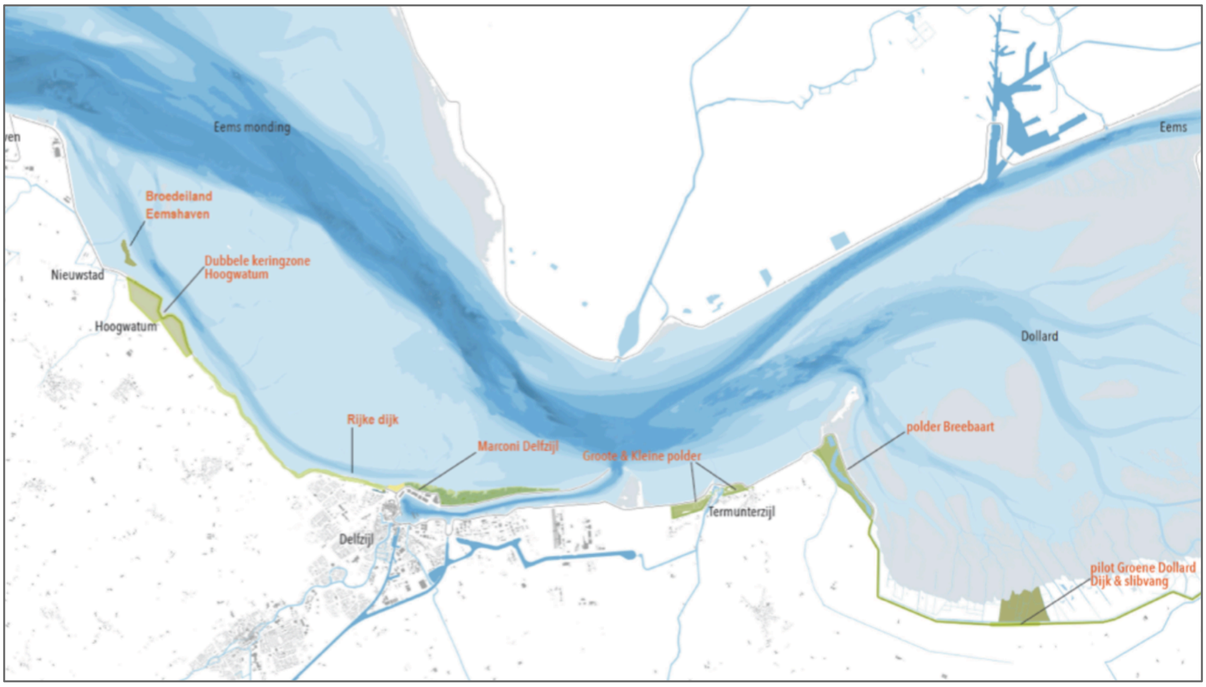

Figure 31: Map showing the 'Vitale Kust' projects for the period 2016-2020 (ED2050, 2016).

Local problems vs. systemic problems – a matter of scale

The Spadenlander Busch faces some significant criticism (BUND Hamburg, 2009, 2010, Rettet die Elbe e.V., 2011, Hamburg für die Elbe, 2015). The HPA uses for instance the excavated soil from the project site to fill up unused port basins elsewhere in Hamburg. This frustrates the declared target to create additional tidal volume (TIDEELBE, 2015). The HPA refers to their legal mandate here ('Hamburg port development act', HafenEG §1), which obligates them to assure the competitiveness and efficiency of the port:

> *"Wir haben wirklich zwei gegenläufige Interessen hier an der Stelle. Wir müssen den Hafen natürlich weiter entwickeln, damit er erwerbsfähig bleibt. Und dazu müssen wir auch so Flächen wie Hafenbecken verfüllen. Aber gleichzeitig haben wir erkannt, dass es eigentlich nicht gut ist und deswegen [wird an] anderer Stelle Wasserfläche geschaffen. Klingt erst mal wie ein Widerspruch aber lässt sich nicht auflösen. Es sei denn man würde sagen, wir machen eben keinen Hafen mehr."*
> (HPA manager)

They point out that the project has a hydrological effect, even if measures in other places exhaust it again. During the approval, they added that other measures and their effects are not relevant to this project (Freie und Hansestadt Hamburg, 2012, Rettet die Elbe e.V., 2011). Further critics arose after the project was dedicated as Natura 2000 coherence measure[m] for the planned Elbe fairway deepening. The latter is currently subject to trial concerning the expected ecological impacts (IBL Umweltplanung GmbH, 2010). The aforementioned 'Elbe Water Dropwort' is particularly endangered by a further river deepening (Knüppel, 2012). The purpose of the Spadenlander Busch site was therefore reformulated:

> *"[...] aber irgendwann gab es einen Schalter, der umgelegt wurde und [...] man gesagt hat, ok, eigentlich wollen wir die Elbe vertiefen, wir brauchen noch Kohärenzmaßnahmen, ja dann wir haben doch hier eine [...]. Und da fühlten sich die [Umwelt-] Verbände dann ganz schön verarscht.[...] jetzt ist es keine Bonusmaßnahme mehr, sondern sie koppeln es mit etwas, was uns ein Dorn im Auge ist. Nämlich der Elbvertiefung."* (NABU specialist)

Accordingly, the project's benefits are counted twice now – as compensation for tidal pumping, and as compensation for Natura 2000 habitats. The nature organizations call this a major fraud (BUND

[m] When projects affect habitats or species of the Natura 2000 network, measures must be taken to ensure their functional coherence, for instance by creating similar habitats nearby. These coherence measures are not generally the same, but often congruent with compensation measures (derived from: www.bfn.de/0316_natura2000.html).

Hamburg, 2010, Rettet die Elbe e.V., 2011). Critics also concern the fairway deepening itself. It will add at least 7-8 centimetres to the present tidal range, while even large-scale measures such as the Spadenlander Busch can lower it by 1-2 centimetres only (BUND Hamburg, 2009). The HPA neglects these contrary effects (Freie und Hansestadt Hamburg, 2012). Hence, the director of the BUND Hamburg, M. Braasch, concludes:

> *"Von einem Wertewandel an der Unterelbe kann erst die Rede sein, wenn die geplante Elbvertiefung gestoppt, eine norddeutsche Hafenkooperation aufgebaut und ein umfangreiches Rückdeichungs-programm umgesetzt wird."* (BUND Hamburg, 2009, n.p.)

In Delfzijl, criticism relates mainly to the value of new saltmarshes for the estuary. As stated earlier, their creation will reduce the present tidal area. The Eems-Dollard has lost significant amounts of the latter due to human modifications already. The consequence is a highly degraded ecosystem and a strong tidal pumping effect (Bos et al., 2012). Hence, although *"salt marshes are ranked among the most important habitats in The Netherlands regarding ecosystem services [...]"* (Van Eekelen et al., 2016, p.3), their creation in Delfzijl counteracts the actual needs of the estuary as a whole:

> *"So this project was again a small part of taking from these tidal areas. Nonetheless we thought that it also creates a lot [...]. But there are lots of scientists who say any loss of tidal area is bad. Especially if you talk about vulnerable area as the Eems. Do not reduce this tidal area. Increase it!"*
> (Conservation advisor)

To a certain extent, Marconi Buitendijks therefore works against the ambition of other programmes with a larger system focus (ED2050, 2016, Natuur en Milieufederatie Groningen, 2014, Schuchardt, 2013). Accordingly, the findings and experiences made in the saltmarsh experiments have limited value for this or other estuaries:

> *"[...] a new project that does the exact same thing as what in project Marconi is taking place – considering the new policy goals – we would say now it is not a good project anymore."*
> (Conservation advisor)

The 'Vitale Kust' programme (Figure 31) for instance involves several projects that add tidal area to the estuary, for instance through the creation of tidal polders (ED2050, 2016).

4.3.6 Discussion

The previous sections presented the findings made for the case studies. The key aspects that stuck out of the analysis are listed in Table 8 and are discussed in the following paragraphs. A colour score is used in the table to indicate the project's fit with the BwN principles, whereas the four BwN key principles are highlighted.

SOCIAL-ECOLOGICAL SYSTEM DIMENSION		
Principles	**Spadenlander Busch**	**Marconi Buitendijks**
Integration of sectors/disciplines	*– Other sectors/disciplines are rarely considered* *– Integration only when necessary or obligatory*	*+ Broad integration as stated programme goal* *+ Workshops and ateliers as basis for decisions* *+ Spatial vision as 'boundary object'*
Participation	*+ Development of new communication strategy* *– Sticks to tokenism and non-participation* *– Other interests/opinions rarely considered*	*+ 'Real' participation based on trust and respect* *+ Decisions follow broad consensus about goals*
Generation of shared knowledge	*– Integration of knowledge frames is restricted*	*+ Interdisciplinary/cross-sectoral exchange* *– Knowledge remains in small CoP* (Ecoshape)*
Long-term focus	*+ Embedded in long-term RESMC-concept*	*+ Part of long-term Marconi programme*
EVOLUTIONARY RESILIENCE DIMENSION		
Principles	**Spadenlander Busch**	**Marconi Buitendijks**
Resistance	*no data.*	*no data.*
Diversity and redundancy	*+ Additional plots for endangered species*	*+ Diversification of touristic possibilities*
Self-organization and feedbacks	*+ Parts of the area formed by natural processes* *– The water basin must be dredged periodically*	*+ Saltmarshes partly formed by natural proc.* *– Dredged material must be added regularly*
Social learning	*+ Large-scale experiment to test new concept* *+ Basis to improve similar projects in the future* *– Fragmented monitoring hampers learning*	*+ Large-scale experiment to gain knowledge/exper.* *+ Comprehensive monitoring approach* *– Learning restricted to small CoP (Ecoshape)*
Room for innovation	*+ Adoption of yet untested hydrological design* *+ Basis for other innovative large-scale projects*	*+ New ways for reuse of dredged material* *– Innovative flood defence concept cancelled*
ECOLOGICAL ENGINEERING DIMENSION		
Principles	**Spadenlander Busch**	**Marconi Buitendijks**
Ecosystem-service approach	*+ Economic focus, with ecol., & social co-benefits* *+ ES valuation conducted during planning phase*	*+ Ecological focus, with social-econ. co-benefits* *+ ES valuation conducted for design decisions*
Proactive creation and utilization	*+ Dissipation of tidal energy (tidal pumping)*	*– Flood defence function was abandoned*
Ecological memory	*– Degradation at other sites not considered* *+ Project embedded in larger protected area*	*+ Plant dispersal within the estuary considered*

Table 8: The BwN framework with the case results. The **+** *symbols mark aspects that are in accordance with a principle; the* **–** *symbols denote those aspects that counteracts them; 'no data' is used when a principle was not sufficiently covered by data. Colour scores are added to visualize the fit for each principle (plusses and minuses of each principle were offset against each other. The results were scored as follows: – (light red), 0 (yellow), + (light green), ++ (dark green)). The identified four key principles are highlighted.*

The SES Dimension

The study shows that the two cases strongly differ in their fit with SES dimension, and particularly in terms of integration and participation. The Marconi programme integrated a whole spectrum of key sectors and disciplines in a less strict and more cooperative planning process. A commonly agreed spatial vision served as 'boundary object' (Zaucha et al., 2016) here and guided the subsequent development of the different projects – such as the saltmarshes. Decisions are made on the basis of workshops and round tables, rather than in the standardized top-down manner. The cooperation between the actors is characterized by trust, openness and mutual respect, and seemingly without any noteworthy conflicts. When put in the context of Arnstein's (1969) 'Ladder of Participation' (Figure 14), the Marconi governance model can be classified as 'placation'; in practice however, decision-making seems to be more characterized by informal talks and consensus-seeking, which suits the degree of 'partnership'. The assignment of management authority for the saltmarshes to a nature organization might even fulfil 'delegated power', the second highest degree of participation. Altogether, Marconi programme confirms that integrated and participative management strategies can avoid policy conflicts, lacking legitimacy or unexpected opposition (Pahl-Wostl et al., 2007, Oen et al., 2016).

In contrast to Delfzijl, the study revealed that integration and participation received far less attention in the Spadenlander Busch project. It was solely plant by the HPA, and other stakeholders were only consulted when absolutely necessary; but even then, they had little or no say. Although the HPA adopted a new communication concept and initiated a pre-approval meeting with some nature organizations, they stick to a minimalist approach of 'consultation' or 'information' (*sensu* Arnstein, 1996) in most instances. In some cases, they even come close to 'therapy' or 'manipulation', which are the lowest degrees of Arnstein's ladder. An example is the tendency to discredit opponents as being misguided. In fact, the analysis suggests that the concerned stakeholders had hardly the opportunity *"to construct, discuss and promote alternative options [...]"* (Few et al., 2007, p.56), and that the HPA puts little trust in the abilities of other stakeholders to make useful proposals. In this context, it can be assumed that the integrative and participative efforts made by the HPA, if not obligatory by law, are first and foremost self-serving ones to safeguard the project's fast approval under the appearance of broad stakeholder consideration.

Another BwN key principle is the generation of shared knowledge. As knowledge frames differ, for instance between academic disciplines, a shared system understanding must be created (e.g. Halliday and Glaser, 2011). This process builds on strong actor interaction and their ability to self-reflect (Pahl-Wostl et al., 2007). The Marconi project has successfully enabled this by communication and learning across disciplinary and sectoral boundaries. This is a crucial achievement but often a key problem for project planning (Pahl-Wostl et al., 2010). In many comparable settings a powerful actor hijacks the agenda for his benefit instead (Vörösmarty et al., 2013). The latter suits the role of the HPA in the Spadenlander Busch, but also with hindsight to the 'Dialogforum Tideelbe' and the upcoming 'Forum Tideelbe'. Here, the HPA seemingly dictates its system perspective by means of ready-made plans, top-down authority and, to a certain degree, with an ignorant stance towards other framings. The creation of a shared system understanding seems hampered under those conditions (Pahl-Wostl et al., 2010).

The Evolutionary Resilience Dimension

The results indicate that both projects are embedded in SES that shifted into rather undesirable conditions. In particular, they are affected by historic water interventions, which eroded both social and ecological resilience (Adger et al., 2005). These circumstances opened a windows of opportunity for experimentation – and an entrance gate for the BwN approach (Van Slobbe et al., 2012). Correspondingly, BwN (WwN) pilot projects were initiated in both cases. The projects costs of 63 (Hamburg) and 10 million Euro (Delfzijl), coupled with exceptional high levels of uncertainty, underscore the present sense of urgency in both cases, since financial insecurity is usually a 'knock-out criteria' under less urgent conditions (e.g. Van den Hoek et al., 2012).

The project's main aim is to turn the unfavourable situation into an opportunity to test and refine new design concepts. Interestingly, the idea for the Spadenlander Busch existed already, but initially vanished in drawers, whereas the saltmarsh design for Marconi had to be developed from the scratch. It should be noted though that the fit of the Spadenlander Busch with the WwN concept was obviously an unexpected, but a highly welcome coincidence. In contrast, the adoption of BwN in Delfzijl was a deliberate, albeit pragmatic decision, since the municipality required the expertise, liaisons, and funds of Ecoshape to keep the Marconi programme running. However, both concepts find a good 'breeding ground' within the long-term programmes in which they are embedded (ED2050, RESMC). Here, a number of possible supporters and potential applications is available (Huitema and Meijerink, 2010b). Undisputable, the previous findings relate to 'transformability' in its essential meaning (Walker et al., 2004). Not surprisingly, room for innovation and social learning where the dominant principles within the resilience dimension. There are reasons to argue that the project initiators conduct some sort of 'transformative entrepreneurship' in the sense of Westley et al. (2013). The HPA for instance uses the occasion of their 'textbook project' to present itself as innovation leader (*sensu* Huitema and Meijerink, 2010b), although it largely resists the urge to transform its own structures and procedures. Instead, the authority considers others to be in need of reform – society and nature organizations for instance. In contrast, the Marconi Buitendijks partners implemented some significant changes already, for instance a fully reconsidered governance model for project planning and management. Economic, social and ecological goals considered from the beginning, and participation is perceived as an advancement, rather than as necessary evil. This model became translated to Province-level lately.

The innovative nature of Marconi Buitendijks and the Spadenlander Busch logically involves a large portion of uncertainties and open questions, which is why learning plays a major role. Generally speaking, they constitute large-scale experiments (Johnson, 1999). Monitoring systems will be applied to assess both projects, and the results will be used to create advanced and flexible concepts for the future. However, the HPA denied the integration of ecological and hydrological monitoring. Further, they denied expanding monitoring beyond the very basic requirements. This might be an omission, since the realization of appropriate SES monitoring draws on sufficient technical and financial resources as well as on interdisciplinary expertise (Aceves-Bueno et al., 2015). It seems debatable if and how this minimalist and fragmented approach can foster learning and whether the results will contribute to future projects or not. The situation differs in Delfzijl. Here, the project's main benefit for Ecoshape, as a profit-oriented consortium, is knowledge and experience in designing functional saltmarshes. Hence, an appropriate monitoring system is a guarantor for their economic success. Whilst this is a good aspect, it appears possible that the consortium will reserve their key findings for future Ecoshape projects only. This means that learning is limited to a small community of practice. This seems disadvantageous, since the ability to identify potentials for improvements (single-loop learning), and particularly to reframe problems (double-loop learning), resides in the exchange between different communities of practice (Pahl-Wostl et al., 2008, Nykvist and von Heland, 2014).

For the other principles of the resilience dimension, only few matches were found. Diversity, self-organization or feedbacks receive little attention, except for the fact that natural forces will partly form the Delfzijl saltmarshes and the shore areas of the Spadenlander Busch. Allowing for more natural variability seems a good choice, since *"[r]esilience is only maintained by probing its boundaries."* (Walker and Salt, 2006, p.146). Finally, no reference was made to resistance, since the studied projects are add-ons to the existing water infrastructures, which primarily focus on resistance already (e.g. seawalls and weirs) (Restemeyer et al., 2015).

The Ecological Engineering Dimension

BwN often includes the reshaping or modification of existing nature. For that reason, project plans should include specifications on what ES are to be sustained, and for whom or what purpose (Biggs et al., 2012). The initial goals of the Delfzijl saltmarshes were to integrate social, ecological and economic aspects equally, whereas the Spadenlander Busch was above all optimized for economic purposes. Both cases however required a proper valuation of present and envisaged ecological features, and a careful weightening between conservation, restoration and re-creation (Temmerman et al., 2013, Elliott et al., 2016). Therefore a ES assessment was carried out for both projects. This research revealed two surprising aspects here; first, the Spadenlander Busch involves some initially unintended 'co-benefits' for conservation and leisure. Hence, despite its mono-functional intent, the project turned out to be a textbook example for sustainable water management. The Marconi saltmarshes, in contrast, fall short of expectations, especially in their social and economic component. Their added value for Delfzijl remains ambiguous from both the studied documents and the interviews. The second aspect concerns the fourth BwN key principle – the creation and utilization of nature. The Spadenlander Busch is actually among the few water-related projects worldwide in which this is done on larger scales (Vikolainen et al., 2014, Perkins et al., 2015). Marconi had comparable attempts, namely the provision of flood protection through semi-natural saltmarshes; but the idea was given up for financial reasons, whereby the project have lost one of its core aspects.

Differences were detected also for ecological memory. As the saltmarshes in Delfzijl will be created from scratch with dredged material, no internal memory is available. Thus, the feasibility study by Dankers et al. (2013) explicitly considers external memory in form of seedling dispersal patterns within the estuary (*sensu* Cumming, 2011). At the Spadenlander Busch, ecological memory came into play when the project was subsequently reformulated as Natura 2000 coherence measure. Nevertheless, although this somehow reflects the 'landscape approach' as advocated by Sterk et al. (2016), neither Ecoshape, nor the PIANC consider coherence or compensatory measures to be conform with their BwN/WwN philosophy (Fuchs, 2014). In fact, Vikolainen et al. (2010) explicitly note that the Spadenlander Busch cannot be considered as BwN project anymore.

SPADENLANDER BUSCH

Information sign for the project next to the construction site.

Photo: M. Martens, 2017

5 Conclusion

This study aims to contribute to the theoretical and practical understanding of BwN – a novel approach for the planning and management of water infrastructures. The objectives were twofold therefore: first, the development of a conceptual BwN framework; and second, its application to two 'real-world' cases. In this chapter, the three research questions are answered with regard to the conceptual model (Figure 13). The findings sum up to answer the main question of this thesis:

How can the BwN approach contribute to the solution of contemporary water management problems?

BwN – an innovative approach with some conceptual weaknesses

Q1 concerned a systematic analysis of the BwN approach and envisaged the assembly of a conceptual framework. It can be concluded that the ambitions of BwN are in line with the current discourses on sustainable development, system thinking and adaptive management (e.g. Pahl-Wostl, 2015, Oen et al., 2016, Gupta and Bavinck, 2017). Based on the concept analysis, BwN can be described as an integrative and learning-based concept for the generation of innovative and nature-inclusive water infrastructures. In that sense, the approach constitutes a remarkable epitome of the emerging new *'building **with** nature'* paradigm. Moreover, BwN fulfils the claims to turn fundamental research into actionable tools for water planning, policy making and management (e.g. Vörösmarty et al., 2013). However, the review also revealed some weaknesses and biases in the prevailing understanding of BwN. Most notably, the societal dimension lacks sufficient consideration. This confirms how Ecological Engineering approaches – such as BwN – too often focus on economic goals, while society and ecologists remain behind with 'feel good' benefits (Elliott et al., 2016). These and other conceptual shortcomings negate the sustainability mission of BwN. Furthermore, they evidently produced some considerable ambiguity and resistance in earlier BwN projects (e.g. Van den Hoek et al., 2014). The BwN community seems to be is aware of this. Van Slobbe et al. (2013) for example called for sharper definitions and the integration of related lines of research, such as community resilience. However, there have been few attempts to do so yet. The need for such a re-conceptualization of BwN is underscored by the fact that the PIANC is currently working on something similar for their WwN concept (*'A guide for applying WwN'*, PIANC, 2016).

For that reason, this thesis is pioneering in the sense that it proposes a much more comprehensive, differentiated and interdisciplinary understanding of BwN than currently available. The herein developed BwN framework can hopefully benefit future BwN research and practice. Figure 32 is an attempt to visualize the new understanding of the approach and adds up to the conceptual model. The four key principles that were identified during the research (4.1.4) are highlighted in the figure: Integration, shared knowledge, social learning, and the proactive creation and utilization of nature.

This ideal-type framework has been applied to two case projects. The research suggests that in both cases persistent water problems impose high pressure on the corresponding regimes. The literature on adaptive management (e.g. Pahl-Wostl, 2006), highlights the need for fundamentally new governance models to handle these challenges. Generally speaking, these should be flexible whilst providing stability at the same time; the assembly of this governance 'silver bullet' remains the central problem of sustainability research (Duit et al., 2010). Not surprisingly, the study demonstrated how the HPA largely maintained traditional top-down procedures of project planning, approval and implementation. Little progress is made in terms of participation, integration, or the generation of shared knowledge. In fact, it looks like that the HPA has instrumentalied these novel principles to sustain their established routines. Marconi, in contrast, marks a good example for the shift from 'government to governance' (*sensu* Jänicke and Jörgens, 2004). The municipality has installed a quite diversified and participative governance model here; further, they implemented a flexible step-by-step approach within their programme on the basis of a commonly agreed long-term development vision.

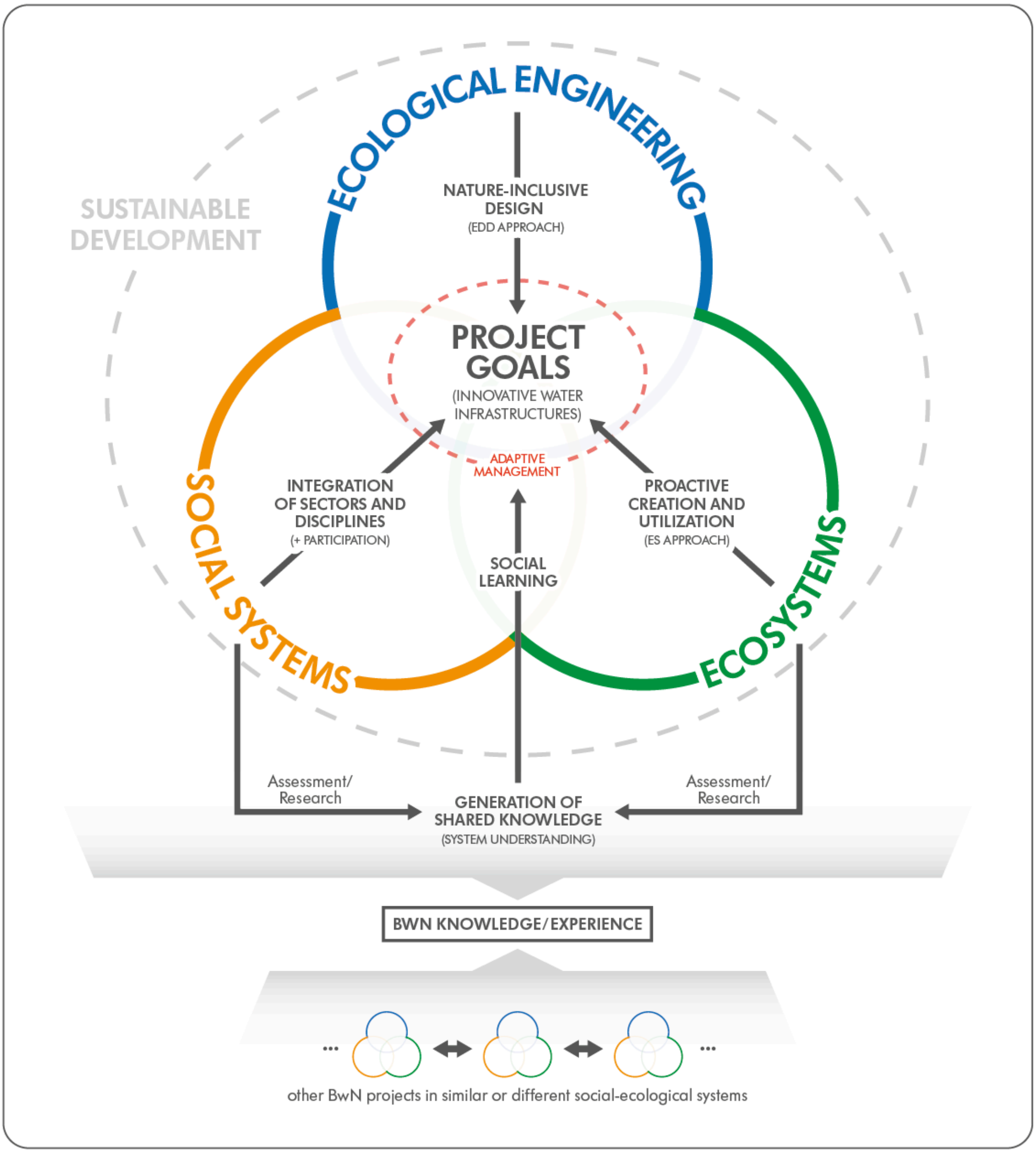

*Figure 32: Schematization of the BwN concept. Social and ecological systems are integrated (**SES-model**), and **Ecological Engineering** is represented by the EDD approach. Project goals results from integrated and participatory planning processes. A shared and improved system understanding facilitates learning, which allows for adaptive project management (**resilience**) (own figure).*

Resilience emerged as a promising new concept in the sustainability debate and also found its way into the BwN approach. Above all, resilience implies that joint learning is an essential element of more adaptive management systems (Whaley and Weatherhead, 2016). The analysis indicated that social learning is also a key element within the two projects. here, the application of untested concepts, combined with a good portion of uncertainty, shall serve as basis for advanced future projects and certainly exceeds the usual 'comfort zone' of those responsible. In that sense, the projects constitute a clear advancement compared to former ones. Nonetheless, resilience as part of SD also requires the explicit link of management objectives to the social dimension (Pahl-Wostl, 2015). The analysis showed that the reoccurring references to adaptive management, resilience or sustainability in the BwN literature and the case studies often relate to infrastructural, and sometimes to environmental aspects, but rarely include societal considerations. In Hamburg for instance, it is not clear whether the tidal park will be built, and if so, would it mainly serve educational purposes; the contribution of the Delfzijl saltmarshes to an improved spatial quality or leisure possibilities seems highly questionable. Ostrom (2009) argues that the lack of social objectives in SES management can be traced back to the independent development of the scientific branches: engineering dominates water management since the early years (*building **in** nature*), whereas ecology gained importance when ecological degradation became undeniable (*building **of** nature*) (Molle, 2009). Societal considerations seem to have a weak profile compared to that.

In line with that, the results also add to the findings of Gupta and Bavinck (2017); the authors show that social and ecological trade-offs in favour of economic growth remain the rule rather than the exception in water management. The key drivers behind the Spadenlander Busch and Marconi Buitendijks turned out as economic ones as well. Ecological or societal benefits were of secondary interest, or emerged as unintended side effects only. The cooperation with Ecoshape for example opened doors for the municipality of Delfzijl in terms of budget, political support and publicity. After all, Marconi seemingly serves the purpose to maintain the city's economic competitiveness. Further, the fit of the Spadenlander Busch with WwN turned out as unintended coincidence, as seen in many other WwN cases (Fuchs, 2014). Correspondingly, it remains questionable if the project really indicates some sort of rethinking within the HPA. More likely, it is just a highly welcome possibility to obscure the authority's strict mission by law, which is to maintain the port economy. Ironically, the research revealed that the project is actually not BwN/WwN-conform anymore since its reformulation as Natura 2000 compensation measure. The latter is, by the way, a consequence of the city's river deepening plans in favour of the port's competitiveness.

In that sense, the study also confirms the impression of Gupta et al. (2013) that water problems have a strong political dimension, covering issues such as ownership and valuation, integration or exclusion, and of course, the focus and design of a management system (Gupta et al., 2013). Logically, this involves some highly normative issues, of which the case studies demonstrated a few. As a clear delimitation of a SES is considerably more difficult in reality than the model by Ostrom (2009) suggests (Figure 8), both projects somehow failed in this context: The Marconi saltmarshes do seemingly not benefit the morphology of the Eems-Dollard as a whole, whereas in Hamburg, the HPA refuses the joint consideration of the Spadenlander Busch site with other projects along the Elbe. This means that the project's interactions within the wider system are not fully accounted for. In other words: enhanced resilience on project scale might go at the expense of resilience elsewhere in the two estuaries (*sensu* Porter and Davoudi, 2012).

BwN between political rhetoric and management practice

The final conclusions drawn in this thesis are in line with Vörösmarty et al. (2013), Pahl-Wostl et al. (2010) and others, who denounce the prevailing gaps between scientific discourses, political rhetoric and actual water management practice. Water management is closely linked to the most pressing challenges of our time (Gupta et al., 2013), wherefore a 'sustainability transformation' (Olsson et al., 2014) within the water domain is of exceptional importance for the realization of SD. A resilience-based and non-anthropocentric relationship between society and nature is the necessary pre-condition (Halliday and Glaser, 2011). While this new paradigm seems well established in the academia by now, the corresponding shift in the water-engineering sector, governance structures and political agendas is only at its beginnings (e.g. Pahl-Wostl, 2006, 2015, Huitema and Meijerink, 2010a).

Accordingly, *"[t]he kind of profound system innovation that BwN advances not surprisingly hits a wall of existing authority and established perceptions of roles."* (Wesselink and De Vriend, 2009, p.11). Since present BwN projects gather broad international attention lately, it is expected that a critical mass of 'success stories' will soon speed-up the required changes (NSR, 2016). The manager of the new Interreg BwN project (compare section 2.2.3), Egon Baldal, envisages the future of BwN therefore as follows: *"Rosy! At the moment BwN is still highly project-specific, but if it gains wider acceptance it can be upscaled. [...] I expect that in 20 years' time we will consider the BwN solution first and then revert to traditional methods if there is no other option." (NSR, 2016, n.p.)*

This research gives a less optimistic impression. As long as economic efficiency and competitiveness stay the main drivers behind water management projects, and since environmental objectives do not belong to the core responsibilities of institutions like the HPA, regimes will always seek to maintain the status quo (Pahl-Wostl et al., 2010). This thesis clearly demonstrated how BwN still provides many conceptual 'loopholes', so that it can be easily re-interpreted or modified to suit the long-standing practices and perceptions of dominant regimes (*sensu* Huitema and Meijerink, 2010a). Hence, BwN will probably face the same destiny as many other approaches towards sustainability: it will either remain a peripheral phenomenon, become adopted only 'on paper', or will be turned into a 'green washing tool' for economic interests. The few BwN projects that make it to realization will probably fall short of expectations. To play a major role in the future, BwN must therefore reduce its conceptual weaknesses and further prove its practicability in large-scale 'business cases'. First and foremost however, it relies on a consequent reconfiguration of water management regimes following the *'building **with** nature'* paradigm Figure 33 sums the conclusions up in a highly simplified way.

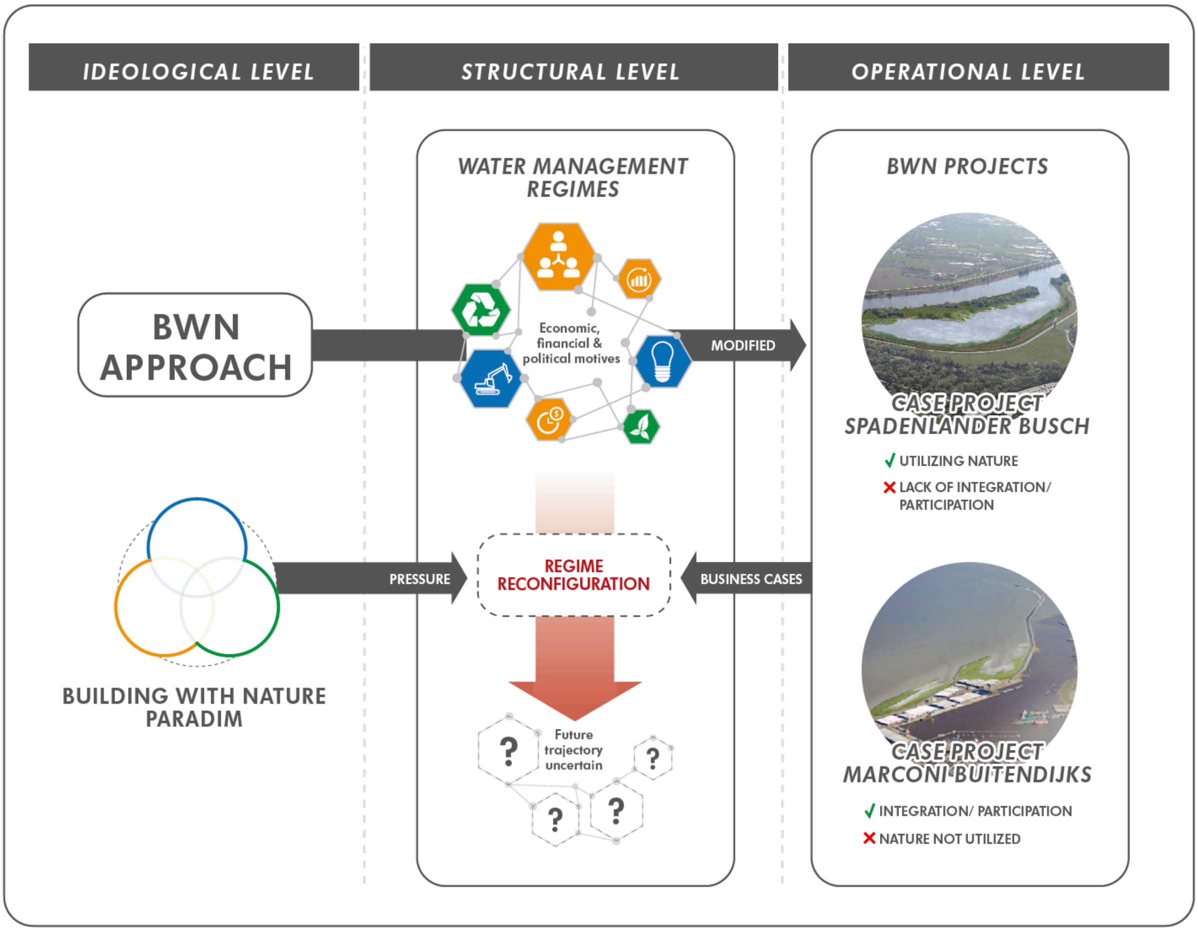

Figure 33: The main conclusions add up to the conceptual model. The current regimes modify the BwN approach to fit their main motives. Consequently, the BwN projects fall short in some aspects. The proper implementation of BwN requires a major regime reconfiguration. Therefore the new paradigm and successful BwN business cases must mutually reinforce to add pressure to the present water management regimes. It remains unclear though how this process turns out (own figure)

6 Reflection and recommendations

In this final chapter, I reflect on the research process itself and discuss the contribution of this study to planning theory and practice. It closes with recommendations for further research.

Relevance of the research

This final thesis has delivered two things: first, an advanced conceptualization of the BwN approach. If applied to practice, as I did within this thesis, the framework can give a qualitative indication how congruent a project is with the BwN approach. The assessment can serve as basis for a discussion about a project's general performance and might reveal potential pitfalls or opportunities that can be easily overseen otherwise. The proposed framework is in line with several claims for an advanced, holistic and applicable BwN 'tool'. Nonetheless, detailed and quantitative project analysis will require a much more sophisticated version and a stronger consideration of normative issues.

The second deliverable is a different perspective on BwN in practice and its role in contemporary and future water management. By now, most contributions about this topic stem from Ecoshape or other BwN advocates. Critical reflections on BwN are actually non-existent. This thesis provides a more objective view by revealing the motives behind two BwN 'success stories' as well as some considerable gaps between aspiration and practice. As both Ecoshape and PIANC want their approaches to be further taken up, this research provides a good opportunity for them to reflect.

Methodological reflection

Several authors have highlighted the risk of researcher-bias when case studies are conducted by single researchers (e.g. Gupta et al., 2010, Nemec et al., 2014) – as I did in this thesis. Besides this, I also developed the BwN framework by myself. Due to this, I took measures to enhance the thesis' reliability as much as possible. For instance, Interviews followed a guideline, were fully transcribed and subsequently analysed with a retrievable set of codes. However, I realized during the transcribing process that the formulation of some questions and the way I asked them might have influenced the interviewee's responses. Also, five interviews of about one hour each is probably not enough for two cases, although they were backed by an extensive document study. Furthermore, I studied two projects that are not even completed yet; therefore some research findings are based on expectations and predictions. Consequently, I cannot rule out the danger of some researcher-biases, and must admit that the validity and generalizability of my case study findings is partly restricted.

Another methodological issue concerns the use of the framework. In this thesis, I applied a limited amount of project data onto it. This directed type of analysis clearly reduces the framework's explanatory power. In a more extensive study, the framework should be applied *onto* the projects therefore, which means the other way around. In that case, data must be collected explicitly for every single framework element, so that more reliable and much more detailed conclusions can be drawn.

Recommendations for further research

Based on the findings of this study, some recommendations for further research can be made:

- The literature suggests that some important contextual aspects might influence the acceptance and success of BwN solutions. These have not been considered yet. One of them is the potential difference in national or regional planning cultures (e.g. Van der Meulen et al., 2015, Wesselink and De Vriend, 2009). Moreover, similar water problems in different areas of the world might require completely different solutions due to their geophysical situation; Gupta and Bavinck (2017) for instance point out that the social vulnerability to coastal disasters strongly differs between the 'Global North' and the 'Global South'. These aspects require further consideration.

- A revised version of the framework should better account for normative issues and subdivide some of the principles that turned out as too broad. Self-organization for instance could be separated into an ecological and social dimension. Moreover, a more extensive case study should analyse and compare BwN projects from different environments to generate more generalizable conclusions.
- The correlation of BwN, regime changes and sustainable development should be further studied by connecting to the research fields of transitions and transition management (e.g. Loorbach, 2010, Huitema and Meijerink, 2010a, Pahl-Wostl, 2015), transformative agency (e.g. Westley et al., 2013), and sustainability transformations (e.g. Olsson et al., 2014). They gained considerable academic attention lately and provide some promising new perspectives on societal change and the relationship of society and nature.

Lessons learned
The various research fields considered within this research are vast and growing. Accordingly, the thesis scratches many topics only on the surface. Nonetheless, it appeared paradox to me to further limit my research scope while writing about the importance of holistic approaches and cross-disciplinary research. In fact, various authors (e.g. Young et al., 2006) point out how future generations of researchers and practitioners must overcome disciplinary boundaries and cross both spatial and temporal scales in their work. Therefore I tried to address the entire bandwidth of BwN in my master thesis. It became clear that this great challenge, but it also gave me an impression of the challenges that water managers face on a daily basis.

My greatest personal achievement from this research – beyond the scientific insights I gathered – is a much more efficient and goal-oriented workflow. I (again) realized how important it is to develop a well-structured and workable research concept *prior* to the actual research process.

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8 Appendix

Appendix A: Translations of German interview quotes

German quotes were translated into English. The translations are listed below and follow the same sequence as in the results chapter.

Page 40
"There was also some kind of external instigation, that Schleswig-Holstein said 'do something'. Hence we said, ok, let's do something. We make the first step towards the concept's implementation." (HPA manager)

Page 41
"An area that was completely useless in terms of nature conservation becomes quite valuable for nature conservation through this HPA measure to lower the tidal range. And, one must admit, these two issues come together here in a nearly perfect manner, which is rather unusual." (BUE specialist)

"You have a small city here surrounded by a steel wall, hence with its back facing to the water. When you walk around a little, it does not all feel like this is a port city. It is completely cut off." (Marconi manager)

Page 42
"We did it right intuitively. We started the project and then we found out about this WwN philosophy of PIANC and their WwN award. So, we just applied for it and won by accident." (HPA manager)

"The HPA did this to decorate itself a little bit. They also received this award for their project, which indeed is some kind of top seller." (BUE specialist)

Page 43
"So afterwards, we asked Ecoshape, because they were already involved in this port project. Thus, we talked to them and asked them, if they also have knowledge about saltmarshes, and they said yes." (Marconi manager)

"The working process went well I have to say, since we were involved from the beginning. Due to the fact that we branded it as conservation area, there were no more target conflicts in terms of nature conservation anymore." (BUE specialist)

"Well here, Kreetsand, it has been developed mainly in cooperation with the hydrology department." (HPA manager)

"So, we were stucked. So the mayor said, we must do something, let's get the people together, since we do not own the dike, not the water areas, and also not the industry – but we want to do something!" (Marconi manager)

Page 44
"No. They were too uncreative for that." (HPA manager)

Page 45
"We receive the documents, but normally everything is done already. This is the design for approval, and the applicant never felt like changing anything fundamentally. This is indeed frustrating for us, since the organizations become involved only at a very late stage in many instances, where it is decided already what's going to happen." (NABU specialist)

"Because we cooperated with Ecoshape, the nature organizations and German partners, we got the OK for this project. The province, who invested a lot in this, found it good that we reached so much together, which is why they gave us the money." (Marconi manager)

Page 46
"We considered several measures and did some modelling, and we found out that altogether, they could have a quite strong effect." (HPA manager)

"It remains unclear whether this works as expected, or completely different. Will nature do what we expect? This is highly complex and hard to predict in an estuary such as the Elbe." (BUE specialist)

Page 47
"I don't know. Indeed, this was interesting for the IBA. We also said, well, if this is a pilot-project, we want to use it as well, which is why we commissioned this study. I think it will be done correspondingly after the project is finalized."
(HPA manager)

Page 48

"This is a project by the HPA, and the HPA is not responsible for nature conservation. This is about port interests and port development, with the aim to create flood space for lowering the tidal gauge. If we were responsible, well, indeed we would have done some things differently, but in total, this is a very good project, also for conservation." (BUE specialist)

"Reducing the tidal gauge has an positive ecological effect as well. Of course, it is a hydrological issues first of all, but ecosystems also suffer due to the exaggerated tidal dynamics." (NABU specialist)

"Well we tried it, but were weren't that far back then. There is still a model on the website, showing plans for a construction of 6 metres height with a sand dune and saltmarshes in front. However, this was too expensive, and we decided only for the saltmarshes in the end." (Marconi manager)

Page 50

"The nature organizations suspect that this is only some sort of pseudo-participation and -discussion without any outcome. Hence, that this is talking only, so that we don't need to act." (HPA manager)

"Most importantly, do it together, this is essential, so everybody benefits, and openness – no secrets in front of each other. Collaboration creates synergies, more drive and consensus." (Marconi manager)

"Well, we and the province asked ourselves if this concept can't be translated to the province. Since then, it was not called Marconi anymore, but Vitale Kust. The way of working is the completely the same." (Marconi manager)

Page 51

"We really have a conflict of interests here. Of course we need to further develop the port to keep it competitive. For that, we need to fill up areas such as port basins. However, we also realized that this is actually not good, which is why we create new water areas elsewhere. This seems like a contradiction, but we can't solve it. Except we would say well, let's stop with the port." (HPA manager)

"At a certain point, there was this switch that was turned over, and it was stated, well, we want to deepen the Elbe, but we need coherence measures, so we just take reformulate the project. Here, the nature organizations felt quite fooled. Now it's no extra measure anymore, but they connect it to something that we oppose: the Elbe deepening." (NABU specialist)

Appendix B: Preparatory note for interviewees

ERLÄUTERUNG FÜR INTERVIEWPARTNER

Mike Martens: Masterarbeit (dualer Master), 2016-2017
MSc Water and Coastal Management (Universität Oldenburg, Deutschland)
MSc Environmental and Infrastructure Planning (Universität Groningen, Niederlande)

Die Rolle von 'Building with Nature' in der Wasserwirtschaft – theoretischer Anspruch und praktische Umsetzung des neuen Konzepts (Arbeitstitel).

Sehr geehrte/-r..........,

Vielen Dank für Ihre Unterstützung bei meiner Masterarbeit! Im Folgenden erläutere ich kurz die Ziele meiner Arbeit sowie inhaltliche und formale Aspekte des Interviews.

In meiner Arbeit behandle ich das neue *Building with Nature* Konzept aus den Niederlanden. Es entstand als Reaktion auf die zunehmenden Umweltbelange und scheinbar 'unlösbare' Probleme, mit denen die heutige Gewässerplanung konfrontiert ist. Kurz gesagt, *Building with Nature* sucht nach nachhaltigen 'Win-Win' Lösungen für Küsten- und Gewässerstrukturen, z.B. im Hochwasserschutz. Dies geschieht u.a. durch den aktiven Einbezug der Natur in Planung und Umsetzung von Maßnahmen.

Ziel meiner Arbeit
Meine Arbeit hat zwei Ziele. Erstens entwickle ich ein *Building with Nature* Rahmenkonzept. Es fasst die 'theoretischen' Ansprüche und Ziele des Konzepts in einer umfassenden Art und Weise zusammen. Darüber hinaus führe ich zwei Fallstudien durch: das 'Marconi Buitendijks' Projekt in Delfzijl (NL), und das 'Spadenlander Busch/Kreetsand' Projekt in Hamburg. Letzteres ist zwar kein offizielles *Building with Nature* Projekt, wurde aber von der PIANC als *Working with Nature* Projekt anerkannt und ausgezeichnet. Die beiden Konzepte sind annähernd deckungsgleich.

In den Fallstudien erforsche ich, warum und auf welche Weise *Building with Nature* in der Praxis umgesetzt wird. Das Interview ist Teil dieser Fallstudien. Dabei möchte ich insbesondere auf folgende Aspekte eingehen:

- Was sind die Motive für die Verwendung von *Building with Nature*?
- Wie wird *Building with Nature* interpretiert und praktisch umgesetzt?
- Welche Vor- und Nachteile ergeben sich daraus?
- Inwieweit beeinflusst *Building with Nature* bestehende Planungsstrukturen und -prozesse?

Ethische Aspekte des Interviews
Ich würde das Interview gerne aufzeichnen und in meiner Arbeit in Verbindung mit Ihrem Namen verwenden. Die Daten werden selbstverständlich vertraulich behandelt und korrekt widergegeben. Bitte lassen Sie mich vor Beginn des Interviews wissen, ob Sie damit einverstanden sind.

Mit freundlichem Gruß,

Mike Martens
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Note: There are versions available in English and German. Each note got personalized.

Appendix C: Interview guideline

1) Introduction

- ***Preparatory note (recapitulation):*** Introduction of myself, my research objective, ethical issues etc.,
- Ask for interviewee's consent.
- Explanation of the role of this particular interview in the research process.
- Clarification of the interviewee's formal background: Organization, position, function etc.
- What are your stakes in (or interests towards) the project?

2) The project background

- What are the main goals of the project in general, and what is planned to achieve them?
- How did the project develop over time, and how does the schedule for the future look like?
  What is the current status?
- Have there been (or will there be) changes in the project plans? If yes – what and why (Examples)?
- ***Action:*** Joint drawing of an organizational diagram of involved actors, organizations etc. and their functions (e.g. steering, advising etc.).

3) Building with Nature

- What is the concrete role of BwN in this project?
- How and at what stage did BwN 'enter' the project?
- Why did the approach change towards BwN? What were the motives?
- Was the adoption of BwN connected to any specific objective, requirement or incentive?

- What are the practical implications of BwN for the planning, implementation and aftercare of the project (Examples)?
- Can you give a concrete example what you are doing differently now (compared to the traditional approach)?
- Which advantages do you see (Examples)?
- Can you name some practical problems from your daily experience with BwN?
  How are they dealt with?

- How does the uptake of BwN in this specific project affect the planning structures and processes more generally? Will it have lasting impacts that go beyond the project (e.g. in decision-making processes)?
- What are your personal expectations from BwN? Do you miss anything from the concept?

4) Closure

- ***Closing question:*** If you had to start the whole project from the scratch again – what would you change, and why?
- Are there other relevant topics you like to discuss?
- ***'Snowball-approach':*** Ask for other potential interviewees as well as for documents the participant considers most important. If required, ask for contact information and how to get the documents.
- Expression of thanks and farewell.

Appendix D: Code tree for data analysis

The table below shows the codes that were used in MAXQDA to analyse the interviews and documents (3.2). Deductive codes are derived from the BwN framework. Inductive codes were added during the analysis and relate particularly to Q3 of this research.

Deductive codes		**Additional inductive codes**	
Category	**Code**	**Code**	**Description**
SES_Lens	Integration	Future_changes	Information about the 'aftermath' of the projects, follow-up measures etc.
	Participation		
	Shared_knowledge	Paradigm_change	Indications of a paradigm change, change in societal values or future planning procedures.
	Long-term_focus		
Resilience_Lens	Resistance	Natura2000	Issues that relate to Natura2000 regulations, which were of importance in both cases.
	Diversity_Redundancy		
	Self-org_feedbacks	Finance	Information about the budgeting of the projects.
	Social_learning		
	Innovation	Time_planning	Information regarding the project's schedule.
Ecol-Eng_Lens	ES-approach	Circumstances	Issues about the project's larger backgrounds, e.g. the political situation, site history etc.
	Creation_utilization		
	Memory	Motives	The motivations behind the projects.

Appendix E: Findings of the BwN concept analysis

The table below lists the BwN sources that have been analysed for the concept analysis (3.1.1). The second column shows the most important aspects of each source; these are also the inductive codes that were developed and applied during the analysis. The right column provides some related key statements from each source.

List of analysed BwN sources

Source	Focus (MAXQDA codes)	Important statements
Aarninkhof et al. (2010)	- Sustainable development - Paradigm shift - Innovation	*"Innovation is needed to develop new, integral approaches towards the design and realisation of marine infrastructure, based on a sound understanding of ecosystem dynamics, construction processes and stakeholder demands." (p.2)*
De Vriend (2014)	- Ecological Engineering - Governance - Hurdles for implementation	*"When working in terms of net present value, make sure the discounting rate is realistic, especially for the nature components in the project. Note in this respect that nature takes time to develop and cannot be bought ready-to-use whenever it is needed." (p.35)*
de Vriend et al. (2015)	- Ecological Engineering - Ecodynamic Design - Integration	*"BwN is about meeting society's infrastructural demands by starting from the functioning of the natural and societal systems [...] it requires a different way of thinking, acting and interacting." (p.160).* *"The design of hydraulic engineering projects is no longer the exclusive domain of hydraulic engineers. Collaboration with other disciplines [...] is crucial to come to acceptable solutions." (p.159)*
de Vries et al. (2016)	- Innovation - Valuation - Ecological Engineering	*"[...] the conventional (usually robust and proven) infrastructure solution should be considered as a reference to answer the questions whether a sandy strategy provides either additional values (for which someone wants to pay) or is potentially cheaper." (p.11)*
BwN Book (De Vriend and van Koningsveld, 2012)	- Paradigm shift - Governance - Diversity - Ecological Engineering	*"Involving the public provides valuable insights into local systems and processes, and so is more likely to lead to better solutions that stakeholders are more likely to accept." (p.10)* *"The BwN approach promotes the consideration of more gradually developing solutions. Especially when used in combination with traditional, proven technologies, this approach can lead to cheaper and more aesthetically appealing solutions that adjust or can be adjusted to changing circumstances." (p.10)*
Lulofs and Smit (2012)	- Windows of Opportunity - Governance - Complexity - Experimentation	*"At least assess carefully the ownership and user rights, stakes and positions and assess the history of the area." (p.15)* *"BwN gives society the opportunity to build while drawing on the dynamics of the natural system." (p.3)*
van Slobbe/Lulofs (2011)	- Fragmentation (in decision-making, funding) - Uncertainty	*"BwN can be considered as an ongoing process of seeking solutions to newly emerging problems and ambitions, [...]." (p.23)* *"Actor's preferences, knowledge and resources change over time and so do contexts. So monitoring governance systems in order to assemble coalitions and map out opposition needs to be done on a continuous basis." (p.23)*
van Slobbe et al. (2012)	- Experimentation - Windows of Opportunity	*"[...] Experiments served as a boundary object [...]. It allowed parties to maintain conflicting positions, while at the same time creating an atmosphere of collaboration and good will." (p.36)* *"The situation forced the existing regime of coastal management to rethink their practices, which created an Window of Opportunity for experimentation." (p.35)*
van Slobbe et al. (2013)	- Resilience - Social learning - Ecosystem services	*"A resilient infrastructure is able to adapt to changing conditions that influence safety thresholds or standards in the long run." (p.1465)* *"Analysis of coastal protection systems must start by 'reading' such systems in terms of dynamic interactions and possible drift phenomena." (p.1465).*
Stive et al. (2013)	- Soft engineering - Paradigm shift	*"The projected climate change and the increased socio-economic pressure on the coastal zone require a paradigm shift in the implementation of coastal interventions, such that these interventions are to become larger and evaluated multidisciplinary." (p.1543)*

Temmerman et al. (2013)	- Ecological engineering - Paradigm shift	*"The creation or restoration of large coastal ecosystems provides a new alternative or add-on to conventional coastal defences [...]." (p.80)*
Van den Hoek (2011)	- Resilience - Uncertainty	*"Resilience-based approaches direct natural system dynamics towards behaviour that is adaptable to changing conditions. This way of managing overcomes the limitations of control-based approaches by pro-actively using natural system dynamics for design and realisation of water engineering projects [...]." (p.1)*
van den Hoek et al. (2012)	- Unpredictability - Knowledge frames - Social learning	*"The use of ecology and natural dynamics inherently adds high and often irreducible levels of uncertainty to a project's design process." (p.86)* *"Strategies are needed to cope with the diverging knowledge frames and interests of stakeholders, because they have different roles and backgrounds. Increasing participation, cooperation and dialogues between stakeholders can be powerful tools in this respect." (p.93)*
Van den Hoek et al. (2014)	- Ambiguity - Uncertainty - Participation	*"To come to a scientifically valid, socially robust, and context-specific knowledge base, different knowledge sources, i.e., expert and local knowledge, should be integrated in participatory processes." (p.10)*
Van der Meulen et al. (2015)	- Natura 2000 - Ecological Engineering - Innovation	*"Compensation for loss of coastal nature in combination with economic (harbour) development, working with natural processes, allowing ample time for nature development and a coastal (defence) policy with joint public and private stakeholders, are key aspects." (p.713)*
van Raalte et al. (2011)	- Ecodynamic Design - Integration - Paradigm shift - Sustainable Development	*"[...] with proper integration of ecology, economy and societal needs substantial gain can be achieved in development of sustainable hydraulic engineering projects." (p.9)* *"[...] stakeholders are open to a constructive cooperation, as long as their interests are understood and transparently taken into account as much as realistically possible." (p.10)*
Vikolainen et al. (2013)	- Natura 2000 - Integration - Hurdles for implementation	*"Nature and the environment are given equal consideration alongside a project's socio-economic goals in the initial stage of project planning and design. [...] the design aims to improve the conservation status of habitats and species compared with the existing status in the project area [....]" (p.1362)*
Vikolainen et al. (2014)	- Natura 2000 - Integration - Hurdles for implementation	*"The aim of the program was to seek infrastructure solutions that both utilize and enhance the natural system, such that the ecological and economic interests of a project are mutually reinforcing." (p.5)*
Waterman (2007)	- Integrated coastal zone development	*"The essence of this principle is: flexible integration of land-in-sea and of water- in-the-new-land, making use of materials, and forces & interactions present in nature, taking into account existing and potential nature values, and the bio-geomorphology & geo-hydrology of the coast and seabed." (p.7)*
Wessellink/de Vriend (2009)	- Sustainable Development - Social learning - Governance -Paradigm shift	*"Ultimately, because of the uncertainty inherent to complex natural systems, opportunities for building with nature depend on the adaptation of a more bold and brave approach where uncertainties are accepted and goals are pursued by learning-by-doing in experiments." (p.4)*
Ecoshape Website (2016)	- Sustainable Development - Adaptability - Ecodynamic Design - Social learning - Integration	*"Society and environment change rapidly. Sustainability and adaptability are therefore important attributes of hydraulic infrastructure." (n.p.)* *"By including natural components in infrastructure designs, flexibility, adaptability to changing environmental conditions and extra functionalities and new natural services can be achieved, often at lower costs on a life-cycle basis than traditional engineering solutions." (n.p.)*

Appendix F: Interview transcripts

The transcriptions of the interviews (see Table 5, p.23 for full list) are digitally available on the attached CD-ROM.