UNCERTAINTIES IN POLICY DEVELOPMENT OF BUILDING WITH NATURE PROJECTS: IS AMBIGUITY MORE IMPORTANT THAN CONTENT?

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Abstract

Uncertainty is increasingly seen as an important issue in disciplines such as water management. For decades, Dutch flood management relied on the construction of dikes and storm surges barriers, creating a 'comfort zone' for society in which they feel safe and secure while uncertainty is perceived absent. Currently, the Dutch water sector has growing interest in approaches aimed at sustainable, nature-inclusive development of water systems. An example of such an approach is Building with Nature (BwN): pro-actively using natural system dynamics for design and realisation of water engineering projects, serving human purposes (e.g., flood protection) while exploring opportunities to promote nature development. However, BwN is associated with the presence of high levels of uncertainty, as nature and its dynamics are inherently unpredictable. In this paper, we study uncertainty in the *Sand Engine* BwN project's policy development process by analyzing key project documents and interviewing project team members and experts. Results from our study indicate that ambiguity is a more important type of uncertainty in BwN than deficits of knowledge. This suggests that different approaches towards coping with uncertainty in BwN policy development are needed.

Keywords

Uncertainty, policy development, water management, Building with Nature, flood protection

1. Introduction

The Netherlands has a long tradition of flood management, with the first official water authority already founded in 1255. Until late in the 20th century, Dutch flood protection was dominated by rigid structures such as dikes and storm surge barriers. These rigid structures were the preferred flood protection mechanisms as society perceives these as a guarantee for safety. Such a contemporary rigid approach can be characterized as a paradigm of "command-and-control", as defined by Holling and Meffe (1996). The natural system is strictly regulated and controlled to create a predictable and stable coastal or river system. Although the application of rigid structures has been a success in the recent past, the "command-and-control" approach to flood management has a negative impact on the ecosystem. This negative impact on ecosystems was regularly not taken into account in policy development. However, in recent years, incorporating ecology in water policy is increasingly perceived as a human responsibility (Gleick, 2000). An example of this changing perception of responsibility was already demonstrated during the construction of the Eastern Scheldt Storm Surge Barrier, one of the Delta Works, in the 1980s. The design of the barrier was adapted due to ecological concerns: the Eastern Scheldt tidal inlet was not fully closed but is now defended by sliding doors (Bijker, 2002; Disco, 2002).

The Dutch water sector is actively continuing the described pro-ecological trend, looking for opportunities to actively increase the role of nature in their water policy and flood management designs. The Building with Nature (BwN) approach is a state-of-the-art example of this nature-inclusive approach to water management. BwN is an innovative water engineering approach that proactively uses natural system dynamics as the starting point for the design and realization of effective coastal, deltaic, marine and river infrastructure projects (van Dalfsen and Aarninkhof, 2009). The BwN approach aims to flexibly integrate land and water by making use of natural forces – phenomena such as wind, waves and currents – and natural materials, such as sand (Waterman et al., 1998). BwN can have multiple appearances. For instance, the Sand Engine BwN project is mega-sand nourishment at the coast of Ter Heijde, of which the sand will be distributed towards the coast by dynamic natural forces (wind, tides and currents). Another example of BwN is the use of vegetation, such as mangrove trees, along (tropical) coasts and riverbanks as a flood defence mechanism ('bio-engineering').

The BwN approach changes the role of uncertainty in flood management fundamentally. Instead of aiming at uncertainty reduction and control, the inclusion of nature and its unpredictable dynamics in the project design implies that the presence of uncertainty is promoted and accepted. However, policy-makers and the public at large generally do not appreciate uncertainty when it comes to making solid decisions (Funtowicz and Ravetz, 1990; Bradshaw and Borchers, 2000). Hence, the presence of uncertainty is stimulated by the design characteristics of BwN but is yet undesirable in policy development, which underlines the complexity of the BwN approach regarding uncertainty in policy development. Therefore, it is essential to have a clear understanding of which uncertainties are most relevant to policy-makers and the public at large in BwN projects. If the key uncertainties of the BwN approach are identified, strategies can be developed to manage these uncertainties effectively to prevent unnecessary cost overruns, delays or cancellation of promising initiatives.

In this paper, we investigate uncertainty in BwN policy development by addressing one specific BwN case, the *Sand Engine* project. By analyzing key project documents and conducting interviews, we identified which uncertainties are most important according to project team members and experts. Furthermore, we address some implications of our results for policy development and managing uncertainty in BwN.

2. What is uncertainty?

Uncertainty is defined as *the situation in which there is not a unique and complete understanding of the system to be managed* (Brugnach et al., 2008). Following this definition, we distinguish three types of uncertainty in this paper:

- **Unpredictability –** uncertainty due to unpredictable or chaotic behaviour of e.g. natural processes, human beings or social processes (Walker et al., 2003; van Asselt and Rotmans, 2002);
- **Lack of knowledge –** uncertainty due to the imperfection of our knowledge, e.g. due to lack of specific knowledge, data imprecision or approximations (Walker et al., 2003);
- **Ambiguity –** uncertainty due to the presence of multiple knowledge frames or different but (equally) valid interpretations of the same phenomenon, problem or situation (Brugnach et al., 2008, 2011; Dewulf et al., 2005; Kwakkel et al., 2010).

It is important to make this distinction between types of uncertainties, as different strategies are needed to manage the different types of uncertainty (Brugnach et al., 2008; Brugnach, 2010). However, we will not address the topic of uncertainty management explicitly in this paper.

3. Method

First, document analysis was performed for the Sand Engine BwN project. Key project documents provide insight in the progress, results and ideas from the project and focus primarily on technical content. Table 1 is an overview of the key project documents studied for this research.

Table 1. Key policy documents studied (names translated from Dutch)

Key policy documents		
Ambition Agreement Sand Engine	Environmental Impact Assessment (EIA) Sand Engine	Several sets of Q&A posed in Dutch parliament
Project Start Notes Sand Engine	Note of Answer to EIA Sand Engine	Historical report on ammunition in North Sea
Guidelines EIA Sand Engine	Swimming Safety Report	Several Sand Engine permits

Second, six semi-structured interviews with members of the project team, the project steering group and experts involved were performed in April and May 2011 using a standardized interview protocol as basic guideline. We chose this group of interviewees as these actors are or were directly involved in uncertainty management of the Sand Engine project. The following key topics were addressed during the interviews:

- The definition of uncertainty according to the interviewee;
- Identification of uncertainties that are or were relevant for policy development;
- Evaluation of uncertainties in the project;
- Uncertainty management in general and of relevant uncertainties in specific.

After the uncertainty identification, the results the document analysis and interviews were combined into one comprehensive list of identified uncertainties. Thereafter, the identified uncertainties were classified according to their types. Furthermore, we determined in which phase(s) of the Sand Engine project’s policy development process the uncertainties are present and relevant.

4. Case study: the Sand Engine project

In March 2011, the construction of the Sand Engine, an innovative sand nourishment project, finally started near Ter Heijde in the Dutch province of South Holland. With a volume of 21.5 million m^3 of sand, the Sand Engine is larger than the current annual nourishment volume for the entire Dutch coast (which is 8 million m^3/year). The Sand Engine's design principles are a clear-cut example of BwN. After construction, the large amount of sand nourished will spread along the coast through natural dynamics (waves, currents and wind), expanding the coastal zone in a fairly natural way. As the Sand Engine is a pilot project, it will be monitored extensively after construction. Currently, it is expected that the distribution of the Sand Engine's sand along the coastline will take approximately 20 years. However – since weather conditions are unpredictable, especially over a 20 year period – this prediction of the sand distribution by natural dynamics involves high levels of uncertainty.

The policy development process of the Sand Engine project consists of six phases (Figure 1). The end of a phase is marked by a milestone, for instance the completion of a key project document or a key activity.

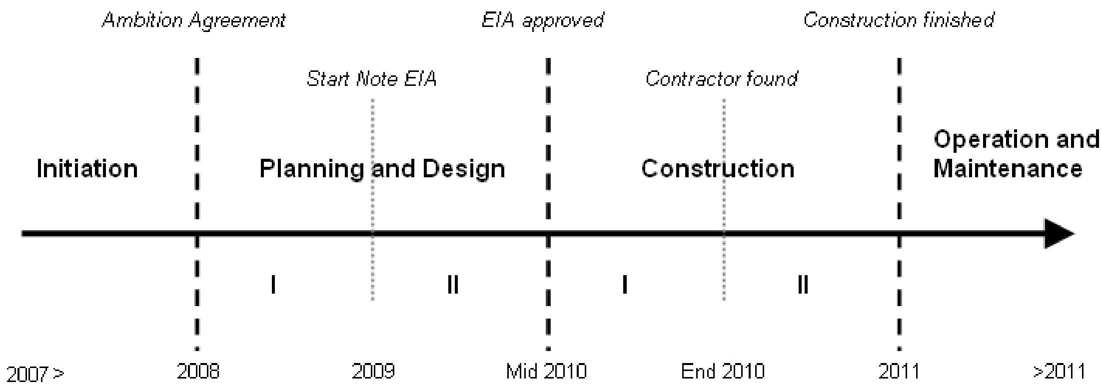

Figure 1. Timeline of Sand Engine policy development process

The main goal of each phase is to achieve its milestone in order to enter the next phase of policy development. Uncertainties that endanger or influence the achievement of a phase goal are expected to be very relevant for policy development. Therefore, we expect differences in the uncertainties relevant for a specific phase of policy development. In the Results section, we will discuss the uncertainties relevant in the several policy development phases.

5. Results

Table 2 represents the results of the uncertainty identification for the policy development process of the Sand Engine project.

Table 2. List of relevant uncertainties identified in Sand Engine policy development

Unpredictability unpredictable behaviour of nature, humans or the system	**Lack of knowledge** imperfection of knowledge inexactness, approximations, etc.	**Ambiguity** multiple knowledge frames, equally valid interpretations of a phenomenon
How will the SE develop morphologically? (e.g., in terms of its shape and speed of development) What will be the effect of the SE on the currents? (e.g., eddy formation, velocity increase) What will be the yield of the SE (e.g., total beach area increase, erosion)? What will be the effect of the SE on Scheveningen Harbour? How much money will stakeholders contribute to the project budget? What will be the effect of the SE on swimming conditions? What will be the effect of the SE on recreational conditions in general? What will be the effect of the SE on beach commerce? How will legal officials behave during construction?	What will be the effect of the SE on the ground water level? What will be the effect of the SE on the fresh water supply (e.g., salt intrusion)? What is the relationship between sand mining and occasional findings of WW2 ammunition on the beach? Which permits are needed for the SE construction? Which effect will the SE have on houses near the coast (e.g., flooding of cellars)?	Is it clear which aspects are most important regarding the project's ecological goals? Is WW2 ammunition a potential recreational safety threat in the context of the SE? Are there clear standard requirements for the (measurement of) sand quality? Is the construction offer economically attractive for potential contractors? Will the SE have an effect on the quality of drinking water? Is it clear who should be the competent authority for the SE nature permits? Are all key stakeholders willing to commit to the SE project? Is the chosen location optimal for the project or not? Is it clear which project goal has the highest priority? Should management of the SE be transferred as planned (31 October 2011) or after construction is finished?

In the **Initiation** phase, it was already recognized that it is unpredictable how the Sand Engine and the natural system will behave after construction. Furthermore, it was uncertain if stakeholders were willing to commit to the project and to contribute financially. In **Planning and Design I**, concerns about the uncertain effects of the project on swimming conditions and recreational conditions (and recreational safety in general) began to surface. Furthermore, the project's goals were still a topic of discussion, as was the Sand Engine's optimal location. Specifically, the effect of the Sand Engine on Scheveningen Harbour was an important topic as it was unacceptable for policy-makers that the harbour would be affected. In **Planning and Design II**, there was ambiguity about the nature goals of the Sand Engine project. Ecologists were unable to reach agreement on this issue. Additionally, a important key uncertainty was first uncovered in this phase: it was ambiguous if potential contractors would frame the Sand Engine as an attractive project. Due to the low budget available, potential contactors from the dredging industry could frame the Sand Engine either as a unique challenge with superior marketing potential or as an expensive experiment with little benefits for their business.

In **Construction I**, the uncertainties about natural system behaviour of the Sand Engine lost their relevance for policy development. The idea of the Sand Engine and its principles were accepted' so the attention shifted to 'getting the construction of the Sand Engine done'. Hence, uncertainty related to the required permits and the attractiveness of the construction offer became far more important. Furthermore, opponents of the Sand Engine project attempted to stop the project by pointing out potential recreational safety risks. However, the most important uncertainty of this phase was the lack of knowledge about the effect of the Sand Engine on the fresh water supply. In **Construction II**, concerning uncertainty, the attention in policy development shifted to issues in the technical and social system that could potentially endanger the successful implementation and management of the project. Legal officials can behave unpredictable, take strategic decisions and have the influence to (temporarily) stop the project. For instance, there was ambiguity about the measurements of the sand quality, which nearly caused a stop of the implementation. Legal officials claimed that sand quality measurements were done incorrectly and showed a deficit of quality. The project team argued that the measurement method was innovative, performed correctly and proved that the sand was of sufficient quality. In the **Operation and Maintenance** phase, currently, only two relevant uncertainties can be clearly identified. The effects of the Sand Engine on swimming and recreational safety in general are expected to be an important issue of control and monitoring by scientists. Opponents of the Sand Engine will probably keep a close eye on the recreational safety situation.

6. Discussion and conclusions

Using the interviews, we observe that the problems concerning swimming conditions and recreational safety, the drinking water safety problems and the attractiveness of the construction offer are key relevant uncertainties of the Sand Engine project. **First**, the uncertainties concerning swimming and recreational conditions were essential as these were used by opponents of the Sand Engine project to negatively influence the perception and level of commitment of the general public and project stakeholders. While the project team continues to communicate that the safety situation is controlled, the opponents express that the area surrounding the Sand Engine will remain unsafe and accidents are likely to happen. Thus, different but valid knowledge frames are present in this recreational safety discussion, causing a situation of ambiguity. **Second**, the drinking water problems only played a role in the Construction I phase, but nearly caused the cancellation of the project. In the Environmental Impact Assessment, commissioned by the project team, it was stated that some effects on the groundwater situation were expected, but that some minor measures were sufficient to decrease this problem. However, an important stakeholder expressed serious concerns regarding the groundwater and drinking water safety. These concerns were not taken into account by the project team until late in policy development. Hence, parties had opposing knowledge frames concerning groundwater and drinking water problems, creating a situation of ambiguity. In the end, the problems had to be solved within two weeks, while all parties participating in the conflict had completely different knowledge frames. **Third**, the uncertainty about the attractiveness of the construction offer mainly was due to serious concerns of the project team that no dredging company would subscribe to the tender. If all dredging companies would adopt a knowledge frame that the construction offer was economically unattractive and unfeasible, this would of course mean that they would not subscribe to the tender and that the construction of the Sand Engine would never be realized. However, the project team involved the market parties in an early stage and hence ensured they would adopt the project team's favourable knowledge frame: the Sand Engine is an attractive and feasible project. Hence, the project team was concerned of a situation of ambiguity about the Sand Engine's attractiveness, but prevented this in the end. **Summarizing**, the three key uncertainties could all potentially have caused the cancellation of the project, are all ambiguities and all concern the societal perception or impact on society of the Sand Engine.

The level of uncertainty about technical issues was low in the Sand Engine project, probably due to the fact that the project is not innovative regarding its nourishment technology. Several interviewees mentioned that the Sand Engine did not provide any technological challenges due to the wide experience with sand nourishments, both in the Netherlands and world-wide. Furthermore, the unpredictable natural forces – the driver of BwN projects and the Sand Engine in specific – were not of direct relevance for policy development process in the studied project. However, the effects and social implications of the natural forces do play a role. For instance, the swimming and recreational conditions have been a key uncertainty during the entire project, as these issues received ongoing attention from opponents and the media. The level of uncertainty about the natural dynamics and the behaviour of the natural system even decreased to a minimum at the start of the Construction I phase. The focus in policy development shifted to realizing the Sand Engine's construction as soon as the nature-inclusive design principles of the project were accepted. Summarizing, coping with the social response of the perceived effects of the Sand Engine was more important than coping with the deficit of knowledge about the natural dynamics.

A last important insight from our study is that BwN solutions have a longer time scale and a larger geographical scale than the "command-and-control" approach to water management. This provides yet another basis for ambiguity, as the policy development actors have to take decisions about a significantly changed system with their existing "command-and-control" mindset. Evaluating the performance of a BwN solution based on its short-term effects on a fixed geographical scale does not fit the characteristics of the project. However, in the Sand Engine case, we observe that a change of mindset has not yet taken place in practice. For instance, policy development actors and the public at large demand safe recreational conditions on the short term. However, guarantees cannot be given due to the unpredictability of the natural dynamics. Furthermore, effects of the Sand Engine on Scheveningen Harbour are not allowed. However, the sand of the Sand Engine does not take geographical boundaries into account.

Our findings correspond with the findings of other studies. For instance, Lach et al. (2005) conclude that managing ambiguous relationships becomes far more important than managing the uncertainties of the structures and routines in contemporary water management projects. However, this means that the current strategies towards dealing with uncertainty are probably not sufficient. Hence, new approaches towards dealing with uncertainty are needed. Otherwise, policy development processes of a Building with Nature project might not be successful in the end.

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