Possibilities for Complex Adaptive Systems in Water Management projects in the province of Groningen

A Comparative Qualitative Research to examine Complexity in current Water Management Projects, considered from a Complexity Theory approach

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Abstract

Water Management projects are increasingly faced with complex issues due to changes in both physical and social systems in planning processes and decision making. Recognizing both systems is key in addressing today's relevant issues that policy makers in water management face, such as climate change, population trends, and increased calls for bottom-up governance. This thesis draws upon a framework of complexity theory, analyzing key concepts of nonlinear development, contextual interferences, co-evolution, and self-organization in four case studies. Three case studies [Marconi Buitendijks, Double Dike, Wide Green Dike] are coastal water management projects in Groningen and one case study [Oosterwold] is a new area development project touted as highly complex in its approach. Analysis of policy documents and qualitative data gathering [interviews] show that coastal projects in water management are open towards incorporating key concepts of complexity, though within contained areas and under central coordination by government. This applies to the physical system but not the social system. As of now, the coastal projects are rather robust and linear overall. The research in this thesis suggests that further exploration and incorporation of complexity on the social dimension could be beneficial if the regional programs seek to further profile themselves as adaptive and as stimulating local economic activity, providing new insights and possibly successful trajectories of bottom-up governance.

Keywords: Complex Adaptive Systems, complexity, nonlinear development, contextual interferences, co-evolution, self-organization, water management, coastal projects

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Chapter I: Taming the Tides, an Introduction

1.1. Setting the Stage

An increasingly changing world of water management has seen planning practices and approaches, as well as the values emphasized in project, shift from an outlook that is one-dimensional to one that is multidimensional. Water management in particular has shifted to more inclusive and broad perspectives in the Netherlands. Planning practices and new projects in water management are increasingly combining different values and sectors, aiming to bring a variety of stakeholders together. These stakeholders can have radically different values and perspectives on how to approach and deal with water and how it is to be used. In the decades after the second World War, the Netherlands went through a period in which top down planning practices were the norm. In water management this meant that water was often seen in an economic context. The province of Flevoland had been 'created', land taken from the sea, and plans existed to do the same with the Wadden Sea. The cultural context of the 1960s and beyond resisted such visions and emphasized ecological values. These additional functions of the Wadden Sea, recreation being another one, became increasingly part of mainstream thought and political discourse. While new values became more acceptable, water management was still characterized by top down planning practices that emphasized water safety. Water was still seen as not just a means for infrastructure, but also a threat from which people had to be protected.

Due to severe river flooding in the 1990s it became obvious that water safety could not be realized through dikes alone. Space had to be given back to water so it could be maintained instead of controlled. At the same time, ecological restoration became increasingly important due to species' decline and further integration and collaboration of and between European countries saw the realization of the European Union (EU). The environmental department of the EU established European-wide Natura 2000 network program, which was adopted in 1992 by the European Union (European Commission, 2019).

1.1.1. The Wadden Sea: A Delicate Complex System

The Wadden Sea is a roughly 8,000 year old (Common Wadden Sea Secretariat, 2019) intertidal zone stretching from the north-west of the Netherlands, all along the coastline, to the far north-east of Denmark. It is the largest tidal zone in Europe, and a UNESCO world heritage site

(UNESCO, 2014), with tidal flats [ebb and flow] and salt marshes along the coastline of the continent and its many islands. The Ems-Dollard is one its estuaries, where salty and sweet water meet and form a unique ecosystem.

The Wadden Sea is both an open and a dynamic system. Exchanges of water [sweet and salt], nutrients, mud, and organic matter interchange between sea and rivers (Waddenacademie, 2019). The openness of the system and it functioning as a connection between the North Sea and the continent means it is far from an isolated system. It is also dynamic, as changes can be observed and happen continuously. The dynamic nature of the islands, receding sand on the western shores and advancing sand on the eastern shores means the islands are 'on the move'. Of course these systems have been exploited and altered by people's desire for robustness, such as through the construction of dikes.

1.1.2. Restoring the Balance

From 2016 onwards, the national government and the region will structurally work on the ecological restoration of the estuary through measures and researches based on a multi-year adaptive program (Postma, 2018). Accordingly, the regional government will match it through the ''Economy and Ecology in balance'' program. By improving the nature of the estuary, through removal of sludge and creating additional salt marshes, not only will the ecology improve but it will also provide possibilities for economic growth (Ibid.). The region is also characterized by much population shrinkage and an improvement of the ecology may just create multiplier effects on economy and increase jobs and possibly prevent brain drain.

This program, which will be on the agenda for the coming decades, has the aim of matching the ecological targets by 2050 (Postma, 2018). As the health of the economy is intrinsically linked to the physical system, it will prove no small challenge to not just making changes to the physical system, but also provide opportunities for local and regional citizen wishes and concerns, and their involvement in the process of improving the estuary. The projects [and the program] consider themselves to be adaptive (Ibid.), acknowledges evolutionary pathways and places much importance on contextual interferences. Along the coastline, a number of different projects have come to life, some of these in urban areas, others in thinly populated rural areas. Some are directly connected to economic development and improving livability, while others are pilot projects where new innovative solutions to dike strengthening are explored.

1.2. Methodology

First, the theoretical argument will be introduced and discussed in Chapter II. Next, a brief case description of each chosen case study, and analysis and comparisons of the cases are presented in Chapter III. The final part of the research, Chapter VI, will conclude the research.

1.2.1. Research question

The goal of this thesis is to analyze core concepts of complexity theory in order to assess *if* and *to what extent* complex adaptive systems [CAS] can be used in future water management projects in the Netherlands. It provides practical examples and lessons for this sector by analyzing and comparing different cases. These are the Marconi Buitendijks, Double Dike, and the Wide Green Dike cases. The Marconi Buitendijks is already in a more advanced executive phase, whereas the Double Dike and Wide Green Dike have just began to take off. Furthermore, the case of Oosterwold will be analyzed, as it is an experimental project that contains characteristics of a complex adaptive system. It is a project which is situated outside of the immediate domain of water management, and will be used as comparison to provide further understanding as to if, and to what extent, water management projects could benefit from adopting characteristics of complex adaptive systems.

The primary research question is the following:

Do current water planning projects along the Wadden Sea coastline show characteristics of Complex Adaptive Systems? And if so, to what extent may they be, or not be, beneficial to future water planning projects?

1.2.2. Secondary research questions

- *What is the current framework of planning in existing water projects along the Wadden Sea coastline in the province of Groningen?*

- *Can these current frameworks be characterized as Complex Adaptive Systems?*

- *To what extent are Complex Adaptive Systems possible in water planning?*

- *Are Complex Adaptive Systems desirable, and if so, in what contexts?*

1.2.3. Research approach

The aim of this thesis is to analyze complexity in a select number of cases of water management projects along the Wadden Sea coastline in the province of Groningen. Through comparing different cases within this sector, and the experimental area development of the Oosterwold case, in the province of Flevoland, can the research question be answered.

First, literature will be explored to provide deeper understanding of the history of planning theory in general and in water management, drawing on the work of Hurbert and Gupta (2016), Rotmans et al. (2001), Healey (1996) and others. Following the works of De Roo (2012, 2015, 2016), Rauws et al. (2014) and others, a theoretical framework will be provided for analyzing complex adaptive systems. The work of van Buuren et al. (2013) on robustness versus flexibility will provide a bridge between planning approaches in water management and complexity theory.

To examine the degree of complexity within the chosen projects, the concepts of robustness and flexibility (van Buuren et al, 2013), as well as the characteristics of complexity – mainly nonlinear development, contextual interferences, self-organization and co-evolution (Rauws et al., 2014; de Roo, 2015; de Roo, 2016) – have been explored. These core concepts are put in a theoretical framework of complexity, and are used for qualitative data gathering.

1.2.4. Research strategy

A qualitative research strategy will be selected for this thesis. It is designed as a comparative research, with four case studies as the object of research, to ascertain if, and how, complexity returns in water management projects along the Wadden Sea coastline. The planning processes of these cases [Marconi Buitendijks, Double Dike, Wide Green Dike] will be compared to one another and to the experimental area development of Oosterwold. Qualitative data gathering is chosen as this research method can provide answers to questions and analysis of complex adaptive concepts such as co-evolution and self-organization. These concepts are ambiguous and how stakeholders define them may vary. Also, when a smaller number of cases

is analyzed, it is more likely to provide more attentive to details that are otherwise overlooked in quantitative data gathering, such as statistical analysis (Lijphart, 1975). Comparative research has advantages of establishing patterns and processes through which stakeholders share and make meaning of space. Through comparison of different case studies, important lessons can be learned for the advantages and disadvantages of *complexity in practice* in water management.

The first cases of this thesis that were selected were the Marconi Buitendijks and Double Dike projects. After conducting several interviews with stakeholders that worked on these projects it became evident that additional cases had to be analyzed to improve understanding of water management projects along the Wadden Sea coastline. The Marconi Buitendijks and Double Dike projects are in their executive phases and prove therefore more fixed in some ways and younger projects provide deeper insights in possibilities of analyzing where CAS can emerge. Thus, two more cases, the Wide Green Dike and the Lauwersmeerdike, was selected for analysis. Both cases are also situated along the Wadden Sea coastline and situated in thinly populated regions and therefore provide variety of insights compared to the first two cases which are either situated in the town of Delfzijl [Marconi Buitendijks] or only a few kilometer outside of it [Double Dike]. In a later stage during the writing of this thesis, a third case, that of the area development Oosterwold, was selected due to its experimental nature and because it postulates itself as complex and as a self-organizing region (Gebiedsontwikkeling Oosterwold, 2019; Lekkerkerker 2016). At a later stage of writing, the Lauwersmeerdike was scrapped as a case selection due to limited information available, which proved to be hindering the analysis, and because the thesis simply became too expansive. Deeper focus was therefore placed on the other case studies.

The projects in this thesis serve as case studies to better understand the planning culture behind water related projects in the province. By drawing on these cases we can observe planning patterns and practices that may or may not be beneficial to future water projects along the Wadden Sea coastline. This will provide existing and future projects – both in the pre-executive state - the capacity to understand - where issues may arise or can be tackled. This research will be based on qualitative research methods, namely literature research, policy documents, interviews, and comparative research. This method is particularly advantageous because it allows for insights that may be overlooked in single case studies. More so, through comparing cases we achieve a better understanding of what may or may not make the

difference observed between the cases. The comparable-cases strategy will be selected (Lijphart, 1975). A comparison of these cases gives greater depth and meaning, and for patterns to be found, which are explored in Chapter III.

1.2.5. Steps of research strategy

The research strategy will consist of the following several steps.

Step I: *Exploration and analysis of theoretical background*.
Careful reading and analysis of academic literature of the history of planning, water management, and complexity theory are necessary in order to situate the cases within a broader planning framework.

Step II: *Exploration and analysis of the background of projects*.
To understand the context and planning processes and approaches of the projects along the Wadden Sea coastline as well as the area development of Oosterwold, analysis of policy documents said projects are conducted. Furthermore, many work ateliers of the Marconi Buitendijks project were analyzed.

Step III: *Conducting interviews with key stakeholders*.
To assess the degree of robustness vs. flexibility and to what extent complex adaptive characteristics return in the planning processes and approaches of the projects, semi-structured interviews were conducted with relevant stakeholders directly involved in project development.

Step IV: *Analysis and interpretation of qualitative data*.
The last step of this research was to analyze and interpret the data that was gathered during the semi-structured interviews. The interview guide contains questions directly related to these concepts. Comparisons were made between projects, to look for similarities and differences.

With these four steps in place, a better understanding can be attained about the prevalence – or lack thereof – of the chosen core concepts in planning practice. It shows to what degree they are found within these projects, and whether current and future regional development

projects in water governance could benefit from embracing these core concepts that return in complex adaptive systems.

1.2.6. Ethical guidelines

Stakeholders were found through policy documents and work ateliers. They were either mailed or called. A number of stakeholders were also found through suggestions made by those interviewed at an early stage. The interview questions were usually mailed in advance to give interviewees ample time to prepare and share relevant information. Sometimes these questions were not mailed because stakeholders were met and interviewed at the Trilateral Wadden Seaports Conference in May 2018. Most interviews took roughly 40 to 60 minutes and nearly all were conducted face-to-face.

Interviewees could end the interview at any moment they deemed necessary. The interviewees were guaranteed anonymity if the information shared was deemed politically or administratively sensitive. This right was invoked by two interviewees, one working for Rijkswaterstaat and another working for the municipality of Almere [area development Oosterwold].

Chapter II: Planning Theory

2.1. A Preview into Complexity

Neither order nor chaos, yet both emerge from the same system we call complexity. We may define it as the in-between phase between order and chaos, where both stability and randomness are co-inhabiting a state of being (Waldrop, 1992). In academic understanding, complexity theory is a collection of theories and consist of a number of concepts, which will be explored in this chapter. Mostly, complexity is explored in natural science but increasingly social sciences have explored and understood the value of seeing social phenomena as also subject to similar phenomena as can be observed in natural systems, although how we describe and interpret these will be a matter of difference (McKelvey, 1999).

Before we can adequately understand new ways and approaches to water management it is key to define the concept of a paradigm first. Having its origins in Ancient Greece, and popularized by the scientist and philosopher Thomas Kuhn, a paradigm is understood as a means of looking at the world. It consists of thought patterns, concepts, and research methods that allow us to provide answers to scientific questions and what is legitimized as truth (Kuhn, 1970). While the nature of water management involves social practices and phenomena it clearly also involves both scientific and technological practices that are guided by an existing paradigm.

It is observed that social reality is also shaped by patterns of thoughts, concepts, and research methods. In water management, social and natural science naturally coexist, as they both deal with natural and social phenomena. A paradigm in planning practice in particular, is revealed through our observation of the assumptions people make about the goals of management, its best approaches to solving problems, how it achieves its goals, and it manages the nature of the system (Schoeman et al., 2014, p. 378). Recognizing paradigms and their characteristics is a useful method that helps us find a better understanding of spatial planning practice. Spatial planning can be defined as the strategies and methods that government and governance use to influence and distribute the activities in spaces and places (van Buuren et al., 2013). Complexity will be the concluding synthesis in this chapter, but first its predecessors require explanation.

2.2. Technical-rational approaches in Water Management

For decades, social science has long imitated natural science through the assumption that social phenomena too, show developments that are stable and replicable. This assumes a worldview where causality is fixed. Consequently, water management, and planning as a whole, has been characterized by rational decision making for many decades. Planning was part of a means by which rationality and science could be achieved. As Allmendinger mentions, planners who worked in public organizations ''had the responsibility to act rationally in an impartial and single-minded way towards the organization's goals'' (Allmendinger, 2017, p.67). In some ways these bureaucrats were even opposed to democracy, preferring to formulate and act through their own forms of legitimacy which was usually purely based on technical expertise (Allmendinger, 2017). Rational planning has its origins in positivist thinking, a worldview in which science alone is seen as fully capable in fixing existing problems in not just the natural world but also the social world. However, there are limitations to such technical-rational approaches as Friedmann pointed out. The more we strive for formal rationality in our actions, the more we realize society is not logically structured but *both* logical and illogical (Friedmann, 1987).

In water management, these technical-rational approaches were specifically seen in command-and-control paradigms (Rotmans et al., 2001). For many decades water management has been heavily characterized by a command-and-control paradigm in which water was purely a means of infrastructure and seen through an economic perspective, a natural resource for agriculture, and something that should be kept as far away as possible from civilians. Central in this line of thinking is engineering resilience, which can be defined as ''the ability of a system to return to an equilibrium or steady-state after a disturbance'' (Holling, 1996). The faster a system bounces back the more resilient it is. As it is firmly seethed within positivism, it should come as no surprise that it seeks efficiency, constancy, and predictability (Ibid.). Engineering resilience is more based on survival and reflects more traditional, top-down responses to deal with perceived [or observed] threats to security. The expertise of scientists and planners is therefore key. Technical solutions to problems are dominant in the command-and-control paradigm. There is also a focus on disaster or risk reduction strategies (Shaw, 2012). Other aspects that could be part of water management - such as tourism, recreation, and nature restoration - are either non-existent or undervalued. The strategy in traditional water management is heavily influenced by its goal of resistance where it aims to ''reduce the

probability of a flood hazard'' (Restemeyer et al.,2015, p. 46). When it comes to the financing of a project, the planning practices where resistance and robustness are central, tend to require high public funds for the construction and more importantly maintenance of defense systems (Restemeyer et al., 2015). Another strategy, which links us to both the next paradigm and more complex approaches later on, that of *adaptability*, requires not just financial support but also social support (Ibid.).

2.3. Communicative-Rational approaches in Water Management

Over the course of the decades after the second World War, a transition has unfolded in how we practice planning. Whereas planning before used to be characterized by top-down decision making and tunnel visioning, in which most planning decisions were made by authorities such as the national government, resistance to these planning approaches began to become more present. Influenced by developments such as globalization, modern communication tools, an increasingly vocal public, as well as values such as environmentalism, calls for equality, and of course the limitations of the old ways of thinking, a transition towards more communicative-rational approaches of planning practice unfolded. These new approaches are characterized by a more holistic view on practicing planning. Generally defined as communicative planning, this paradigm provides more possibilities for all stakeholders to be heard and to take part in the decision making process.

These new planning approaches gained a foothold within planning in the 1960s and 1970s. Dubbed as the ''ecological turn'' (Disco, 2002), it was mostly an environmental movement emphasizing the destruction of human agriculture and technology upon ecosystems leading to loss of [habitat for] species and loss of biodiversity (Schoeman et al., 2014). Social scientist Healey (1996) describes the changes in the 1980s and 1990s in planning practice. She noticed that academics and planners alike were increasingly interested in the societal changes that influenced planning practices and planning decisions. Trust in political organizations had declined while other stakeholders, such as businesses, non-governmental organizations [NGOs], and citizens had become increasingly important in planning practices and decision making. Healey (1996) recognizes communicative planning as central within this change in planning. She mentions how planning underwent paradigm shifts in the 20th century, first towards instrumental rationality, and secondly towards the analysis of the structuring of different economic dynamics in urban regions (Ibid.).

These changes however did not recognize the diverse ways in which we make sense of places. The focus on material conditions influenced planning heavily. In modern planning practice, a much broader and inclusive form of planning can be observed. It is more characterized by concerns of a range of different values and its participants are expected to understand and put themselves in each other's perspectives. It seeks to avoid the old pitfalls of pure material self-interest and competitiveness. It can thus be said that this new wave of planning, as Healey calls it (1996), is better able to deal with today's problems. We now live in an increasingly interconnected global world where cultural tensions and environmental concerns have become more important. This new wave of planning approaches does not necessarily rids itself of the old, it merely sees the old way of technical language as one language among many. Before, under the spell of technical-rational approaches, planning was mostly still caught up in the fundamental Enlightenment ideal of 'the more rationality the better' (Flyvbjerg et al., 2003). Over the course of the recent decades we have seen a shift within planning in which the power of rationality became increasingly scrutinized and seen in a negative light. No longer was it merely a force of good for those that gained from it: now it was seen as authoritative, a sign of dominance *over* and suppression *of* other perspectives (Flyvbjerg et al., 2003).

The communicative 'turn' in planning practice can briefly be characterized by an emphasis on broader stakeholder involvement, integration of various sectors, issues and disciplines, a recognition of ecological values and cultural values besides economic values, and adaptability (Schoeman et al., 2014, p. 377). Shoeman et al. mention how this also applies to the sector of water management, where these elements are emphasized (Ibid.). Overall, more attention is given to the human dimension of water management. While these values are not new, in the last few decades they have however gained attention (Ibid., p. 378). Whereas economic goals and safety goals were dominating the scene of water management in the 1950s and before, new values gained increasing importance not only due to environmentalist movements but also changes in the economy in the developed world. The transition of a production oriented society towards a service oriented one led to a managerial turn (Bickerstaff & Walker, 2005) as well as opening up to human values that go beyond mere survival. These values can be linked to Maslow's pyramid, which mentions the so called ''hierarchy of needs''. In this pyramid, lower values of safety, food, and survival become a given when a society reaches a more prosperous level, in which higher values of self-actualization and self-transcendence become more at the forefront. Goals outside of the individual take hold and

lead to a person having more concern for other values, such as environmental values and social values (Maslow, 1969). It should come as no surprise that new paradigms, emphasizing new values of inclusion and more holistic approaches in planning practice, gained most ground in developed countries such as the Netherlands (van Slobbe et al., 2013), the United Kingdom (Woltjer et al., 2009), and Germany (Restemeyer et al., 2015). The trend can also be found, to a lesser degree, in places found in developing countries such as Thailand (Lebel et al., 2009) and China (te Boekhorst et al., 2010).

However, like technical-rational planning, communicative planning also has its own limitations. When an increased number of stakeholders are heard and given a place, decisions may not be made or may be made too late. Different stakeholders may have different perspectives and visions concerning the appropriate planning practice and what outcomes are acceptable or desirable for of any project. The failures of both existing that have been explored here – technical-rational planning and communicative rational planning- has led to a number of new ways of perceiving and acting with water management (Schoeman et al., 2014). The vast range of different and new approaches to water management, with different academic labels no less, may lead to theoretical ambiguity and fuzziness. The next section will therefore explore upon this further and delve deeper into water management specifically.

2.4. Changes in Water Management

At times when planning practices became more dominated by communicative planning we have seen similar changes away from purely technical-rational planning strategies in water management. Unlike the old approach of command-and-control, new approaches in water management, have been less about control and predictability and more about the unpredictability and sense of loss of control over our water (Schoeman et al., 2014). Increasingly in water projects, the strategy in water management is not about reducing the probability of flood hazards, but ''minimizing the consequences of flooding''(Restemeyer et al., 2015, p. 46). A central concept within new water management strategies is risk management instead of hazard control (Ibid.). Examples such as Building with Nature (van Slobbe et al., 2013) and Room for the River projects, as well as water storage in agricultural areas in the Netherlands illustrate a more adaptive approach and acceptance of planning practices in water management where there is a sense of loss of control. Water is allowed to exhibit more freedom (Disco, 2002; Restemeyer et al., 2015; van Slobbe et al., 2013). Another striking difference between the old

planning practices and the new ones are, respectively, the separation between people and ecosystems on the one hand and the inclusion of the two on the other hand (Schoeman et al., 2014). When the two are combined into social-ecological systems it becomes relatively easier to accept that these systems are, as Schoeman et al. mention, ''inherently unpredictable and difficult to control'' (Ibid., p. 378). In contrast to the earlier practices of command-and-control and of engineering resilience, new water management strategies tend to favour, or at least lean, towards ecological resilience. Unlike the former, ecological resilience defines resilience as to how much disturbance a system can take whilst remaining within critical thresholds (Holling, 1996; Davoudi, 2012). Social-ecological resilience also helps in capturing the various dynamics of uncertainty, change, and relations between both complex social and ecological systems (Davoudi, 2012). Restemeyer et al. (2015) also add three central attributes necessary in resilience strategies. Next to the existing degree of robustness, there is also a need for adaptability and transformability in these newer strategies. Adaptability goes beyond robustness and accepts a certain degree of 'surrender' to water. The land is adjusted to flooding. Examples of this are elevation of houses, evacuation roads, or the alarm systems that in place. Allowing for adaptability will also bring with it a social dimension in water management (Restemeyer et al., 2015). It moves beyond a mere technical-rational approach in which the technical expertise of the engineer or the planner matters. Water management therefore becomes a task of society, asking for cross-disciplinary participation and collaboration. Lastly, transformability is a key attribute of social-ecological resilience strategies. It can be defined as the capacity of a city or a region to realize a shift from fighting the water to living with the water (Ibid.). Where robustness is well aligned with technical-rational planning, adaptivity is well aligned with communicative planning and complexity.

Despite the unpredictability of social-ecological systems, water management and academic literature have still tried to create a sense of order despite the prevalent new planning practices of communicative-rational approaches in planning in general and adaptivity in water management in particular. Some approaches to water issues - such as Integrated Water Resource Management [IWRM], Adaptive Management [AM], and Ecosystem-Based Approaches [EBA] - are quite elaborate (Schoeman et al., 2014). When these approaches are explores, we can see their differences and how planners may use communicative-rational approaches in different ways. Whereas, IWRM provides a political platform for broad stakeholder involvement and the promotion of shared values, EBA and AM - whilst not ignoring

participatory governance - tend to rely more on a scientific basis for the decisions that are being made in water management (Ibid.). EBA in particular tend to go into a direction that aims for certainty (Munang et al., 2013). The strong grounding that AM and EBA have within the sciences provides a more solid background (Schoeman et al., 2014), whilst acknowledging the importance of IWRM and its attributes is also a necessity in today's complex world. The latter acknowledges the values that have been recognized since the communicative turn in planning. The inclusion of AM and EBA within a framework of IWRM could be more fruitful because there is room for both predictability and order as well as unpredictability (Jewitt, 2002; Roy et al., 2011). As we will find out in the last section of this chapter, these combinations will prove to align well with a complexity approach.

2.5. Towards Complex Approaches

In recent decades, more emphasis has been places upon acknowledging the balance between robustness on the one hand, most strongly exemplified through the old planning practices (technical-rational planning), and flexibility on the other hand. Flexibility is more strongly exemplified by newer planning practices (communicative planning) and in adaptive planning in water management (van Buuren et al., 2013). Van Buuren et al. argue that adaptation, specifically in the face of climate change, requires balancing between these two approaches. Here we can see an attempt to move beyond the existing dichotomy. First we have the one of command-and-control, emphasizing robustness, safety, and economic values, and on the other hand newer planning practices that emphasizes unpredictability, flexibility, and participatory inclusion. These two approaches align with the general planning approaches of technical-rationality and communicative-rationality. The four key issues that can be observed in modern day issues in water management, such as climate change, are uncertainty, contentiousness, multiplicity, and complexity (see table I).

Characteristic	Demand for robustness	Demand for flexibility
Uncertainty	Asks for solid and judicial guarantees safety, liability, and durability.	Asks for possibilities to adjust policy strategies and designs.
Contentiousness	Asks for decisiveness, authority, and clear and transparent rules.	Asks for provisions to facilitate joint problem-solving.
Multiplicity	Asks for enabling of effective planning choices through unambiguous policy.	Asks for space for polycentrism and bottom-up initiatives.
Complexity	Asks for institutional provisions that lead to complex governance networks in order to bring collective action.	Asks for experimental policy designs and experimental strategies in planning.

Table I: Demands of the four key issues on spatial planning, based on van Buuren et al. (p. 36, 2013).

One issue in today's world in particular, that of climate change, is an increasingly returning topic in water management (van Buuren et al., 2013; Schoeman et al., 2014; Hurlbert & Gupta, 2016). Climate change is inherently complex and unpredictable, and will lead to increased risk of extreme events such as droughts and floods. This will prove challenging as throughout most of planning history the planning practices have had a strong reliance upon robustness and predictability.

In practice, planners in water management tend to go with either of three approaches. Hurlbert and Gupta (2016) explain the three approaches that are explored within water management and environmental issues such as climate change: Adaptive Management, Adaptive Co-management, and Anticipatory Governance. Adaptive Management tends to understand a natural resource through the lens of the natural sciences, placing a high sense of importance on hypothesis testing, monitoring, and evaluation. Adaptive Co-management places more importance on flexibility and a communicative-based approach to natural resource management. Anticipatory Governance is more characteristic of complexity, placing importance not only on flexibility but also using scenario planning (Ibid.). It also realizes that there are situations in which a more robust and science-based approach is necessary (Ibid.).
These three approaches relate to the three approaches or *turns* in planning practice, that of technical -rationality, communicative-rationality, and complexity (de Roo, 2010). Technical-rationality tends to focus on goals and is object oriented whilst communicative-rationality is institutional or subject oriented, focusing on interaction and actors. Complexity approaches on the other hand recognizes that systems can be robust and flexible at the same time (de Roo,

2010). The third approach in environmental governance, Anticipatory Governance, shares similarities with complexity. In this approach, scenario planning and broad stakeholder participation is involved, as well as a wide range of possible futures are taken into consideration (Hurlbert & Gupta, 2016). This approach allows for a so called hybrid construction of risk, based upon reality as well as people's perception. Unlike the technical-rationality and communicative-rationality, and unlike the Adaptive Management and Adaptive Co-management, it does not just resolve any diversity by searching for common understandings, scientific or social. In Adaptive Management, risks and uncertainties remain in actuality, but have no decisive solution (Ibid.). In the other two approaches, as well as the other two planning theories [technical and communicative-rationality] the pursuit for common understandings remains, whereas Anticipatory Governance and complexity aim to move beyond such certainties and predictabilities (see figure I).

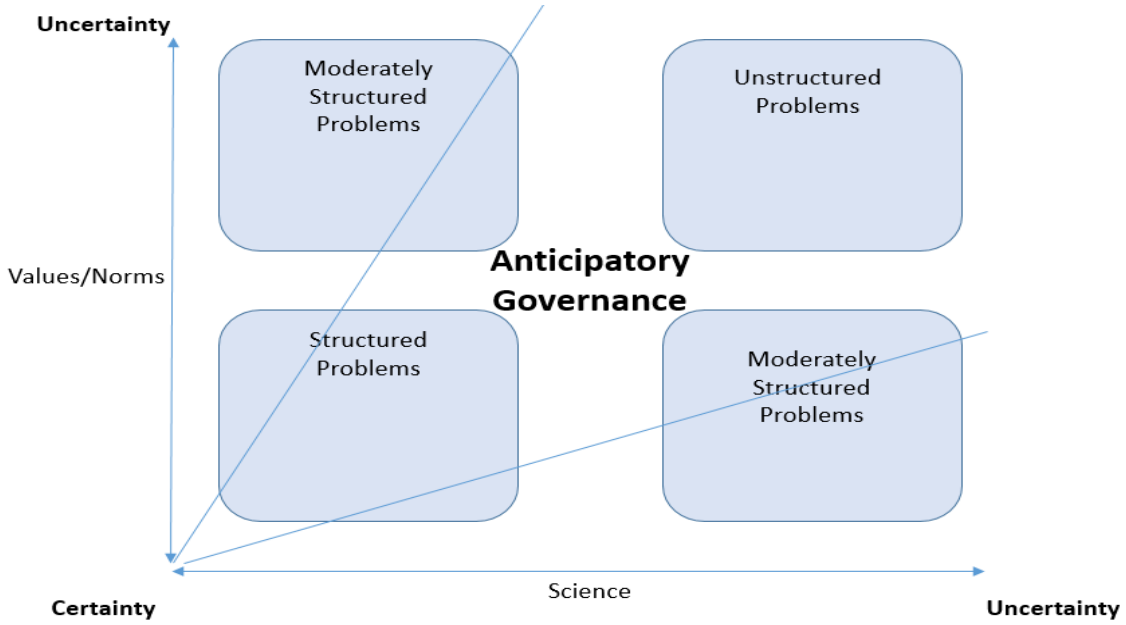
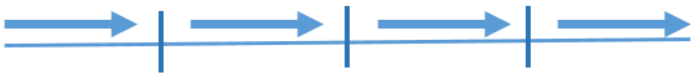


Figure I: Anticipatory Governance tends to operate outside the boundaries of certainty (based on Hurlbert & Gupta, 2016).

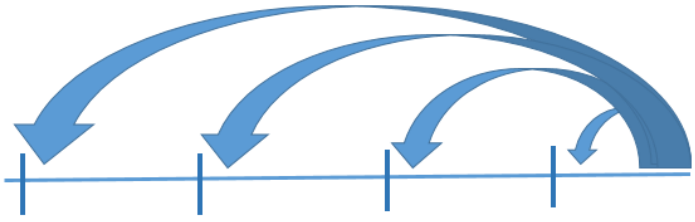
Unlike the other two approaches, Anticipatory Governance *includes* the other approaches. It practices adaptive capacity and social learning in order to respond to 'wicked' problems (Hurlbert & Gupta, 2016). Wicked problems could be the issue of climate change and the impact it may cause to an existing policy framework.

In light of the fuzziness and unpredictability of water-related issues, as well as climate change and its impacts, the transition towards a new planning practices in water management

are likely to have a degree of unstability. Such practices tend to be characterized by non-linear behaviour (Rotmans et al., 2001). Generally, a transition is understood as a set of connected changes in different areas such as culture, economy, institutions, and technology. Rotmans et al. distinguish four different transitions phases. The first phase is that of *predevelopment* where the existing status quo is not subject to change. In the second phase, a *take-off* takes place where the system begins to crack and changes get under way. This leads to a *breakthrough* where visible changes occur in the earlier mentioned areas such as institutions and culture. Finally, the speed of change decreases in the *stabilization* phase, in which a new equilibrium is achieved (Rotmans et al., 2001, p. 17). In developed countries such as the Netherlands, transition in water management reached its climax in the 1990s after a number of major river floods. New 'values' - ecological restoration, tourism, and recreation - started to become more important in a world which up until then was mostly dominated by a command-and-control approach. Transitions happen on three levels: micro, meso, and micro (Rotmans et al., 2001). On the micro level we can see individual actors and individual technologies gradually or rapidly leading to variations or deviations from the status quo. At the meso level changes occur in the dominant practices, shared rules, and assumptions. As we move onwards to the macro level we can see more, harder-to-define, realities of existing political cultures, social values, worldviews, and the natural environment (Ibid.). As can be understood, changes are easier to define and more concrete on the micro level compared to the more distanced socio-technical landscape of the macro level. According to Rotmans et al. changes happen when developments on one level come together with developments at other levels. Another important characteristic of transition management is that is not linear and gradual, but goes back and forth and can therefore lack fixed goals (Ibid.) as figure II below shows.



Old paradigm: Gradual and linear.



New paradigm: Back-and-forth and non-linear.

Figure II: Whilst the old planning practices in water management were characterized by policies that were gradual and linear, newer practices in water management increasingly consists nonlinearity and back-and-forth casting (based on Rotmans et al., 2001).

Transition goals can thus change over time and policies are seen more as a process, allowing for experiments, in contrast to the past where goals were fixed and thinking was dominated by blueprints (Rotmans et al., 2001). As mentioned in earlier (van Buuren et al., 2013), it cannot be concluded that everything about existing or older systems, such as robustness, are totally out of fashion. What is clear however, is that transition management, according to Rotmans et al., ''tries to utilize the opportunities for transformation that are present in an existing system. It joins in with ongoing dynamics rather than forcing changes'' (Rotmans et al., 2013, p. 25). Similarly, transition management, whilst having long term goals, does not fixate upon them but goes back-and-forth between the different stages within the process of policy making. A fixation on long term goals could lead to problematic situations such as ''lock-ins'' (Rotmans et al., 2013).

Whilst transition management from a less command-and-control paradigm and engineering resilience seems to grow in popularity, at the very least in the developed world, many governments implicitly or explicitly make statements that still reflect the old (Davoudi, 2012). Economic arguments may still prevail, even in the case of holistic approaches in planning (Restemeyer et al., 2015). However, this need not be contradictory as new planning practices can obviously still embody robustness and traditional elements in water management such as agricultural and economic practices. Where it differs from the old ways of thinking is in its broader, multi-actor, and multi-disciplinary approach. On both these dimensions we will see the connection it will have with complexity theory.

2.6. Complex Adaptive Systems

So far there have been new planning approaches in which multi-actor and multi-disciplinarity have increased over the decades. In complexity this is taken one step further. It takes planning practices to a new level where there is room for both robustness and flexibility. It is brought forward as applicable to an increasingly uncertain and dynamic spatial context, and is often paired with terms such as alertness, flexibility, and the capacity to adjust (De Haan et al., 2011; Duit & Galaz, 2008; Mettau & Hulsenboom, 2018; Skrimizea et al., 2018). Complexity planning goes beyond flexibility and asks to let go of the static perspectives we have about our environment and changes (de Roo, 2019). In contrast, it starts with a dynamic perspective and

takes uncertainty and unpredictability as foundational for environmental planning. These characteristics embody complexity itself. Change itself is accepted as the greatest constant, and a changing world demands continuous adaptations. These may or not be unsuspecting changes (de Roo, 2019). A system with a high degree of adaptivity is well suited to respond to changes and uncertainties (Ibid.).

These changes and uncertainties in planning are often caused by wider transformations, induced by technological innovations, social upheavals in society, and climate change (van Buuren et al., 2003; Haasnoot et al., 2012). Sometimes these changes may instigate unexpected routes. Decisions taken by planners within these contexts are often criticized by society as they may not fully grasp the dynamics of context, in particular urban and peri-urban areas (Rauws et al., 2014). Complexity science offers planners a remedy for understanding such contexts and can provide them with more realistic trajectories of planning systems. Complexity science, as Rauws mentions, portrays a world in ''a state of continuous change in which uncertainty is considered to be an intrinsic element'' (Ibid., 2014). Within a complex system these uncertainties are essential for systems to adapt, as well as vital to changing circumstances.

Complexity science, by analyzing these changes through a complexity lens, provides a contribution to an improved understanding of planning contexts and tensions between deliberate, conscious planning interventions and the uncertainties that penetrate through planning practices. It combines both robust measures as well as an open field. The central key here is that these open fields are deliberately kept open, and as Rauws mentions, the robust measures supports ''the functioning of an area in a volatile context'', whereas open fields strengthen its ''preparedness to coevolve with this context'' (Rauws et al., 2014, p.33). We can thus understand that complexity tries to seek a 'balance' between the old paradigm of robustness and its follow up paradigm of context and relativity, and is therefore more likely to cater to contexts within an existing and future world where contexts may become increasingly unpredictable. Contrarily to the technical-rational and communicative-rational planning approaches, complexity science does not resort to either a Newtonian conception of the world, which relies on a purely predictable, determined world (Heylighen, 2008), or nor does it rely on a relativist conception of the world. The components of planning systems that are characterized by complexity tend to be independent (Heylighen et al., 2007) and dynamic (Rauws et al., 2014).

2.7. Main characteristics of Complex Adaptive Systems

Four main characteristics will provide us with a foundation of understanding complex adaptive systems, and will provide a framework for gathering the qualitative data in this thesis. These characteristics are nonlinear development, contextual interferences, self-organization, and co-evolution. These are generally the key components of complex adaptive systems (Rauws et al., 2014).

2.7.1. Nonlinear Development

Complex adaptive systems are characterized by their nonlinear development. They consist of cause-effect relations that are disproportional (Rauws et al, 2014). This means that strategies developed by planners that embrace such systems do not rely upon a Newtonian view, where a world is assumed where all facts and knowledge can be known independent of time (Bettencourt, 2013). Instead, developments that are important and relevant to complex adaptive systems, such as climate change, are recognized to proceed non-linearly. This means that cause-effect relationships can have radically different outcomes than we would expect. Small changes may have great impact, making the approach of a complex adaptive system recognize disproportionality. This characteristic of a complex adaptive system ties in with its general acceptance of unpredictability and the need to not assume perfectly predictable planning settings.

Furthermore, nonlinear development assumes that spatial structures and their functions can change within their context (Rauws et al., 2014). These spatial structures are situated in space and time and adapt to changes in their context. Complex adaptive system approaches also recognize a multilayered view. The changes in a system cannot always be simply reduced or attributed to a single actor or factor (Liljenström & Svedin, 2005), and are therefore not closed but open systems (Byrne, 2005).

2.7.2. Contextual Interferences

Planners tend to focus on the here and now, imposing the best possible decision, usually along a technical-rational or a communicative approach. Decisions and assumptions about the spatial environment tend to be seen in predictable ways. With a complexity approach, these assumptions and decisions are not as easily proven to be correct or valid and shown to have

limitations (de Roo & Rauws, 2012, p. 270-271). Higher degrees of complexity are observed in open systems in which contextual factors are greatly intervening in the project's processes. The spatial environment itself, be it an urban or a rural area, changes over time due to these contextual factors, externally and internally (de Roo & Rauws, 2012).

Complexity follows a reality that moves towards a state of being that is not orderly, predictable, and clearly defined. This means that in such systems we see more openness to a variety of planning practices concerning governance. During a single project alone we may see an increased level of bottom-up governance on one aspect of the project, for instance land management, yet at the same time, we may also see top-down governmental decisions made concerning land ownership.

Closely related to nonlinear development, contextual interferences explain changes through multi-layered points of view instead of looking at singular factors or actors as a primary cause for changes in systems (Liljenström & Svedin, 2005). Contextual interferences may trigger changes in configurations of a system, attempting to create a 'best possible fit' with an environment (Rauws et al., 2014).

2.7.3. Self-Organization

The principle of self-organization can be rather ambiguous. It relates to a state of 'becoming' rather than 'being' (Hillier, 2006; de Roo, 2010). As de Roo argues, self-organization triggers situations, systems, and stakeholders in a connected way, which leads to a sequence of actions and changes which can trigger further effects and a chain of events that is ''seemingly unorganized, nevertheless producing patterns'' (de Roo, 2016). Organizations are very much goal-oriented and are supposed to support or maintain a state of affairs (Ibid.). Central is the separation of an organization and an external environment. As De Roo states, ''The organization carries out its actions purposefully, intentionally, with a well-informed internal structure ready to carry out its intended function. 'Organization' relates therefore to institutionally prearranged collective intentions, which contradict what we consider self-organization as a non-linear phenomenon to be'' (Ibid.). Self-organization is spontaneous and often uncontrollable, creating new 'realities' and phenomena that *may* have been taken into account as an abstract possibility for planners, but their exact outcome is not predictable. We can imagine the 'creation' of new pathways in a landscape, made by people walking outside of

existing pathways. The planning context and its decision makers may accept such developments but the how and why are filled in by people, often in spontaneous ways that are complex and unpredictable. Self-organisation places emphasis on the practice of planning being conditional (de Roo, 2015). It relates to conditions being of vital importance instead of either content, in the case of communicative rationality, or processes, in the case of communicative rationality (Ibid.).

Moving beyond the dichotomy of technical-rational and communicative approaches towards an approach more akin to one of [increased] complexity can also be met by seeing regions as complementary to one another. A region or place can gain an advantage in being complementary to another region or place (de Roo, 2012). Complexity, however, is not absolutist. It is a means to differentiate *between* the various planning issues and degrees of complexity should be recognized (de Roo & Rauws, 2012). When it concerns self-organization new institutional structures can arise when actors bring forth spontaneous organization (Heylighen, 2008). Self-organization is found in such spontaneous adjustments (de Roo, 2016). These adjustments happen after a break of symmetry, which can either happen because of a conditional change, or it can be structural, or a mismatch between the structure and function (Ibid.) of a spatial environment. These changes or mismatches can lead to unpredictable and spontaneous outcomes.

Recognizing such changes and mismatches, that we can also view as breaks in existing systems, and understanding their consequences can help planners initiate tailored solutions to planning questions. In what context a system can be ready for such changes will depend on the pre-existing conditions. Despite the realisation that self-organization is spontaneous and an autonomous process, it may still be desirable to create the necessary conditions to reap maximum benefits from self-organization. As has been observed in theory on self-organization, it simply cannot be ''internally controlled'', and this means there is a need and possible desire to create the right conditions for the system and its processes to change (de Roo, 2016).

If planning seeks to create changes that happen internally, to the process and project itself, then these may give way for self-organization to take place (de Roo, 2015). While achieving this, it moves beyond the dichotomy of technical-rationality on the one hand and communicative-rationality on the other. In contrast to these two approaches, self-organization refers to non-linearity and places emphasis on the practice of planning being conditional. It

relates to conditions being of vital importance instead of either content, in the case of technical-rationality, or processes, in the case of communicative-rationality (de Roo, 2015).

2.7.4. Co-Evolution

Previously we saw how existing structures and uses of spatial environments are preconditioned in self-organizing systems. In our last characteristic of complex adaptive systems, co-evolution, this is recognized as path-dependency, meaning that existing structures in planning contexts and projects already shape the continuation and outcomes of future planning contexts and projects. Preconditions can be the cultural aspects of a region, its natural environment and climate, or even its architecture. As with self-organization, co-evolution recognizes that affairs and processes can be in a state of discontinuous change (de Roo, 2015). Changes in systems can move from solid, predictable, and an unchangeable situations or states of being to ones that are characterized by multiplicity and containing path-dependent trajectories (Ibid.). As the situation is no longer predictable and easy to define it brings forth a reality that is more fuzzy and vague. In co-evolution, these processes mean that actors manipulate a system and the system consequently changes in response to these manipulations. The changes in a system are also interdependent with the present environment (Gerrits et al., 2012).

These recognized changes show us that complex adaptive systems are not fixed systems. These systems are about internal interactions between dynamics on the one hand, and robustness on the other, and seemingly move between order and chaos (Gros, 2008). This is an additional aspect of such systems and why they differ so strongly from the old paradigms of technical-rationality and communicative-rationality. In contrast to these two older planning practices, a Complex Adaptive System allows for transformations of a system along a structural and functional sense (Geels, 2005; Gerrits et al., 2012). Practically, it will mean there is a two-way process between the environment and the relevant stakeholders that seek to change it, without any pre-defined and fixed narrative in advance. In this way, the system adapts to a new context and is it possible to create a better fit between it and the environment.

2.8. What Complexity Science can offer Planning

In contrast to both the technical-rationale and reductionist planning perspectives, as well as the communicative-rationale and collaborative planning perspectives, complexity offers us a fresh alternative that contributes to a better understanding of, and approaches of how to deal with, the spatial challenges in today's world, which are increasingly dynamic and

multidimensional. It provides us with, as Rauws describes, a ''…time-sensitive, dynamic view of urban and peri-urban developments by emphasizing the importance to cities and other spatial systems and networks of ongoing processes of reorientation, transformation and renewal, if they are to remain vital.'' (Rauws, 2015, p.37). Specifically in the context of water planning in the Netherlands we have seen a drastic need over the decades to include new planning tools and planning practices in order to cope with new challenges such as river flooding and climate change. As we will see in the results of this thesis, various interviewees emphasize the need for changes and more adaptive and dynamic solutions, not just in relation to technological solutions but also in how we operate within the social context of planning.

The previous two planning perspectives, one based on a technical-rationale and the other based on a communicative-rationale, are lackluster in providing spatial planners with the necessary means to effectively deal with uncertainties in their field. The former perspective acknowledges uncertainties but assumes they are the consequence of a lack of knowledge, whereas the latter perspective sees uncertainties as a consequence of values, interests, and perceptions in conflict among stakeholders. In contrast, complexity science sees the world dynamically, ever-changing, and it can therefore be said that they are more seen as nouns and less as verbs, or, as Tsoukas and Chia (2002) mention, as things that are 'becoming' instead of things that are accomplished events. With complexity science changes as both continual and unpredictable.

Less certainty and robustness are often the result of, and accompanied by, a degree of decentralization. Decentralization has become one the strategies used for the renewal of environmental policies in many western European states (Lemos & Agrawal, 2006; Zuidema, 2016). Zuidema argues that the popularity of decentralization in the last couple of decades can be associated with an increased acceptance of communicative models of governance (Ibid.). This communicative model of governance relies more on mutual dependence between public and private parties. Whether it can also be characterized by flexibility would depend upon the governance practices within a planning process. A project strictly defined by rigidity and target setting done by private stakeholders would in essence, be no less a case of communicative planning and effectively characterized by decentralization, as one committed by a central government (Zuidema, 2016). Within complexity theory we also see an increased acceptance of various interrelations between problems, their causes, and their effects (Ibid.). These interrelations can bring multiple and perhaps conflicting values and objectives to light.

Zuidema also argues that a more coordinative model of governance can be undermined in such cases because of the existence of mutual dependence between public and private parties.

In planning, complexity science therefore offers us an alternative to the older and existing planning perspectives that may prove lackluster in making planning decisions and strategies in a world increasingly characterized by complex changes and decentralization, a world that is also increasingly recognized as dynamic and multidimensional. With complexity science we can look at planning contexts and recognize pitfalls of older planning perspectives and provide meaningful alternatives that may prove to be more beneficial to an increasingly changing and interconnected world. It provides us with a theoretical foundation that addresses the unpredictable nature of planning processes and the physical systems in which they function.

Chapter III : Exploration and Analysis

3.1. Exploring the Coast

The first three projects are situated along the Wadden Sea coastline and within the province of Groningen [see figure III below].

Figure III: The chosen cases along the Wadden Sea coastline. Project I [Marconi Buitendijks], II [Double Dike], and III [Wide Green Dike]. (picture taken in Google Maps, 2019).

3.1.1. Marconi Buitendijks

To examine this project the context of Delfzijl is key. Increasingly over the last few decades much of the outer countryside of the Netherlands has been characterized by a shrinking population. The town of Delfzijl has been hit by this development in particular (Cobouw, 2016; RTV Noord, 2018). By 2040 it is expected that a staggering 32% of its population size of 1990 will have disappeared, making the municipality of Delfzijl the fastest shrinking municipality in the Netherlands (CBS, 2012). Many young people in particular flock to the larger cities, such as Groningen, but also to the rest of the Netherlands. This is in line with general trends towards urbanisation and the strengthening position of economic centres in an era of globalization and regional inequalities (Krugman & Venables, 1995).

Originally, the town of Delfzijl experienced much economic growth in the decades after the second world war. It fashioned itself as the 'Rotterdam of the North'. Its harbour was bustling and much industry in the chemistry sector had been established. The connection between the sea and the town from a recreational and liveability point of view however were never truly exploited. Arguably, much of this can be contributed to the traditional Dutch attitudes of fighting against the water. During the 2000s, in an era of increased population shrinkage and increased vacancies of homes and empty shops, politicians began to think about ways to restore liveability and improve the connection of the town centre with the seaside

(Interview Bosch, 2018; Interview Province of Groningen, 2018; Interview Groningen SeaPorts, 2018).

At the same time, complementary goals of other governmental bodies and nongovernmental organisations came forward. The water boards and Rijkswaterstaat emphasized the need to create stronger flood protection. Keeping Delfzijl as an competitive region for businesses in the chemistry industries was also deemed an important key theme of the municipality of Delfzijl (Interview Bosch, 2018; Interview Groningen SeaPorts, 2018). Gradually, a nature goal followed closely and was put forward as an attractive option to increase liveability and recreation, as well as providing flood protection. To achieve this, the creation of a salt marsh [from scratch] was opted. The tandem of business interests, nature interests, and people's interests came to be represented by respectively the semi-governmental Groningen SeaPorts, the nature organization Het Groninger Landschap, and the governmental layer of the municipality of Delfzijl. The former two came to have a more advisory role, whereas the project itself became dominated by the goal of creating a more liveable Delfzijl for its people and with an attractive connection between town centre and seaside. A steering group was formed, which came together every one or two months to discuss and present new discoveries, research done, and possibilities explored for the construction of the project (Interview Bosch, 2018; Interview Groningen Seaports, 2018).

Figure IV: Impression of the Marconi Buitendijks project in its finished state, with a salt marsh and beach (Programma naar een rijke Waddenzee, 2019).

Next to the (re)connection of town centre with the seaside, and the creation of a beach, are two salt marshes. One salt marsh will be available for the public for recreation and one salt marsh, to the left, will be inaccessible for the public and function as a primary breeding ground

for terns. The salt marsh will develop along the coast and with a dike [the so called *schermdijk*] behind it. The exact outcome that the creation of the salt marsh will bring is not going to be a matter of certainty. It is as of yet unclear how the ecology will function, as interviewees emphasized (Interview EcoShape, 2018; Interview Groningen Seaports, 2018; Interview Het Groninger Landschap, 2018: Interview Waterschap Noorderzijlvest, 2018).

3.1.2. Double Dike

The Double Dike [Dutch: *Dubbele Dijk*] project is situated to the north of the town of Delfzijl, and falls under the same municipality. Along the coastline the dike itself is to be partly strengthened and partly weakened, in order to create an inwards flooding area [see figures V and VI]. As with the Marconi Buitendijks project, the principle of Building with Nature is key here (for further information; EcoShape, 2019).

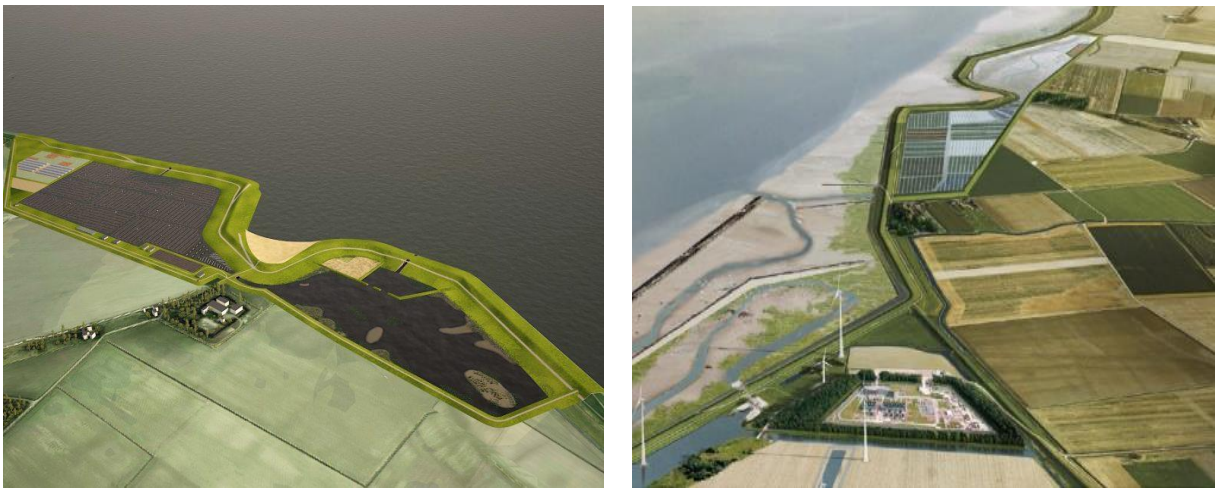


Figure V: An impression of the Double Dike project, with an area for silty agriculture on the left and an area for nature development on the right (Programma Eems-Dollard 2050 [2], 2019), and in figure VI rom a different angle (Wageningen UR, 2016).

A secondary dike is created behind the existing dike for improving water safety, hence the name *Double Dike*. In-between the two dikes two polders are created. The first polder catches sludge and provides space for nature whereas the second polder provides space for silty agriculture. In between these two polders will be another area for production purposes. Here, cockles will be produced as well as sea plants such as samphire (POV-Waddenzeedijken, 2018; Provincie Groningen, 2019).

Reason for the reconstruction of the dike lie in its old structure. It no longer meets the quality standards of a 'safe dike', due to sea level rise, soil subsidence, and the earthquakes due to gas

extraction westwards of the municipality (Provincie Groningen, 2019; Eems-Dollard 2050 [2], 2019). This was acknowledged by the Delta programme of 2015 in which it was concluded that the coastal zone had to be improved to meet new standards, as well as realizing three additional goals. The first goal is a sustainable and climate-proof coastal defence aimed at adjusting to rising sea levels. Second, the development of innovative silty agriculture. And last, the development of nature and sludge trap of the Ems-Dollard estuary. Narrow sediment with sludge will enter between the two dikes, where the sludge will mature. When the area is fully created, the clay soil can be used as agricultural land, and another area can be used for nature development, as breeding ground for bird species (Ibid.). Possibly, the project's outcome can give a boost to local recreation.

The project is considered a 'pilot', an experiment in which a new form of agriculture, silty agriculture, will be practised (Provincie Groningen, 2019; Provincie Groningen & Ministerie van Infrastructuur en Milieu, 2015). The area is approximately fifty hectares and is being built inside the dike. The Double Dike project officially started in February 2017, though in previous years there were explorations of dike parts by consultancies Boskalis NL and KWS Infra (POV-Waddenzeedijken, 2019). In December 2014 the steering group Dijkversterking [Dike strengthening] Eemshaven-Delfzijl decided that the double dike variant was the preferable option as it was praised for its multi-functionality (Kwakernaak & Lenselink, 2015).

3.1.3. Wide Green Dike

The Wide Green Dike project [Dutch: *Brede Groene* Dijk] is situated along the Dollard estuary [see figure VII], and like the previous projects, part of the Ems-Dollard 2050 programme as well as the dike improvements programme of the water boards, the POV-Waddenzeedijken.

This dike will be made with three types of local clay: clay from the nearby polder, clay from the sea, and clay from the salt marsh (POV-Waddenzeedijken [2], 2019). The different types of clay will be used at different positions of the dike. The aim of the project is to achieve a better understanding of which type of clay provides the best outcome [i.e. flood protection and dike stability]. The project is therefore meant to be experimental, and will be used as a pilot study and a case study for future research in dike improvements elsewhere (Waterschap Hunze en Aa's, 2019). Expectations are that a dike made out of local clay will reduce costs compared to traditional dike reinforcements which usually consist of asphalt covering (van Loon et al., 2014).

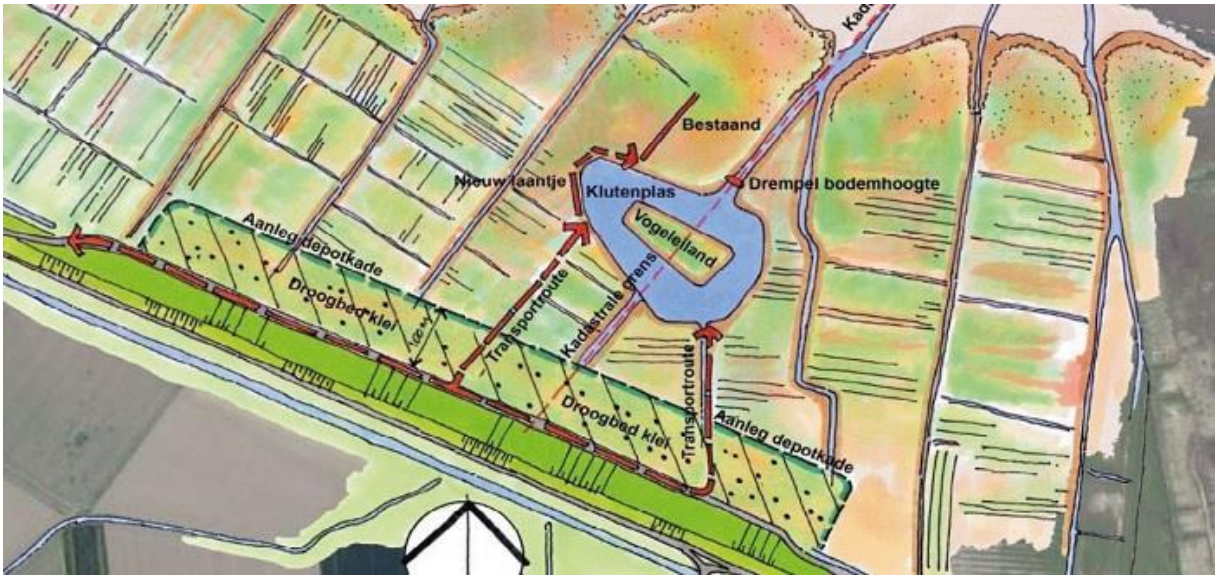


Figure VII: An impression of the Wide Green Dike project, showing the new puddle and clay deposit [Dutch: *Droogbed klei*] (Waterschap Hunze en Aa's, 2019).

The current phase [starting from September 2018] will consist of exploring matching opportunities to combine possible external needs with the project. Beyond the initial concerns of water protection and cost reduction, the water board Hunze en Aa's will conduct further dialogue with other parties for possible matching opportunities. These parties are the municipality of Oldambt, local farmers that own land on the salt marshes, and nature organization Het Groninger Landschap (Interview Hunze en Aa's, 2018).

3.1.4. Area Development Oosterwold

Oosterwold is a practical experiment of doing regional development in a new way. Situated in the province of Flevoland [see figure VIII and IX], it embodies bottom-up initiatives from newcomers, both households and businesses, to make the project as it comes along without any blueprint, predefined vision, or ideal picture. If anything, the road travelled by the initiators, who are held together by a number of core principles, is central. This approach is, contrary to the planning context in the Netherlands - be it water, infrastructure, housing, or environment - rather unpredictable and contains a high degree of unstructuredness, and can be characterized by fuzziness and volatility. Markets have shown much interest in the project and after three years the project contained 320 active initiatives (Lekkerkerker, 2016).

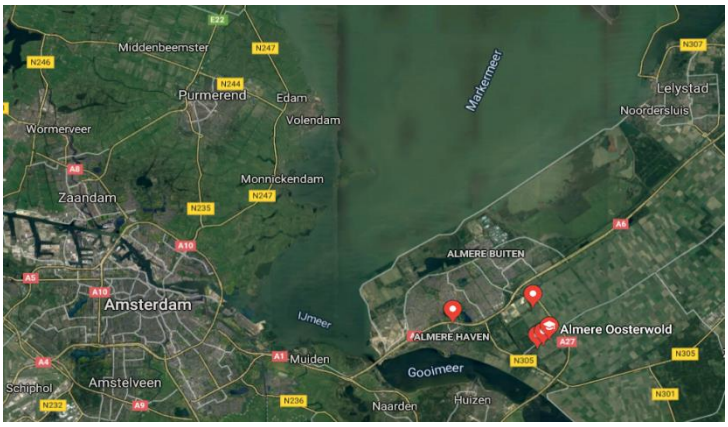


Figure VIII and IX: Oosterwold as viewed on Google Maps (2019), east of Almere, and a closer look of Oosterwold on the right figure (AVROTROS, 2018).

The main ambition underlying the project is Oosterwold develops itself in ''a green living and working landscape'' with the catchword of ''people make the city'' (Lekkerkerker, 2016, p. 4). The project must also contribute to the greater region, with the city of Almere, as a whole, which would indicate that the two are, in a sense, complementary. The Oosterwold project is based on organic area development, which in principle, is not new nor revolutionary. Throughout history, the first residents settled where they wanted and over time concentrations of people occurred, creating villages, towns, and cities, with eventually town planners, developers, and politicians making decisions (Lekkerkerker, 2016). This is particularly relevant in the Dutch context where space is scarce and the landscape can and will have many functions, often competing ones.

The project has come into being from both a supply as well as a demand position. The creator of the Oosterwold project came up with the idea of building your own place instead of letting architects and developers make the decisions. Almere was deemed a good place and, together with the MVRDV architecture and urbanism planning bureau in Rotterdam, advertisements were placed in newspapers to recruit people who wanted to participate in the project (Interview Gebiedsontwikkeling Oosterwold, 2019).

The project is run on a number of core principles. These are loose 'rules' that can be summarized as followed: 1) Not the government but the people make Oosterwold. Initiators can work together as a group or individually, provided there is alignment, 2) Free housing lot choice, 3) a fixed space distribution (20% buildings, 50% (urban)agriculture, 30% green space, water and roads), 4) specific housing lots, standard and green options, 5) freedom and restrictions concerning building to keep the green character of the area intact, 6) the head infrastructure remains the responsibility of the government, 7) over two thirds of space is green

(broadly defined incorporating agriculture, forests, and gardens), 8) housing lots are self-sustaining, and responsible for their own water, energy and wastewater management, 9) every initiator is financially self-sustaining, which means that every initiative is assumed to happen without governmental subsidizing, and 10) public investments are following, meaning that the government will only invest in more infrastructure if enough initiators are present (Gebiedsontwikkeling Oosterwold, 2019).

3.2. Exploring Complexity in Practice

In this section, the characteristics of complex adaptive systems - nonlinear development, contextual interferences, co-evolution, and self-organization (de Roo, 2012; de Roo, 2015, de Roo, 2016; Rauws et al., 2014) will be explored and analyzed through the selected case studies.

3.2.1. Non-linear Development

Nonlinear development relates to techniques and strategies that allows orderly systems to emerge. Nonlinear development gives systems the chance to co-evolve, self-organize, and adapt over time (Rauws et al., 2014). Its characteristics are the opposite of linear development, which are characterized by command-and-control strategies and a high degree of predictability, and systems may shift in both structure and function (Ibid.).

3.2.1.1. Marconi Buitendijks

This project in Delfzijl shows mixed results. Generally it provides opportunities for the system to shift in its structure and function. There have been changes throughout time, as initially, the project was a means to increase liveability in Delfzijl by improving the connection of the town with the sea. In the 2000s there were other initial goals that were either eliminated or drastically changed in the 2010s. The additional creation of a salt marsh was also not part of the original plan. Here we can see there has been a certain degree of unpredictability within the project, although it has been steered much from above by the municipality of Delfzijl.

Minor changes in structure and function of the area can be spotted, because of the region being used as bird watching area and a place of nature value for people, despite it having an industrial function. The way some people have used the area has therefore, in part, moved from one of industry to one of nature and recreation (Interview Het Groninger Landschap, 2018). The created salt marsh will be a claim of land taken from the sea, changing the very structure of that area. The function is changed too, as it provides nature development [on land] and recreation. However, the creation of the salt marsh is made in coordination between governmental bodies and the nature organization. Looking into these changes, we can see there is room for adjustments and changes from the original goals, on the main condition that safety and environment are not jeopardized (Interview InVra Plus, 2018; Interview Noorderzijlvest I, 2018). This also means that motives and principles steered from top

down organizations remain key.

Changes in government on the national level also proved to be of significant influence. The 2010 elections saw the rise of a more right wing government and meant that nature protection became less of a topic for consideration to the national government (Interview Bosch, 2018). Major cuts were made in the development of ecological corridors. Pressures were felt by nature organizations and the removal of the Griesberg disappeared from the agenda (Interview Bosch, 2018; Interview Het Groninger Landschap, 2018). As a result of this, Rijkswaterstaat decided to give more attention to adding ecological restoration elsewhere in the region. This topic was also less on the agenda within the Marconi Buitendijks project in the 2000s (Interview Bosch, 2018; Interview Gemeente Delfzijl, 2018). All in all, we can see how the structure and function of the area did change over the decades, although, despite people using the area as recreation, it has, in this project, been mostly steered as a top-down endeavour. Nonlinear development therefore returns only partially and remains limited throughout the Marconi Buitendijks project.

3.2.1.2. Double Dike

In the Double Dike project, compared to Marconi Buitendijks, and closely situated next to Delfzijl, there has been a different road towards the existing organizational structures. Like Marconi, a blueprint was present, but economy and ecology, and no other issues, became the main goals of the project. The project, containing two major goals in the creation of a new polder that is economically viable, as well as improving ecology and preventing the silting up of the Ems-Dollard, has brought together different stakeholders. New agro-entrepreneurs have to be found to start silted agriculture or aqua agriculture. Research was conducted by the NIOS to understand if and where these new forms of agriculture can be practised, and by what conditions (Interview Provincie Groningen, 2019; Provincie Groningen, 2019). The exact establishment of the dike itself is, as of yet [summer 2019] an unknown as well, and this could lead to discrepancies between governmental goals and local wishes or concerns.

As with the Marconi Buitendijks project there is a partial shift concerning land use (Interview Bosch, 2018), as there is a change from sea to agriculture and nature development. The existing infrastructure and land use change, as well as a change to silty agriculture, requiring different techniques, water levels, and planning [examples of structure]. Partially, the purpose of the area changes as well, as one section is dedicated to nature development and

another to agriculture, while both areas used to be sea, changing the purpose of the land [function].

There is a lot of room for experimentation and innovation within the Double Dike project. While this occurs concerning land use it remains less of a possibility in the governance structure as the purpose and goals of the project are clear; to create ecological restoration and silty agriculture, which can serve as a pilot study and possible inspiration for future projects along the coastline elsewhere. Because of this practice being 'new', at least within the modern Dutch context, it asks for a playing field of where and how to practise it. The water boards and governments are looking for a basic formula (Ibid.), which by itself does show a desire for predictability. Yet the experimental aspect behind the project does allow for the system to *potentially* shift in the future, hinting at nonlinear development *within* the physical system and the boundaries of the area, though it is contained. The project's agricultural or ecological goals may fail, leading to a different function of the region. It's generally not 'expected' yet the *possibility* is accepted (Interview Provincie Groningen, 2018). However, the changes made in this area can still be attributed to specific actors from governmental bodies. Any unexpected outcomes will exist within a contained system. When it comes to governance process there is no non-linear development involved.

3.2.1.3. Wide Green Dike

Due to the Wide Green Dike not changing much of the area, and considering there are few stakeholders involved that seek to drastically alter the landscape, the project is characterized by linear development. The dike itself is seen as a means to guarantee water safety. It contains a cycling area but it is not too well used (Interview Noorderzijlvest III, 2018). This makes additional goals such as recreation and tourism a less relevant part of the agenda. On the other hand, there is ample room for a close connection between the strengthening of the dike and improving the quality of the ecosystem. The structure of the dike and the area surrounding it, on both sides, remains the same. There is no change in land use or infrastructure. The function of the dike remains the same as well [water safety]. Changes were made within the salt marsh, a puddle was created, in coordination with the nature organization. What the dike as well as the area is 'supposed to do' remains water safety [dike] and ecological maintenance and water safety [salt marsh].

As there are fewer stakeholders involved it can be observed that the area of the project, and quite possibly the extended rural region of the Dollard, is also unlikely to change in the future concerning structure and function of the dike and the surrounding area. Flood protection and ecological values remain solid and key in the area and no additional goals or explorations, such as recreation or local citizen's initiatives are part of the project. As it stands the Wide Green Dike project is not indicating signs of nonlinear development as there is no change in structure and function.

3.2.2. Contextual Interferences

3.2.2.1. Marconi Buitendijks

The project has a number of key stakeholders and citizen initiatives and there are clear responsibilities among them and in relation to the project. Because of the very urbanized context of this project there is much reliance on understanding and formalizing the project within its local context and in tune with local wishes and concerns. Interferences that are determined by context are important. This undoubtedly assumes that local stakeholders will have key influence over the course, as well as outcome, of the project.

Besides businesses, local residents in general have been involved in the process and regular info meetings have been held (Interview Groninger SeaPorts, 2018; Interview InfraPlus, 2018; Interview Noorderzijlvest I, 2018). This concerned the desire for a beach, and a better connection between town and seaside. There has been no form of [significant] protest among local residents. Stakeholders have been involved in the project, but always through the municipality of Delfzijl, Rijkswaterstaat, and the water board Noorderzijlvest (Ibid.), showing centralized coordination. The creation of the salt marsh has been less of a focus in these info meetings, possible due to it being created in a later stadium. This has caused issues elsewhere, with local businesses being informed too late about changes in the area, as well as the decline of existing parking spots that may cause issues to these businesses as well as create friction among stakeholders (Interview Bosch, 2018; Interview De Kleine Zeemeermin, 2018). This can lead to reduced chances for a best possible fit due to stakeholders being informed too late. It potentially puts limitations on the possibility of contextual interferences occurring, as top-down planning decisions may overlook context and a best possible fit.

Most responsibility for the project rests with the municipality, and most interviewees consider this the right approach. Despite concerns from some entrepreneurs (Interview Bosch, 2018; De Kleine Zeemeermin, 2018) it can be argued that this approach is, paradoxically, perhaps *the best possible fit* concerning the governance of the project, considering all stakeholders emphasize the importance of governmental responsibility and leadership. However, some stakeholders argue that, in some cases, such as the expected removal of the Griesberg, the appropriate government body [in this case Rijkswaterstaat] does not hold enough power, and has not been open enough in their communication (Interview Van Es, 2018).

Over time, changes that were made throughout the project, and the addition of a salt marsh, shows that the area is, and stakeholders are, able to re-organise themselves and find the best possible fit. While the initial goals are clear the open culture has been seen as favourable unanimously by interviewees. This allows policy makers within this project able to anticipate [new] development paths that may improve the region better.

3.2.2.2. Double Dike

Contextual interferences are present in the Double Dike project. There is much room for making mistakes and achieving a best possible fit. The water board Noorderzijlvest also emphasizes the importance of making mistakes, as innovation cannot work without it. The Double Dike is also stressed as a ''project transcending invention'' (Interview Noorderzijlvest II, 2018). The three water boards join forces [i.e. POV-Waddenzeedijken group] in finding the right formulas for successful dike projects that do not just mean dike enlargement, hence there are various experimental designs along the coastline. Together with research institutes and consultancies, the water boards look for appropriate designs (Interview Noorderzijlvest II, 2018) that make a best possible fit possible.

Different scenarios have been put forward by the Province of Groningen (Interview Noorderzijlvest II, 2018; Interview Provincie Groningen, 2018). What must be stressed, however, is that these scenarios are still pre-planned and did not come by surprise, which very much shows that, whilst there is a degree of unpredictability, it also does not match the requirements of a ''pure'' complex adaptive system. There is still a high degree of flexibility *within* the project, concerning its outcomes in nature development and agricultural experimentation. Climate change is cited as reason for the drive behind these calls for flexibility. Silted agriculture, or aqua agriculture, is seen as a recent development. Experimentation and gaining experience is

seen as essential is coming up with solutions that target climate change impacts (Interview Noorderzijlvest II, 2018). The chosen strategies for this project and other pilot projects along the coast are practised within a specific context. Any obstacles or 'mistakes' made in this project, due to the wrong crops or cockles grown, or a failure to develop the expected type of ecological functions, is accepted. These examples show us that the project is an open book, though *within* a specific contained region.

3.2.2.3. Wide Green Dike

The Wide Green Dike project is relatively good to oversee for the stakeholders that are mainly responsible for its process and outcome, with the water board Hunze & Aa's as its key player. While looking for a best possible fit, a degree of unpredictability may occur as the type of clay being used may be proven unsuitable. The best option will be better known by 2021 (Interview Hunze en Aa's, 2018). This will mean that continued research and practice will occur that is looking for the best possible fit for adapting to climate change and strengthening the dike.

From local residents and other sectors, besides government and nature organizations, there is little participation. The connection is strongly emphasized between the two parties of the water board Hunze & Aa's and nature organization Het Groninger Landschap, as well as a close cooperation with Groningen SeaPorts (Interview Hunze & Aa's, 2018; Interview Het Groninger Landschap, 2018). Other important key stakeholders are the landowners. The outer area, the salt marsh, has three landowners, two third of the land belongs to Het Groninger Landschap and one third belongs to two private owners. These stakeholders were involved and invited by the water board in this project straight away (Interview Hunze & Aa's, 2018). Of the two private land owners there is one farmer and one society of shareholders. Both were open minded towards the idea of creating a puddle within the salt marsh. Historically, the land was owned and used by the agrarian sector and part of it is still extensively grazed by livestock. Here too, we see how [historical] context playing a key role, and the best possible fit is explored. Improving water quality at sea is the main responsibility of Rijkswaterstaat and by creating 'win-win situations' and linking existing interests of water quality, water safety, and ecological concerns it proved to be possible to find ways to create a puddle within the salt marsh and use the clay for strengthening the dike (Ibid.). However, it remains only relevant to the few stakeholders that play a role here and the project is, besides the Ems-Dollard 2050 Vital Coast programme, not upscaled or connected to any larger sense of governance. The contextual

interferences here are limited to the interpretation of the few. There is no possibility for the system to re-organize itself and as only the type of clay used for dike strengthening may change, [new] development paths are unlikely to be anticipated. The knowledge from changes in the physical system [clay type], however, functions as comparative analysis and could be used for dike strengthening elsewhere.

3.2.3. Co-Evolution

3.2.3.1. Marconi Buitendijks

Co-Evolution is closely tied to unpredictability. Some of this unpredictability can be seen in the eventual outcome of the project, even though the project does have end-goals set in advance. Significant changes to the project have occurred over the years. An original idea of local entrepreneurs, which is the creation of a large beach, had to be greatly downsized. A smaller option had to be accepted (Interview Bosch, 2018), while other [minor] changes were made over the years, such as the height of the parking spot (Interview Noorderzijlvest I, 2018).

The project started out small and concerned itself with local goals - the desire for a beach, a connection between city and sea - and other goals, such as the enlargement of the dike through the water protection programme, were incorporated to the project later on (Interview Bosch, 2018; Interview Gemeente Delfzijl, 2018). Even so, the project has been relatively robust over the years concerning its main goals, although smaller goals, such as the exact outcome of the salt marsh, have been subject to changes. Such changes, through actor manipulations, are key in co-evolution, as they were changed in a process where actors [recreational] provided opportunities of an industrial brownfield to be seen in another light, that of being an area of recreational value because of ecological quality. It will depend on how people will use the region, but there is opportunity for co-evolution to occur.

The Marconi Buitendijks project is, despite changes, relatively robust in its 'end plan'. In the 2000s there were initial goals that were either eliminated or drastically changed in the 2010s. The additional creation of a salt marsh was also not part of the original plan. From this we can see there has been a certain degree of unpredictability within the project, although it has been steered much from above by the municipality of Delfzijl and there is an end goal in place, that of improving the connection between seaside and town, and the creation of a salt marsh (Interview Het Groninger Landschap, 2018). Local stakeholder influences have shaped

details of the project, but never endangered the project itself. There is potential for co-evolution, as the recreational use of an originally industrial area shows, but in the same way these evolutionary pathways are eventually controlled or taken up by government. Most interviewees were positive towards this approach and called it a matter of stability and necessity for a governmental layer to take the reins.

3.2.3.2. Double Dike & Wide Green Dike

As these two projects are in either an early executive phases, it is not sufficient to tell whether great changes have been made within and throughout the project, as the interviewees of the water boards emphasize (Interview Noorderzijlvest I and II, 2018). The areas themselves are tightly regulated, either due to it falling within the Natura 2000 network [Wide Green Dike] and because they are relatively small areas with land use that is either fixed [salt marsh, agriculture, and dike in the Wide Green Dike project, or new agriculture and nature development in the Double Dike project].

Co-evolution may occur in both these projects in the future. In the Double Dike project the actors [agri-businesses] will manipulate land management as land is taken from the sea, changing the system in respond to these manipulations. The same occurs in the land taken from the sea that is used for nature development. In the Wide Green Dike project there is no change in land use, but only a change in the type of dike and the creation of a puddle within the marsh, as ecological compensation due to changes made to the dike. In both projects there are few actors involved, and these actors operate within the guidelines. This makes a two-way process between actors, who manipulate a system, and the system changing to these manipulations limited, at least in the foreseeable future. As there are clearly defined end-goals concerning dike safety [in both cases], and additional goals or 'plus' situations or not on the agenda [Wide Green Dike] it makes co-evolution difficult to occur as it rests on a situation where no such clearly defined end-goal is set (Rauws et al., 2014).

3.2.4. Self-organisation

In complex adaptive systems self-organisation is key. Self-organization relates to spontaneous order, where different issues, such as urban development, social transformation and changes in spatial contexts are connected (de Roo, 2016). Among the projects along the Wadden Sea coastline in the province of Groningen there have been few observations and possibilities for

self-organisation to occur. Some have occurred and have had an eventual impact upon decision making and central coordination.

3.2.4.1. Marconi Buitendijks

This connectedness returns in Marconi, where linking urban renewal and depopulation concerns with ecological restoration of the estuary as well as economic growth, is key. However, strictly speaking, 'spontaneity' does not occur as there is no pre-existing path dependency existing independently of decision making independent of authorities.

Compared to the two 'smaller' projects, at least in scope, it is noticeable that the Marconi Buitendijks project does contain genuine examples of spontaneity through the actions of residents and recreational usage of its area. The part of the project that will see the realization of a created salt marsh used to be an industrial 'brown field' that was used for leisure and bird watching despite it never having said recognized function in local planning decisions (Interview Groningen SeaPorts, 2018; Interview Het Groninger Landschap, 2018). This example of an area of 'Marconi Buitendijks', even before the project arrived, where it was used by people for different purposes, seemingly creating paths and usages of the local area spontaneously for purposes not created by planners is a prime example of self-organization. Next to the example of Delfzijl's coast being used for other purposes than planners intended, it is not inconceivable that further changes during and after the Marconi Buitendijks project, as well as changes in the other three projects, could potentially bring forth spontaneous self-organization, as local entrepreneurs and citizen's initiatives may start new projects and activities (Interview De Kleine Zeemeermin, 2018).

Using existing spontaneous usages of spatial contexts by consumers, such as recreation and bird watching along the Delfzijl coastline, is an example that planners must notice and could possibly use that will result in new usages of the spatial environment and extent meeting the desires and wishes of a broader spectrum of stakeholders. As de Roo argues, ''In other words, planners could enhance their commitment to the built environment, also further enabling change to happen, not just in accordance with a controlled and predefined plan but also in a 'natural', uncontrolled way (2016).'' Therefore, a degree of control is possible and desirable in achieving self-organization. Considering the multiplicity of stakeholders and interconnectedness of issues within the higher urban density of Delfzijl it seems more likely to

unfold within an urban context compared to the more rural context of the other three projects along the Wadden Sea coastline.

3.2.4.2. Double Dike & Wide Green Dike

These two case studies are smaller in scope and size, and this will prove more difficult in applying and recognizing self-organisation. The projects deal with less stakeholders, and residents and local concerns are mostly dealt with through the regional government and local municipalities (Interview Hunze en Aa's, 2018; Interview Noorderzijlvest, 2018; Noorderzijlvest II, 2018). The projects contain a degree of unpredictability and experimentation along technical endeavours but less so in the realm of governance. No spontaneous developments have emerged thus far in the realm of governance.

Spontaneity can potentially occur in the physical system. It returns in practice in the deliberate search for the right vegetation on dikes [Lauwersmeerdike], the most useable type of silty agriculture [Double Dike] and type of clay used for dike strengthening [Wide Green Dike]. These experiments show a degree of acceptance of spontaneity in practice, although they all exist within the boundaries of contained spatial contexts and can therefore be seen as examples of containment planning. Spontaneous usages of regions, such as the *a priori* recreational space in the Marconi project provide opportunities to recognize self-organisation, in the social environment, early on. However, in the case of the other three projects such spontaneous usages of the dikes have not been noticed.

From a higher echelon such usages might be stimulated if planning practice is taking a different direction. The drive to achieve planning results more efficiently, and less rigidly, can be observed in the projects, incrementally (Interview Hunze en Aa's, 2018; Interview Noorderzijlvest III, 2018). The Wide Green Dike and the Lauwersmeerdike projects are examples where desires for internal changes are occurring. Some of the stakeholders have hinted at a need to broaden not just the scope of the projects and the recognition of flexibility, but also letting go of a sense of governmental control and ''doing things more like the market does'' (Interview Noorderzijlvest III, 2018), with greater efficiency and less bureaucracy (Ibid.; Interview Groningen SeaPorts, 2018; Interview InVra Plus, 2018). The water boards however still create conditions and control for changes, though it can be argued that self-organization could potentially take place within these contexts. At the same time, without a change in its governance component this drive would stay mute. If we take the spatial environment from a

non-linear perspective we view the role of the planner rather differently, one where we look for the best possible position in a context or environment, a place where robustness and dynamics are in flux.

3.3. Area Development Oosterwold

3.3.1. Non-linear development

The fuzzy and unpredictable nature of the project leads to a matter of constant adjustments as there is no blueprint. This could indicate that there is, at least theoretically, potential and possibilities for the region to shift in structure and function over time. There are fixed rules concerning land use however, such as number of households and the percentage of land destined to remain green space, but a crisscross could occur due to changes in the housing market (Interview Gebiedsontwikkeling Oosterwold, 2019). The spatial uses of the region however are still generally fixed, which may hinder the possibilities for parts of the region to shift in structure and function. Non-linear development could therefore occur but it would do so within chosen boundaries, making the project an example of nonlinear development in a contained and controlled system, and not a strictly open one.

3.3.2. Contextual Interferences

Concerning contextual interferences there is much room for public green areas, cycling and pedestrian lanes, and city agriculture. With the combinations of different land uses there is a search for the best possible fit for the region. Large business districts are denied access inside the region as these do not match the initial goals of the region being a space for residence and recreation.

The area director (Dutch: *gebiedsregisseur*) is a key figure and stimulates initiatives and advises where it is necessary, though much freedom and responsibility lies with the initiators themselves. The area director uses a develop-forum and an interactive plan map, which consists of all the ideas, wishes, questions, and initiatives and creates alliances (Gemeente Almere & Gemeente Zeewolde, 2013, p.19). The fact that an area director goes to such an extent to look for the best possible fit shows us the importance of contextual interferences within this project.

3.3.3. Co-Evolution

Evolutionary principles return in the overarching vision of the Oosterwold project. Adjustments are taken as a fundamental building block, and while there are rules and governmental responsibilities in place, the project overall is characterized by one that acknowledges changes and adaptation along the way. There is in fact no blueprint (Gebiedsontwikkeling Oosterwold, 2019). Oosterwold provides maximum freedom for initiatives, albeit granted within the previously mentioned 10 principles (Gemeente Almere & Gemeente Zeewolde, 2013, p. 20). This can potentially lead to processes in which actors manipulate the system and the system changing in response, as there is much freedom and exploitation possible as the principles have a certain ambiguity to them. Due to the accepted unpredictability of outcome, the project's principles can be viewed as ambiguous and open to radical changes, provided they do not hinder the project's initial goals. Within this, citizens form collectives to help one another out. In the meantime adjustments are naturally formed over time, which occurred when complaints were made due to the lack of a sewage system in place. Citizens were expected to create their own wastewater treatment which proved insufficient. As a consequence, the water board now monitors whether these citizens meet the safety and quality norms of wastewater treatment. It was found that none of the existing requirements were met (Gebiedsontwikkeling Oosterwold, 2019).

One notable case that could prove a hindrance in continued co-evolution is demographic composition. In the future the demographics of the region are likely to change as house lot prices have increased (Gebiedsontwikkeling Oosterwold, 2019). As the project is upscaled more governmental influences may occur, as we have seen with changes in responsibility concerning waste and wastewater management. Upscaling could lead to more rigidity and a decline of complexity and evolutionary pathways. At this point however this remains speculative.

3.3.4. Self-organisation

The past couple of decennia have shown a development towards more control and agency for individuals. This creates more opportunities for self-organization to bloom. The towns of Almere and Zeewolde have played a significant part in being trendsetters in private commissioning (Lekkerkerker, 2016). In Oosterwold, municipalities will go one step further by

asking: *What will happen if area development is also mainly the responsibility for individuals? And is this still possible (Ibid.)?* The governments will take a step back to provide judicial means to make this development strategy possible. To make this possible, municipalities have made an inter-municipal structure vision, and for the project's first phase, a destination plan that will allow permits for initiatives (Ibid.). The project is viewed as a system breaker within Dutch planning and regional development. The norm in the area will be one in which there is ''passive'' land use (Lekkerkerker, 2016) which means no primarily governmental involvement save its responsibility to guarantee the core principles.

The residents and entrepreneurs have to view Oosterwold as 'their' region, as they have made it from the bottom up (Gemeente Almere & Gemeente Zeewolde, 2013, p. 18). The government keeps a distance which will lead to less complaints about 'the government' (Ibid.). Few rules are in place and much space is provided for bottom-up initiatives, and the residents and entrepreneurs use this freedom enthusiastically. Responsibility is, next to freedom, is seen as an important ingredient in the project's success (Ibid.). The area director gives the initiators qualitative preferences, such as sustainability. Every initiator will, together or by themselves, find a way within this process. The houses are isolated, many have solar panels, and other means of generating sustainable energy. Water purification happens sustainably as well on own lot or decentral in small units (Ibid.; Gebiedsontwikkeling Oosterwold, 2019).

Oosterwold is meant to develop itself ''organically'' (Gemeente Almere & Gemeente Zeewolde, 2013) in that initiators in the region itself are seen as its developers. As part of the project's vision, a relatively high percentage of employment will be jobs at home, in the broadest sense (Ibid. p.19). On average there will be 1,2 workplace per home. The interviewee of the municipality of Almere stressed that in this case here there is room for different types of incomes and people (Gebiedsontwikkeling Oosterwold, 2019).

If we look past minor changes in waste and wastewater management, great changes throughout the project have not yet occurred, but, at the same time these changes are likely to occur in the project as the foundation on which it stands very much incorporates evolutionary pathways and tries to actively stimulate initiatives and therefore self-organization among its populace.

3.4. Case comparisons: similarities and differences

3.4.1. Nonlinear Development

The case studies show great differences between them concerning possibilities for nonlinear development [as can be seen in table II]. The urban context of the Marconi project provides limited space for changes in structure and function, and changes that did occur spontaneously, such as the general acceptance of viewing the region as having ecological value by pedestrians and tourists, have later on been taken up by policy makers to incorporate in the overall picture of the area. Originally, the project was to reconnect town with seaside, and create a larger beach, with the addition of a salt marsh only added later on. Changes happen, but they are still steered from above.

In the two dike projects we see no spontaneous changes occurring, but merely changes made within the area that are seemingly perfectly controlled. The Double Dike allows for experimentation and failures are accepted, but still not expected as there is a sense of confidence in the project. Exact outcomes of silty agriculture and nature restoration are a question mark, but there is little doubt that there will not be a successful development on both sides. Here, as with the Wide Green Dike project, there is no room for spontaneous developments within the project, nor have there been spontaneous changes occurring in the areas where structure and function have changed. These will change, but only within their contained areas, and as these changes are controlled for, they do not characterize nonlinear development.

	Nonlinear Development	
Marconi Buitendijks	- Officially limited space for changes in structure and function, but do occur. - Steered from above, most changes still 'guided' towards desirable outcomes.	- Safety and command-and-control paradigm remain fundamental.
Double Dike	- Structure and function change within a contained area.	- Playing field exists within the area, allowing experiments.
Wide Green Dike	- No changes occur in structure and Function, save [minor] ecological ones.	
Area Development Oosterwold	- Fixed land uses, but space for changes In structure and function within contained area.	- Constant readjustments due to project embracing unpredictability.

Table II: Main insights concerning nonlinear development within the projects.

The area development of Oosterwold shows a radically different system, where people do have space and possibilities to go about their own ways, provided they adhere to the core principles of the project, as agreed upon by the government and the founder of the project. Constant readjustments are being made, such as is the case with wastewater management. Land uses are still fixed however, as there are areas with fixed purposes and functions, such as recreation, nature, agriculture, and housing.

Nonlinear development, characterized by changes in systems on both structure and function, may or may not occur with governmental influence or coordination. In practice it is hard to either occur or be implemented in planning practice as we have seen areas where context can become rather fixed. Areas may have fixed functions on the map, be it 'nature', 'residence', or 'industry'. Over time it becomes increasingly hard to radically alter their functions, although it happens within contained areas such as the Double Dike, or with the creation of the salt marsh in the Marconi project. In the Oosterwold case too, changes are still occurring within a contained area, and with the approval of government. This approval is more distanced in the Oosterwold case whereas any changes in the other three projects, particularly the dike projects, are tightly controlled by governmental bodies. It can be observed that, within the context of Dutch planning, a looseness and distance from government to changes in structure and function of a region, proves to be beneficial if policy makers seek to stimulate nonlinear development.

3.4.2. Contextual Interferences

The best possible fit is explored by stakeholders throughout the projects selected. In practice this does not necessarily align well with each stakeholder involved. In the Marconi project, context of the project has changed with the additional function of the region through the inclusion of a salt marsh, but some entrepreneurs have been vocal and sceptical about these changes and the subsequent lack of parking space close by, on which they believe they depend to attract visitors. The municipality did not approve of a new parking space and has not brought forward an alternative thus far. The beach too, may not yet have the best possible fit concerning people's wishes, as recent news suggested, where people complained about the lack of basic services, such as sanitation (Bakker, 2019). In the two dike projects we see less complaints as these projects are situated in thinly populated, rural contexts, which could contribute to making decision making from a top-down perspective less controversial. Some complaints were made

by locals, noticeably one farmer, about the changes to the land in the Double Dike project, but overall less people were involved, and the regional government could hasten the project's process. Even so, criticism of this approach is noticeable by various interviewees.

	Contextual Interferences	
Marconi Buitendijks	- Best possible fit is explored with locals and major stakeholders in mind.	- Frictions with stakeholders occur, Reducing contextual interferences in governance.
Double Dike	- Physical system changes allow for context to change, but *within* a contained area.	- Case is viewed as a pilot, and will be used for comparative analysis.
Wide Green Dike	- Similar to Double Dike, with room for failure and mistakes, but also *within* a contained area.	- Dike strengthening methods to be used elsewhere, for relatively similar systems.
Area Development Oosterwold	- Much room for experimentation and mistakes among residents.	- Experiments *are* the context.

Table III: Main insights concerning contextual interferences within the projects.

The Oosterwold project is, like Marconi, situated in a more urbanized context, and in contrast also has direct impact on residents, and not just a few entrepreneurs. As Oosterwold embraces unpredictability and an experiential design, it can be said that these characteristics are its context. Policy makers here accept mistakes and adjustments, of people learning to take responsibilities that would otherwise be solved by either a water board or the municipality. Still, a degree of modesty is required here, as governments *do* intervene, but only if there are no alternatives and if problems are significant enough to warrant governmental intervention.

3.4.3. Co-Evolution

Process where actors manipulate either the physical or social system in place, and systems changing accordingly to these manipulations occur in the Wadden Sea projects, although they occur with guided determination by policy makers in government. Changes in Marconi co-align with changes made in politics, most noticeably the regional elections of 2011, which saw a movement away from purely economic and liveability standards to one which incorporated ecology also. The Economy & Ecology in Balance program proved to be a much praised initiative that joined different values and improved connections between these two rather

different aspects. End goals however were, and are, still present in the project, making spontaneous changes and manipulations less likely.

	Co-Evolution	
Marconi Buitendijks	- End goals present, though trajectories to get there changed considerably.	- Actors have changed some of the area spontaneously in its purpose.
Double Dike	- Land uses change, but are still determined.	- Changes in the system and its environment are interdependent.
Wide Green Dike	- End goals present, and land use is determined and will not change.	
Area Development Oosterwold	- End goals are not present, merely core principles. The project is an open book.	- Potential upscaling of project could reduce co-evolution.

Table IV: Main insights concerning co-evolution within the projects.

The two other Wadden Sea projects are similar in that regard, and are even more rigid in their fixed land use management. The Wide Green Dike will offer no manipulations to land use planning, but merely adjustments made to the dike and the salt marsh, without allowing for actors to change the system itself.

Oosterwold in contrast has no blueprint, but only 10 core principles, which are ambiguous, and offer much freedom in their application. The project is therefore an open book. Challenges to evolutionary pathways may occur in the process of upscaling the project, as some responsibilities, such as wastewater management have been taken by government. Compared to the three other projects however the Oosterwold project is very much an open book and has built-in guarantees, through its core principles, that allow for processes to unfold where a playing field occurs between actors' choices changing the physical system. This allows for co-evolution to occur as policy makers do not define a clearly set end-goal, but merely a number of conditions that need to be met. The other projects do not have such built-in strategies, as responsibility for land management and the goals set in place are more rigid and changes [minor] only occur within a far more contained area.

3.4.4. Self-Organization

In the three case studies in the province of Groningen there is no proper developments emerging as of yet that show self-organization to be a possibility in planning practice. The interactions between actors occur in all these projects with external, governmental coordination. The major coordinative bodies here are the municipality of Delfzijl [Marconi], the regional government of Groningen [Double Dike], and the water boards [Double Dike, Wide Green Dike], leaving the ability for the physical system as well as the social system to self-stabilize and self-innovate dire. The frameworks of planning practice are changed at the behest of these external coordinative bodies.

	Self-Organization	
Marconi Buitendijks	- Changes are governed and steered by government, limiting self-organization.	- Minor changes occur [see also co-evolution] but taken over by government, preventing bottom-up governance.
Double Dike & Wide Green Dike	- Local concerns and initiatives are steered by government through fixed land uses.	- Spontaneity exists in case of agricultural experimentations and the physical system, but not in governance.
Area Development Oosterwold	- Citizens primarily responsible for keeping to the principles. Much responsibility lies with them.	- Citizens have much space for innovation, government only interferes if core principles are not met.

Table V: Main insights concerning self-organization within the projects.

Likewise, the Oosterwold case contains external coordination, in the municipality of Almere and the area director foremost, however within the system there is more leniency for self-organization to occur. This is mostly through for the social system in place, as residential responsibility is held in high esteem, and only if mistakes prove to go against the core principles does external coordination lead to a more direct approach. Meanwhile, much developments may occur that are only halted at times when there is no alternative. The Oosterwold case is therefore capable of allowing residents to experiment and innovate within the social system of the project. The physical system is more rigid, as there are fixed land management uses concerning housing, nature, and recreational areas.

Compared to the other three projects it can be observed that Oosterwold, as in the case in analysing co-evolution, provides in-built strategies that provide residents and stakeholders with opportunities to make mistakes and learn or develop their responsibilities for planning. While there are core principles that must be adhered by, the project itself is allowing for the

social system to self-stabilize and self-innovate to a far greater extent than the other projects due to its foundation and original purpose.

3.5. Complexity in Water Management

Seeking solutions for coastal development is a challenging pursuit. The approaches in these projects are linked to multiple interests - such as flood protection, ecological restoration, town revitalization, and population decline - and, as a consequence, lead to different strategies. In addition, the starting goal and the population context [more rural or more urban] are also of major importance, as is the main body responsible for the project's process and outcome.

Different options, from robust to more flexible ones, have been put forward as planning strategies in water management. Every perspective has its advantages and disadvantages. A tightly controlled and robust strategy can prove successful in rapid implementation of experiential dike designs, where building with nature principles reign supreme. At the same time such strategies may be met with disapproval of stakeholders and residents whom believe the externally controlling stakeholder [government] makes changes occur too rapidly and at the cost of the wishes and needs of others. It may also turn out that original ideas put forward by key stakeholders become contested or subject to radical change due to upscaling of the project in a larger context [Marconi incorporated within the Ems-Dollard 2050 program] or additional new projects within a project gain a foothold [creation of a salt marsh].

The Oosterwold project has thus far shown a high degree of flexibility and adjustments as anticipation for these changes have been anchored in the project early on. It allows for a playing field where actors [residents, entrepreneurs] can take matters into their own hand. There are possibilities for co-evolution to unfold due to the lack of clearly defined end goals. Instead, the project is an open book. Actors here are given a great degree of freedom and are innovators in practice, making self-organization possible. Because many different actors, provided they follow the core principles, may change the system, nonlinearity can occur and changes in the project can potentially be non-attributable to a single actor or factor. For both aspects of complex adaptive systems, the foundation of the project allows fertile ground for both self-organization and nonlinear development to come to life.

In the coastal projects explored, planning decisions have to be made that deal with different issues, that of water safety and climate change, which are directly impacting liveability

and agriculture. It therefore seems daunting to apply practical knowledge of the benefits of a project such as Oosterwold, more closely resembling a complex adaptive system, to projects that still seem to require so radically on robustness and collective responsibility instead of individual innovation and self-reliance. However, it can be noted that even the Oosterwold case is not a perfect example of self-organization. A degree of central coordination, through the municipality and the water board, does present itself when residents make mistakes or fail to uphold the core principles of the project (Interview Gebiedsontwikkeling Oosterwold, 2019). As has been emphasized in Chapter III, complexity is not absolutist, and degrees of complexity should be recognized (de Roo & Rauws, 2012). Even on a smaller scale within a project, self-organization and complexity characteristics may still occur, despite the overall larger system being coordinated or upscaled by a central stakeholder, such as a government. Spontaneity however is more difficult to examine in the coastline projects. Both co-evolution and self-organization in particular become increasingly hard to realize in projects characterized by water safety and [relatively] few stakeholders involved. Actors that may bring forth such developments in the Oosterwold case, such as residents and small businesses, find themselves represented by a different party [i.e. municipality] and are faced with tight land use management. These systems may change in form and structure on the level of the physical system [creation of salt marshes, new agricultural practices] but they do not relate to the social system [governance] of these projects. This means that at least only partially, on the level of the physical system of the project, and within a specific contained area, room for experimentation and innovation and for unpredictable outcomes exist. There may be adjustments made, but for their final 'acceptance' these will have to be approved of government[s], who function as external coordinators. While this occurs, self-organization lies dormant. Because of this, changes made in the physical system as well as the social system and governance behind the project, stay predictable and provides policy makers with the capacity to oversee [to a degree] the project's process and its outcomes. This means cause-effect relations within these processes remain proportional. Due to the low or no possibility for self-organization to unfold, nonlinear development will also be hindered. Because said projects also have defined end-goals and targets set in advance, the characteristic of co-evolution does generally not return either.

3.5.1. Living with Water? Robustness remains a Necessity

The observations made in this research seem almost paradoxical when looking at these physical systems in their base natural state. Estuaries are by their nature complex adaptive systems, but the manner in which we organize their functions and exploit these areas are strongly characterized by robustness and linearity. While the old paradigm of control-and-command is not necessarily in place when we look at the greater scale of planning practice concerning the estuary - since different strategies involving the *building with nature* principle do apply - the manner in which we plan and change the land is still heavily influenced by it. The projects along the Wadden Sea coastline have clear targets, ecological and economic ones, and do not involve spontaneous adjustments or self-organizing systems to come to life. There is room for innovation and experimentation but it is controlled and contained.

Complexity as a whole is best seen as a spectrum with relatively complex systems and highly complex systems at the very end of it (de Roo, 2003), rather than an 'all-or-nothing' theoretical perspective, in which a system or spatial context and environment either *is* or *isn't* complex. Such an extreme position would nullify complexity and make it hard to pinpoint, whereas accepting degrees of complexity would provide us with a better understanding of how and when complex adaptive systems are recognized and how they evolve. The projects in this study have elements of both, to various degrees, but are limited.

As the physical system is complex and adaptive by itself it seems disconsolate to not embrace aspects of complex adaptive systems in the planning practices of water management. The current focus on the estuary is heavily focussing on ecology and preventing the silting up of the estuary, as it also hinders the local economy and large businesses. This could create further resistance in the future as not everyone may feel adequately involved in these processes. The upscaling of the projects into the wider Ems-Dollard 2050 program can lead to policy decisions where planners have to limit stakeholder involvement, meaning diversity becomes limited. The current program is aimed to benefit both larger businesses dependent upon sea travel as well as the overall ecology of the estuary, but other concerns, such as local businesses and residential concerns less so. Other social actors may then become less visible and disconnected, reducing additional opportunities that may improve the project. This is most striking for the Marconi project, though less in the Double Dike, and significantly less in the Wide Green Dike case, due to its highly ruralized context. The more urbanized the setting is, the more relevant strategies embracing complex adaptive system's thinking becomes. Based

on the case studies selected, different types of strategies and different degrees of embracing characteristics of complex adaptive systems are discernable, depending on the project's original fundamentals, actors put forward as leading, the project's geographical place [within an urbanized versus ruralized context], and its size [smaller areas provide more security for principles of robustness and predictability]. These pieces of the puzzle play key roles in increasing the capacity for characteristics of complex adaptive systems to emerge [see figure X].

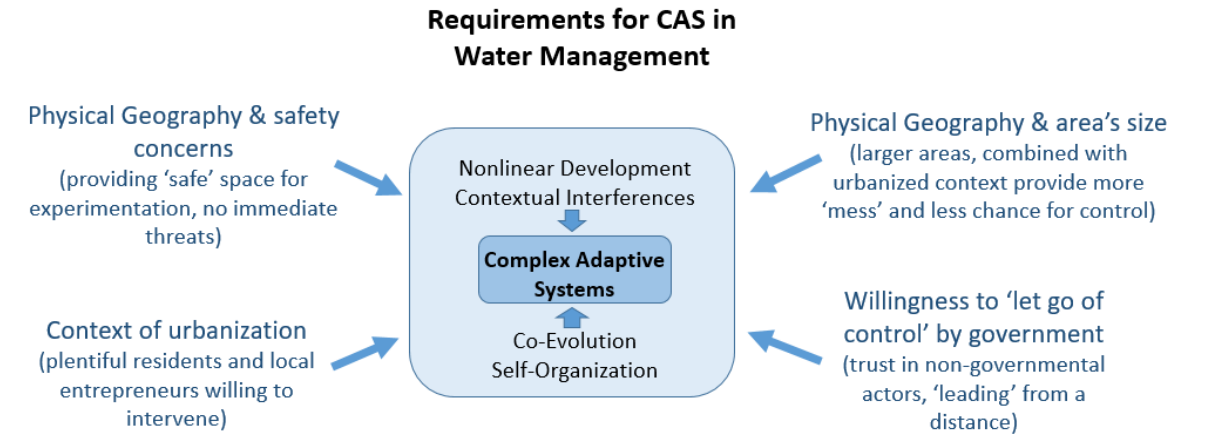


Figure X: Requirements for CAS to emerge in future coastal water management projects.

Complexity would increase with more direct involvement of residents and local businesses. While these groups are represented by larger organizations, at the same time, they may still be [or feel] undervalued. Complementing these in a better way would naturally only be considered by policy makers if the original economic and ecological goals would not be achieved without it. Also, as seen in Chapter III [Planning Theory], increased debates and bottom-up involvement could delay operations and possibly lead to rising costs of the project. Due to the fact these coastal projects deal primarily with water safety and the regional economy and ecology, broadening the scope of governance could lead to adverse consequences of original goals, making the current trajectories perhaps more feasible. On the downside, it can lead to missed opportunities as well as a false sense of security, where the currently taken route reconfirms the goals. This makes the planning processes and the debates generated mostly an affair by stakeholders that are each other's supporters, providing little incentives to change course or explore paths that can oppose the present course.

So, all things considered, can we state that complex adaptive systems are desirable in water management projects along the Wadden Sea coastline? Yes, they do, but only partially

so. They do contain advantages of limiting citizen's concerns and creating possibly new innovative practices concerning governance. The projects and policy makers involved consider the projects 'adaptive' (Ems-Dollard 2050 program, 2019) and pride their projects on being innovative, experiential, and will use them as possible export products for existing, exploratory projects elsewhere, and possibly in other countries. In the immediate context of the Wadden Sea, other projects, such as the Lauwersmeerdike, spring to mind. To avoid potential struggles against residents and local entrepreneurs, it might be helpful to attract and join locals in a very early stage in the project. As it is now, the water boards will first explore potential dike improvements, and only consider additional 'plus' solutions afterwards (Interview Noorderzijlvest III, 2018). This could prove to late however, as technical and juridical measures may overlook such alternatives, which may prove popular with locals. A more open system, like that of the Oosterwold, could prove to be of benefit here. It may question established ideas and provide alternatives, creating opportunities that would otherwise be missed.

A pure complex adaptive system however seems difficult if not impossible to realize in water management. On the level of the physical system there is plenty of room available to enhance the complexity of estuaries and ecology, however a certain degree of robustness and command-and-control seems necessary to guarantee water safety. Self-organization seems therefore out of the picture. In the Wadden Sea projects this is even more so the case as policy makers deal with relatively small contained areas. These projects could however provide more space for such characteristics as nonlinear development and co-evolution to occur. New water management projects could therefore learn from the Oosterwold case, in part, and provide more leniency in the exploratory phases, but are still required to expect predictable outcomes and central coordination, considering the sector's goals.

Chapter VI: Conclusions

4.1. Inferences and Recommendations

Policy makers make many attempts to find appropriate strategies for planning in water management. The Wadden Sea is a complex system but this often does not reflect the manner in which policy makers approach it. Often, a desire for robustness and stability triumphs in the face of an unpredictable and erratic reality. New projects along the coastline have shown some leniency in how they deal with the physical system, allowing for experimentations and innovations concerning new agriculture, alternatives for dike strengthening, and the creation of new salt marshes. The systems however are still centrally coordinated by governmental bodies and do not allow for much space in creating spontaneous co-evolving, nonlinear, self-organizing systems to take hold. It is only within the physical system where these characteristics of complexity are able to come to life, but in the social system they generally do not. Comparisons were made between three coastal projects and the area development of Oosterwold. In the latter case study, such characteristics have more space to thrive, as they are the very building blocks of the project. Here, residential responsibility and bottom-up initiatives core principles, any mistakes are acceptable, and no blueprint exists. Even so, the physical system is, here too, guided to some extent by governmental bodies to avoid critical thresholds that may endanger the project as a whole.

It would be tricky for water management project to freely incorporate such aspects of complex adaptive systems. The desire for robustness and governmental responsibility is seen by all stakeholders participating in this research as critical. Yet, there are also concerns over the manner in which governments may hasten project processes, which can lead to friction among local entrepreneurs. Second, the projects are upscaled in larger regional programmes. While these programmes mention adaptivity and local economic opportunities, there is still a heavy focus within the projects on fixing the situation of the silting up of the estuary and improving the ecology. This in turn is linked to sea travel and the importance of the industries to the regional economy. Smaller businesses and 'soft' economy such as tourism and recreation may be overlooked, possibly creating missed opportunities, and making any mentioning of 'soft' economy a form of box ticking. Next to these issues there are also geographical aspects to consider: a project situated in a more urbanized context will likely have more residents and entrepreneurs available who are willing to actively participate, whereas projects in more rural,

thinly populated contexts are less likely to cause friction when a more robust trajectory is chosen.

Even so, lessons could be learned for the water management sector here, if it wishes to further incorporate additional 'pluses' to projects and improve the social system next to the physical system. The latter allows for increased complexity, albeit within contained areas, on some aspects. The former will prove to be more difficult, yet lessons can be learned from the Oosterwold case. Avoiding the possible dilemmas of communicative-rational planning, more stakeholder involvement early onwards, and perhaps even social experimentation could be explored. Not by giving every stakeholder equal power or influence, but by exploring possibilities in earlier stages. The current projects experiment much with the physical system, and a bridge to the social system could prove beneficial too. This would avoid missed opportunities and expand learning possibilities that could open up the system, creating the 'pluses' that various stakeholders seek. Naturally, this is a tentative advice as this research recognizes the importance of robustness and the central coordination of government[s] in water management projects. However, if policy makers continue mentioning such pluses and enhancing local economy it does beg the question why these are not further explored. More adaptive strategies will help stimulate a learning environment (de Roo, 2019). We have seen incremental stages of these developments throughout the cases. This can allow institutions and organizations to positively change to new circumstances, creating so called 'niches' (Rotmans & Loorbach, 2009). A journey towards more complexity and adaptivity provides us with the means to adapt to changing circumstances concerning the environment, demographics, and governance. This provides space for innovations and flexibility, reducing the chance of narrow and strict strategies that hinder progress and may lead to fatal planning mistakes (Rauws et al., 2013). On the other hand, more predictability can provide us with [legal] certainty and the restrictions of external effects (de Roo, 2019). Too many regulations however can create obstacles and hinder progress, yet too few can lead to opportunistic behaviours and unwanted effects (Ibid.). In a complex adaptive systems approach, therefore, we find space for both flexibility and robustness. There is space for experimental policy designs where we co-align different planning strategies and activities, and there is also space for institutional provisions to facilitate governance networks (van Buuren et al, 2013). The drive towards more adaptive strategies and a complex adaptive system does increase the chances for diversity of solutions and can enhance societal and institutional innovations (de Roo, 2019). The coastline

of Groningen - characterized by ecological restoration, economic opportunities, but also population decline – could function as an interesting experiment for increased complexity in not just the physical system in contained areas, but also the social system of planning.

4.2. Reflections

This research will contain a number of limitations due to the chosen research strategy and selected cases. Qualitative data was gathered by studying policy documents and conducting interviews with key stakeholders. The first issue that arose is a certain bias in policy documents, as the same stakeholders tend to write these documents and will present a picture of their project that is seemingly well balanced, mentioning stakeholder agreement, benefits to local economy, and matching [radically] different interests. In practice, it also turned out that many interviewees emphasized that things went well in the project[s], and planning processes and decision making were seen as how planning 'ought to be done'. Other interviewees proved to be more critical, particularly those whom were involved with project[s] for longer periods of time. Also, some interviewees were newcomers to the project[s], yet still the relevant person of their organization. Some of these interviewees could not answers questions in depth, and at other times their distance to the project proved large (Interview Gemeente Het Hoogeland, 2018). To partially solve this issue, other people were contacted, whom are no longer part of the project[s] but had significant influence over the course of project[s] in the past (Interview Gemeente Delfzijl, 2018; Interview Rijkswaterstaat, 2018). A final issue with qualitative data gathering was the lack of response from some relevant stakeholders for interviewing, despite repeated mails and calls.

The chosen theoretical background of this research proved to be difficult to apply to case studies that are closed systems and mostly, at least by the end of the day, a top-down affair. Even so, aspects of complexity can be observed, and a relevant distinction was made between the physical system and the social system to ease the analysis of the case studies.

4.3. Future Research

The chosen theoretical framework for this research, where four characteristics of complexity theory were analysed in planning projects, provides opportunities for future research. Not much research has yet been done on [coastal] water management project from a similar complex adaptive systems' approach. Other studies (Gerrits, 2008; Seijger, 2014) were explored,

which focussed on co-evolution and the necessity of interactive knowledge development respectively. As estuaries are complex systems by themselves, and as there is an increased avocation for bottom-up governance, there is much potential to conduct further research into the relationship between complexity and water management.

Furthermore, additional research of a quantitative nature would be beneficial. This could prove beneficial in avoiding desirable answers and could be conducted with a greater sense of anonymity. Specifically, questionnaires could increase knowledge analyse local entrepreneurs' perspectives, in order to ascertain to what extent they feel involved in the projects and to what extent they [feel] could interfere in planning processes and decision making. This would lead to an increased understanding of both opportunities and barriers of increased complexity in these projects.

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Interviewees

Note I: The following list shows the interviewees. From left to right: Reference as used in thesis, name, function, and organization.

Note II: The names of organizations were usually chosen as reference, and only if the person had an independent function were surnames used to avoid creating the impression that these persons may represent the interests of a specific organization.

Note III: Two interviewees wanted to stay anonymous.

- Bosch, 2018 : Bosch, A. *Strategic area advisor*. De Laar.
- van Es, 2018 : van Es, K. *Senior advisor*. Wing, partner in ruimte en ontwikkeling.
- Gebiedsontwikkeling Oosterwold, 2019 : - anonymous - . Gemeente Almere.
- Gemeente Het Hogeland, 2018 : Piso, A. *Strategic advisor*. Gemeente Het Hogeland.
- Gemeente Delfzijl, 2018 : Groot, E. *Mayor Gemeente Delfzijl (2008-2015)*. Gemeente Delfzijl.
- Groningen SeaPorts, 2018 : Kuijper, T. *Senior project leader Port Technology*. Groningen SeaPorts.
- het Groninger Landschap, 2018 : Reintsema, R. *Quartermaster*. Het Groninger Landschap.
- Hunze en Aa's, 2018 : Jolink, E. *Program manager*. Waterschap Hunze en Aa's.
- InVra Plus, 2018 : de Vrieze, A. *Owner InVra Plus*. InVra Plus.
- de Kleine Zeemeermin, 2018 : de Vries, G. *Restaurant owner*. De Kleine Zeemeermin.
- Noorderzijlvest I, 2018 : Wijnstra, A. *Project manager high water protection*. Waterschap Noorderzijlvest.
- Noorderzijlvest II, 2018 : Veendorp, M. *Knowledge manager POV-Waddenzeedijken*. Waterschap Noorderzijlvest.
- Noorderzijlvest III, 2018 : Van Dijken, P. *Environment manager*. Waterschap Noorderzijlvest.
- Provincie Groningen, 2018 : Buurman, M. *Senior policy advisor Water*. Provincie Groningen.
- Rijkswaterstaat I, 2018 : - anonymous - . Rijkswaterstaat.

- Rijkswaterstaat II, 2018 : Jorissen, R. *Director high water detention program*. Rijkswaterstaat.
- WUR, 2018 : Baptist, M. *Senior scientist marine ecology*. WUR [Wageningen University].

Interview Guide

Date: .....
Place: .....
Interviewee, organization, function: .....

Introduction

- Brief introduction of interviewer and explanation of thesis topic.

1. Heeft u een rol gespeeld en wat voor een rol spelt u binnen dit project?

2. Wat is de rol van uw organisatie binnen dit project?

- Wat is de rol van uw in de realisatie of huidige totstandkoming van het project [...]? Speelt zij meer een coördinerende rol of neemt het ook zelf een actieve rol in?
- Speelt Gebiedsontwikkeling een belangrijke rol binnen het project?
- Welke partijen spleen een belangrijke rol?
- Hoe start dit process; waar let uw organisatie op?
- Hoe wordt er invulling gegeven aan de Gebiedsontwikkeling?
- Is er al een bepaalde visie aanwezig, van uw organisatie dan wel een andere partij? Zoja, is de aanstaande visie rondom gebiedsontwikkeling daarom ook meer sturend?
- Spelen kleinerestakeholders een belangrijke rol of is het een bepaalde overheid die bepaald en de rollen verdeeld? In hoeverre worden niet overheidspartijen bevordert in hun vrijheid om zoveel mogelijk eigen creatieve inbreng te geven aan het project?
- Wordt onderlinge interactie en samenwerking bevordert? Zo ja, wie heeft hier de voornaamste of beslissende rol in? Zou iemand anders deze rol volgens u beter kunnen uitvoeren?
- Op welke wijze is de bevolking van gemeenten [...] e.o. betrokken in het project? (Zo niet, op welk moment (en waarom op dat moment) vindt dit plaats?

3. Project omschrijving

- Is het project volgens u opgesteld aan de hand van duidelijke criteria die het succes van het project kunnen toetsen?
- Is het project volgens u goed gedefinieerd?
- Is het onder de stakeholders duidelijk wie welke verantwoordelijkheden heeft?
- Is het proces van het project goed te overzien of is er een grote mate van onvoorspelbaarheid?
  (Zoja, ervaart u deze onvoorspelbaarheid als bevorderlijk voor het project of juist onbevorderlijk?)
- Wordt het project volgens u meer gekenmerkt door robuustheid en standvastigheid (waarin er wordt vastgehouden aan de beginselen en weinig tot geen afwijkingen zijn) of is er een bepaalde mate van flexibiliteit?

- In hoeverre speelt de lokale context een rol? Word er vastgehouden aan een grote visie of juist gekeken naar de best possible fit?
- Kunnen lokale bedrijven en organisaties [zoals lokale belangen] een grote invloed uitoefenen op de uitkomst van het project? Is er enig protest ontstaan n.a.v. het project en de visie van het project?

4. Organisatie

- Zou de overheid (lokaal, dan wel provinciaal of landelijk) zich meer of juist minder moeten inmengen in het project?
- Is er genoeg politieke steun vanuit de Gemeenten en de Provincie Groningen voor het project? Is hierin een verandering ontstaan door de jaren heen?
- Zijn de regels rondom het project en de uitvoering daarvan flexibel of juist strak?
- Hoe ervaart u dit proces? Is het voor het project bevorderlijker als er een andere weg wordt ingeslagen?

5. Financiën

- Is het project financieel gezien verandert door de jaren heen? Is er bezuinigd of juist meer geïnvesteerd in het project (door zowel overheden als bedrijven/organisaties)?
- Is het onder de stakeholders duidelijk welke financiële bijdrage er van ieder wordt verwacht?
- Welke financiële voorwaarden zijn nodig om het project te doen slagen?
- Welke financiële voorwaarden zijn nodig om extra waarde te geven aan het project? (het breed trekken van het project naar gebiedsontwikkeling en/of extra waarden als bijvoorbeeld een energielandschap of stimulatie van de recreatiesector)

6. Evolutie

- Zijn er door de jaren heen grote veranderingen ontstaan in de evolutie van het project? (zijn er stakeholders afgehaakt of juist bijgekomen?)
- Hebben stakeholders het project sterk doen veranderen door de jaren heen? Is het project daardoor verandert van karakter of in de einddoelstellingen?
- Is er ruimte voor het maken van fouten? Wordt er geëxperimenteerd binnen het project, of liggen de doelstellingen en de kaders juist vast?
- Zijn er mogelijkheden om af te wijken van het huidige proces? (bijv. om meer te doen voor recreatie, of natuur)
- Waarom wel/niet.. ? Heeft dit te maken met historische ontwikkelingen in het gebied, of ook met de huidige mogelijkheden en/of beperkingen?

7. Belangen

- Vinden jullie dat de belangen van jullie organisatie voldoende zijn of worden gewaarborgd binnen het project?
- Hebben jullie doelstellingen die niet gerealiseerd kunnen worden? Zoja, welke? Waarom niet?
- Hebben jullie ambities in het gebied die nu niet spelen onder andere stakeholders? Willen jullie wellicht het project verder uitbreiden voorbijgaande aan de huidige kaders?

- Op wat voor een manier hopen jullie terug te kunnen kijken op het project in de toekomst?
- Wat moet gerealiseerd zijn specifiek volgens jullie belangen?
- Welke positieve eigenschappen van andere water- en/of dijk gerelateerde projecten zouden moeten worden meegenomen naar nieuw te realiseren water projecten in de provincie? (Hoe kun je deze bevorderen?)
- Welke negatieve eigenschappen van andere water- en/of dijk gerelateerde projecten zou men moeten proberen te voorkomen? (En hoe kun je deze voorkomen?)
- Samen met de andere twee waterschappen vormen jullie de POV-Waddenzeedijken om te onderzoeken naar koppelingen tussen verschillende belangen. Wat nemen jullie specifiek mee van andere projecten naar dit project?

Tot slot

- Zijn er zaken die niet aan bod zijn gekomen waar u nog iets over kwijt wilt?
- Zijn er personen die ik zou moeten spreken n.a.v. dit gesprek en over dit project?
- Zijn er nog vragen van uw kant?