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Pilot projects in ecosystem-based adaptation

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Abstract
This paper presents the concept of ecosystem-based adaptation by discussing a pilot of the Dutch 'Building with Nature' innovation programme. The aim is to contribute to the knowledge base about practical implementation of pilot projects in ecosystem-based adaptation. Ecosystem-based adaptation is an approach which uses biodiversity and ecosystem services to adapt to climate change. It covers a range of existing and new initiatives, often spanning multiple sectors and geographical scales. Specific characteristics of ecosystem-based adaptation in water management are a long-term perspective, the prominent role of ecology, ambiguity, a focus on resilience of the system and a cross-catchment perspective. Pilots are one way of learning about ecosystem-based adaptation. Ecosystem-based pilot projects take place in confined spaces of social-ecological systems. Here, learning about climate change innovation occurs and multiple actors are involved. A pilot project at Lake IJssel in the Netherlands is presented as a practical example of ecosystem-based adaptation. Sand engines are constructed to experiment with nature development, improve beaches for recreation and create shallow foreshores. Four observations are being done. First, the success of a project not only depends on reaching the formal objectives, but also on the learning experience that take place. As such, 'failed' pilots do not exist as the lessons learned during the process are used when further developing the product. Second, pilots can be instrumental in dealing with uncertainties in social-ecological systems under climate change. Third, pilots can serve as an opportunity for actors to become involved in the process. Finally, voluntary involvement in pilot projects could lead to unconventional actor coalitions. The paper concludes with presenting a number of questions for further research.

Introduction

Worldwide, people face challenges in the area of water resources management. Deteriorating water quality, a decline in biodiversity, flooding, and droughts are few examples of the issues currently threatening people's livelihoods in many parts of the world. Innovative plans and ideas are needed to meet these challenges, especially in the face of a changing climate. As most of the impacts will be felt through the water dimension, there is an important role to play for the water sector in climate change adaptation. Climate change adaptation is defined as 'adjustments in natural or human systems in response to actual or expected climate stimuli or their effects, which moderates harm or exploits opportunities' (IPCC 2007, p.869).

The use of ecosystem services (see box 1) and biodiversity is one of the opportunities to adapt to climate change in the water sector. 'Ecosystem-based adaptation' (EbA), where biodiversity use and ecosystem services are integrated in an overall adaptation strategy, is increasingly being promoted by scholars, international NGO's and governments (Colls, Ash et al. 2009; EC 2009; The Nature Conservancy 2009; de Groot, Alkemade et al. 2010). It is argued that EbA is a more cost-effective solution in the long term and that it offers multiple benefits for society.

More knowledge about the costs and benefits, technological design and institutional capacity of EbA is however needed (Naumann, Anzaldua et al. 2011). One way of addressing these issues is through the execution of pilot projects. Indeed, pilots in the field of ecosystem-based water management are currently carried out throughout Europe to gain experience with this relatively new approach. Pilot projects however have not been the subject of much study, particularly in the natural resources field (Vreugdenhil, Slinger et al. 2010).

This paper addresses both the issue of EbA and pilot projects by describing and analysing the governance process in a pilot from the Dutch 'Building with Nature' innovation programme. As such it aims to contribute to the knowledge base about practical implementation of EbA pilot projects. The main question I am hereby asking is: What are experiences with EbA pilot projects in practice, and which scientific questions follow from this? To create the conceptual framework, literature about EbA, pilot projects and innovation has been reviewed. Further, project documents and articles about the pilot project have been used.

The outline of the paper is as follows. First, the concept of EbA will be explained. Then, pilot projects and their place in the innovation literature will be discussed. Subsequently, the Building with Nature pilot will be described followed by an analysis of the governance process. The paper is finalized by a discussion and questions for further research.

Ecosystem-based Adaptation

The concept of ecosystem-based adaptation builds on findings from the Millennium Ecosystem Assessment (Millennium Ecosystem Assessment 2005) and The Economics of Ecosystems and Biodiversity (TEEB 2010). These reviews highlight the importance of healthy ecosystems for sustaining the livelihoods of people; their goods and services provide a basis for economic diversification and provide resilience against disasters and climate change impacts (see box 1).

Box 1. Ecosystem services are the outputs of ecosystems from which people derive benefits. The Millennium Ecosystem Assessment distinguished between provisioning, regulating, cultural and supporting services. Ecosystem services are a result of ecosystem functions, which are defined as 'the capacity of ecosystems to provide goods and services that satisfy human needs, directly and indirectly'. Actual use of a good or service provides benefits which in turn can be valued in economic and monetary terms (see figure 1) (de Groot, Alkemade et al. 2010).

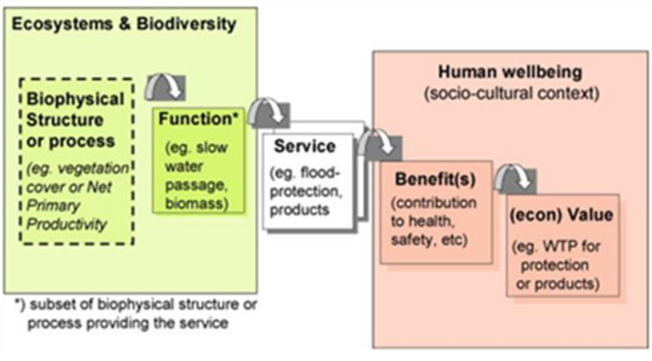

Fig. 1. Framework for linking ecosystems to human wellbeing (de Groot, Alkemade et al. 2010)

The European Environmental Agency distinguishes between three types of adaptation: ecosystem-based ('green' measures), technological solutions ('grey' measures) and behavioural, managerial and policy approaches ('soft' measures) (EEA 2010). EbA is often promoted in developing countries where economics and livelihoods depend largely on ecosystem services, but they are also valid for other regions, especially where people strongly depend on natural resources (Vignola, Locatelli et al. 2009). Increasingly, EbA approaches are researched in Europe (Doswald and Osti 2011; Naumann, Anzaldua et al. 2011).

The definition of EbA as given by the Convention on Biological Diversity is most often referred to. It defines EbA as 'a type of adaptation in which biodiversity use and ecosystem services are integrated in an overall adaptation strategy, with the goal to help people adapt to the adverse impacts of climate change' (Secretariat of the Convention on Biological Diversity 2009, p. 41). Vignola, Locatelli et al. (2009) specify this definition by referring to 'adaptation policies and measures that take into account the role of ecosystems services in reducing the vulnerability of society to climate change, in a multi-sectoral and multi-scale approach' (p.692). EbA involves national and regional governments, local communities, private companies and NGO's in addressing the different pressures on ecosystem services and in managing ecosystems (Vignola, Locatelli et al. 2009), thus spanning multiple sectors and institutional levels.

The question might arise to what extent the ecosystem-based approach differs from other initiatives undertaken in the last decades, such as improving the urban environment by means of green roofs and planting vegetation, biodiversity conservation or floodplain restoration. In fact, a lot of projects which are now framed as EbA did not start out as climate change adaptation projects. In many cases, projects did not state adaptation as their primary objective; it rather emerges as positive side-effect. Also, many projects are labelled as disaster risk reduction or landscape management and not as climate change adaptation initiatives. This is particularly true for projects related to water management (Doswald and Osti 2011). The ecosystem management and conservation goals are seldom explicitly linked with climate change adaptation (Vignola, Locatelli et al. 2009). It can thus be concluded that the term 'EbA' covers a range of existing approaches next to new initiatives, of which the latter explicitly mention the use of ecosystem services for climate change adaptation. Based on this, I define EbA as 'an approach which uses biodiversity and ecosystem services to adapt to climate change, spanning multiple sectors and geographical scales'. In this paper I specifically focus on EbA initiatives in the field of water management, which covers sustainable water management (river basins, aquifers, flood plains and associated vegetation providing water storage and flood regulation) and disaster risk reduction (restoration of coastal habitats as a measure against storm surges and coastal erosion) (Secretariat of the Convention on Biological Diversity 2009).

The characteristics of EbA can be explained by looking to the context in which it takes place: the social-ecological system. The social-ecological system approach does not see the social (or human) system and the natural system as independent of one another, but rather as linked and integrated. Humans are thus no longer seen as external entities to ecosystems but as components of the system itself (Berkes, Folke et al. 1998). EbA can be placed in the context of social-ecological system thinking as it emphasizes the use of ecosystem functions (the natural system) by people (the human system). On the basis of literature about EbA and the notion that EbA takes place within social-ecological systems, the following characteristics of EbA are formulated:

- *Long-term perspective*. As a result of the prominent role of ecosystem services in EbA, it is more common to take into account the long-term effects of the approach than in projects where ecosystems are not taken into account. A long-term view is inherent to the nature of ecosystems where developments and changes can take decades. This also has implications for the costs and benefits associated with EbA. As the benefits often are only visible after a long time and difficult to predict, conventional cost and benefit methods are not suitable. This makes comparison with projects which do not take into account ecosystem services more difficult.

- *Ecology as an actor in the process*. In the last decades, there has been a shift in the role of ecologists and nature conservationist within water management projects. Water management a few decades ago focussed more on technological solutions, which in some cases had a significant ecological price (Disco 2002). In a reaction to this, environmental NGO's strongly opposed infrastructural water management projects which paid little attention to ecology. In the course of time however, ecology got a more prominent role in water management decisions. Related to this, ecologists became a more prominent actor in the process. Nowadays, NGO's representing the environment are one of the (many) actors in issues related to water management. Moreover, they are part of new innovative initiatives and in some cases even lead this process. An example of this is the 'Markerwadden' initiative of the Dutch NGO Natuurmonumenten, who wants to create artificial islands in the Markermeer as a first step towards large-scale nature development.
- *Ambiguity*. Ambiguity is one of the three types of uncertainties as distinguished by (Kwakkel, Walker et al. 2010) which can be observed in social-ecological systems. The other two are ontological uncertainties (unexpected situations and surprises due to variability in systems' phenomena) and epistemological (lack of knowledge about certain phenomena). Ambiguity is a result of different perspectives of different actors about what the issue is exactly. This is based on their experiences, expectations, values and forms of knowledge. They thus frame the issue in different ways, creating this specific kind of uncertainty (Dewulf, Mancero et al. 2009). Within EbA projects, almost always multiple actors with different backgrounds and perspectives are involved which can thus lead to ambiguity.
- *Ecosystem resilience.* Uncertainties resulting from unexpected situations, lack of knowledge and different perspectives are thus inherent to social-ecological systems. Related to this, another difference between EbA and more technological approaches can be found. While traditional technological approaches try to reduce the uncertainty in the natural system by deliberately influencing the system, Eba tries to manage the uncertainty by using ecosystem services. As such, it seems that EbA acknowledges that uncertainties are part of the system and tries to work with this, rather than against it. Gunderson and Holling (2002) distinguish between 'engineering resilience' and 'ecosystem resilience'. Characteristics of engineering resilience are efficiency, control, constancy and predictability. These features are appropriate for systems where uncertainty is low, but they can be counterproductive for dynamic systems with high uncertainties. Ecosystem resilience on the other hand focuses on persistence, adaptiveness, variability, and unpredictability. The authors argue that sustainable relationships between people and nature require an emphasis on ecosystem resilience. As the interdependency between humans and nature is the main component of social-ecological system thinking and the concept of EbA can be placed in this context, I argue that a focus on ecosystem resilience is another characteristic of EbA.
- *Catchment perspective*. EbA initiatives in catchments include water storage and floodplain restoration. Water storage upstream increases the water availability there while at the same time decreasing flood risks in downstream areas. Initiatives such as Payments for Ecosystem Services (PES) in watersheds increasingly link upstream and downstream water users (Smith, de Groot et al. 2006). EbA measures taken at a certain location in the catchment can positively influence other locations, which refers to the term 'connectedness' which is inherent to present-day perspectives on catchments (Blackmore, Ison et al. 2007). In the case of traditional technological approaches, this can be different. Dams used for hydroelectricity or water storage are

beneficial for some locations, but could have a negative impact on areas more up- or downstream. Storm surge barriers could prevent areas from flooding, but at the same time hinder fish migration which affects fishermen in other areas of the catchment. Therefore, I argue that ‘connectedness’ is more characteristic for EbA than for traditional water management approaches.

Table 1 summarizes the points above by stating the characteristics of EbA water management and traditional, or grey, water management. With grey water management I refer to the grey, technological adaptation measures mentioned earlier in this paper. The aim of the table is not to judge the approaches or indicate a preference, but rather to serve as an illustration of my perspective on the differences between ecosystem-based and traditional water management.

Table 1. Differences between ecosystem-based water management and traditional water management

Ecosystem-based water management	Traditional water management
Long-term perspective as a result of the prominent role of ecosystems in the approach	Long-term perspective is not related to the role of ecosystems and can be less present
Ecology as one of the actors in the process	Ecology often opposes the approach and is not involved in the process
Ambiguity as actors with multiple backgrounds and knowledge are involved	Less ambiguity as the actors involved often have a common (technological) background
Focus on ecosystem resilience	Focus on engineering resilience
Connectedness throughout the catchment	Often location specific

The increased complexity in ecosystem-based water management projects makes it difficult to design a blueprint as they are too context dependant. However, learning from previous experiences is a way to proceed and further develop the concept of EbA. One way of learning is by executing pilot projects, which is the focus of the next section.

Pilot projects in ecosystem-based adaptation

As ecosystem-based adaptation is a relatively new concept, currently much experimentation takes place in the field. Pilot projects are one way of experimenting with the new approach. Both literature on socio-technical innovations as on Strategic Niche Management discusses experimentation and pilots as part of the innovation process. In literature on socio-technical innovations, experiments are considered necessary to cope with the large uncertainties that follow from new combinations of knowledge, applications and markets. Moreover, experimentation is a way to evaluate the reactions of consumers, government, competitors, and suppliers (Hekkert, Suurs et al. 2007). Experiments are one way of testing social acceptance, especially when many kind of stakeholders are involved (Geels, Hekkert et al. 2008).

Strategic Niche Management places experiments and pilots in so-called niches; protected spaces or incubation rooms where novel approaches emerge and are protected from mainstream market selection. A variety of actors is involved in the niches which offers opportunities to build social networks supporting innovations (Geels 2004). One of the added values of pilot projects lies in their potential to establish cooperation within unconventional actor coalitions. This can be attributed to the special status of pilots which is visible in the attitudes and expectations people have towards the projects and in the flexibility within the project management (Vreugdenhil 2010).

Niches also provide locations for learning processes (Geels 2004). When it comes to learning, one can distinguish between single-loop and double-loop learning processes. Single-loop learning occurs when plans, models, and policies are implemented and evaluated. Learning is characterized by the collection of data and information to incorporate in these plans, models or policies. In double-loop learning, the principles, values, rules and assumptions underlying the plans, models and policies are questioned. As such, second-loop learning is learning about single-loop learning (Vreugdenhil 2010).

Pilot projects as part of the innovation process

Pilot projects are thus expected to contribute to the innovation process. In order to visualize this process, I use the model introduced by (Pinch and Bijker 1984). They take a social-constructivist view on technological innovation by presenting innovations not as a linear development process, but rather as a process which involves both failed and successful development of what they call ‘artefacts’. Artefacts can be defined as man-made, tangible objects (see figure 2).

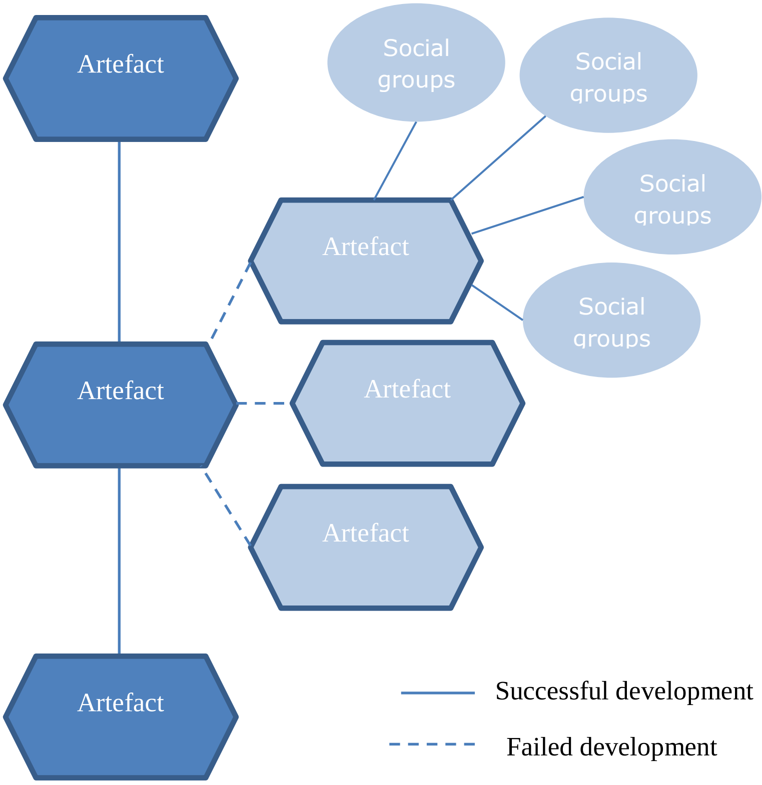

Fig. 2. Illustration of the innovation process, where ‘failed’ artefacts contribute to the establishment of successful artefacts (Pinch and Bijker 1984)

The idea behind the figure is that, in order to come to successful innovations (dark coloured artefacts), alternative artefacts (light coloured artefacts) have been developed in an earlier stage. In terms of successful development, the light coloured artefacts can be considered as ‘failed’. However, in terms of skills, knowledge and experience gained, this does not have to be the case. The success of development of a product depends on the criteria defined to measure this success. This coincides with the statement of Down and Kondolf (2002) that success of a project should be defined both in terms of the objectives reached and in providing a significant learning experience, where the learning experience can (greatly) contribute to the establishment of the innovation. Therefore, I argue that without the ‘failed artefacts’ the development of the final product or service would not have been the same. Or as (Holling

2001) puts it: ‘As in good experiments, many will fail, but in the process, the survivors will accumulate the fruits of change’.

The artefacts are surrounded by ‘social groups’. The term is used to denote institutions and organizations as well as organized and unorganized groups of individuals. The main feature which makes them a social group is the shared set of meanings attached to a specific artefact. Social groups can be ‘consumers’ or ‘users’ who obviously want to use the artefact, but also groups which are against the development of the artefact (opponents). Social groups are not homogenous and can therefore be divided into separate groups (Pinch and Bijker 1984). Separate groups in EbA can be farmers, nature conservationists, recreationists and government agencies.

For the purpose of this paper, I adapt the model of (Pinch and Bijker 1984) (see fig. 3). The term ‘artefacts’ is concretized for ecosystem-based adaptation initiatives by using the term ‘land use configurations’. In EbA, land use planning and design plays a prominent role. It results in new forms of land use consisting of different landscape elements (configurations). The land use configurations can be based on experiments and pilots. Therefore, I use the term ‘pilots’ instead of ‘failed artefacts’. Even though the formal objectives of a pilot may not be reached, the lessons learned from the pilot can contribute to the development of the land use configuration. Multiple actors are involved in the pilot projects; therefore I speak of ‘multiple actor groups’ instead of ‘social groups’. These multiple actor groups can consist of individuals and organizations from the public and private sector and from civil society.

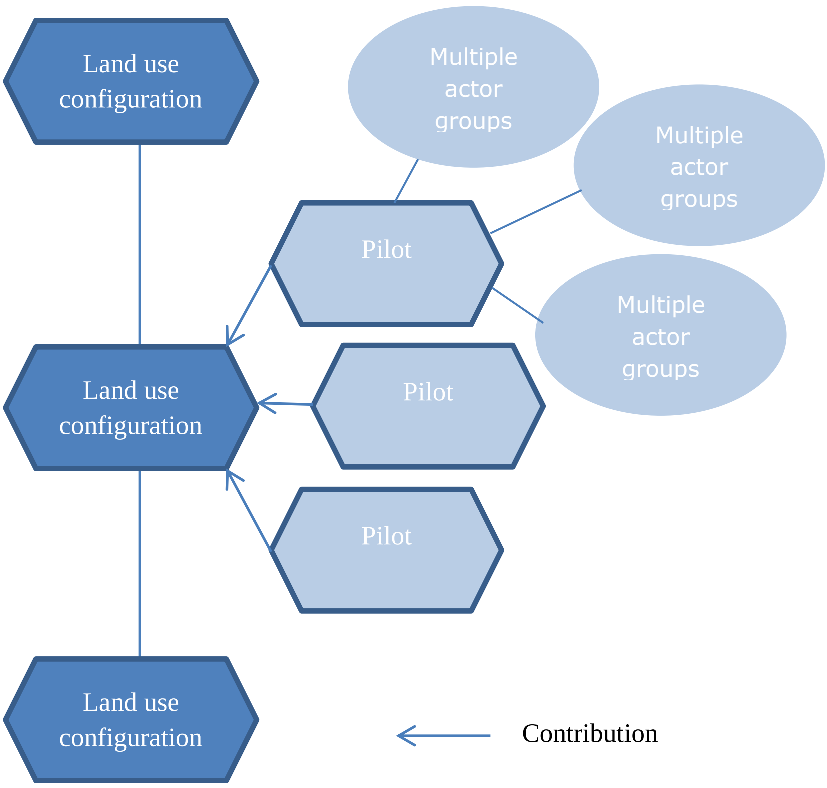

Fig. 3. Illustration of elements in the EbA innovation process, where multiple-actor pilots contribute to the development of new land use configurations.

Based on the previous text, a number of differences can be observed between pilot and what I call 'regular' (non-pilot) projects. These are presented in table 2.

Table 2. Characteristics of pilot and regular projects in water management, adapted from Vreugdenhil (2010)

Pilot projects	**Regular projects**
Focus is on innovations. These can be technological, conceptual, institutional or process oriented.	Existing or proven technologies are used.
2nd loop learning is a central part of the project, amongst others by means of monitoring. Knowledge is collected about the functioning of the innovation under different circumstances.	Learning through experience.
Projects are allowed to fail, in the sense that they do not reach their formal objectives.	Projects are not allowed to fail. In case of failure, measures are being taken (investigation, fines, etc.)
There is room for unconventional actor coalitions due to the special status of the project.	Established attitudes & expectations and little flexibility leaves less space for unconventional actor coalitions.

There is no common definition of pilot projects (Vreugdenhil, Slinger et al. 2010). Therefore, I conclude this section by giving my definition of pilot projects based on the previous text. Pilots can be described as 'projects in confined spaces of social-ecological systems involving multiple actors where learning around climate change innovations occurs'. But how does this work in practice? I will discuss this on the basis of a current ecosystem-based innovation programme, namely Building with Nature.

Sand engine pilots as an example of ecosystem-based adaptation

The Dutch 'Building with Nature' innovation programme (see http://www.ecoshape.nl/) is a four-year (2008-2012) initiative from two major Dutch dredging companies. Together with universities, government agencies, consultancies and research institutes they form a novel consortium, aiming at finding innovative solutions to deal with rising sea levels and increased flood risks in coastal areas and rivers under a changing climate. The strategy of Building with Nature is to work *with* rather than *against* nature (van Slobbe and Lulofs 2011). Hydro-morphological (sedimentation, erosion, water- and wind transport) and ecological (food webs, bioengineers) processes in coastal zones are used to increase resilience. New engineering approaches support these processes and are tested by means of pilots. Part of the programme is monitoring of the governance processes within these pilots. One of the pilot areas is Lake IJssel in the Netherlands, which is used as case study area for this paper.

Sand engine pilots in Lake IJssel

In a reaction to the reports of the Intergovernmental Panel on Climate Change (IPCC), the Dutch government initiated a study to the robustness of the Dutch national water and flood protection systems for the next 100 years (Deltacommissie 2008). One of the scenarios of the commission recommended to prepare for a lake level rise of Lake IJssel (see figure 4) of 1.5m by the year 2100 to guarantee fresh water supply to surrounding areas. The Dutch government adopted the recommendations from the report and used it as input for its future strategy. However, there was strong criticism on the report from regions surrounding the lake. Lake level rise would affect historic and industrial sites, as well as recreational facilities and valuable nature areas. Also, groundwater flows and drainage of surrounding polders would be affected. Finally, the costs of the measures would be paid by the regions along the Frisian coastline of the lake, while the benefits would go to other parts of the Netherlands (van

Slobbe and Lulofs 2011). Therefore, the regional authorities did not share the perception of the national government that lake level rise would be a sustainable solution for lake IJssel.

In this context, the Building with Nature programme was asked in 2009 by the national government (Ministry of Infrastructure and Environment) to initiate a pilot study along the Frisian coast of Lake IJssel. Regional parties were invited to join the process. Although they were against the plans for a rising lake level, they realized that if they wanted to influence the plans, they needed to become involved in the process. The Building with Nature pilot offered a possibility for these actors to become involved in the policy process (van Slobbe 2010). Also, the ministry emphasized that the 1.5 m lake level rise was just one of the four scenario's presented by the Delta commission. Three actors took the lead in the process: the deputy of the Province of Friesland, the chair of water board Friesland and the director of It Fryske Gea, an NGO. Driven by the aspiration to innovate and to stimulate the regional economy, they formed a coalition. Besides these common goals, each actor had its own interest. It Fryske Gea wanted to revitalise the natural coast by stimulating sedimentation processes and ecological succession. The water board was looking for an alternative for costly dike reinforcements, while the province wanted to renew the landscape and land use along the Frisian coast. Another important actor group in the process were local recreational entrepreneurs. They wanted to improve the swimming and surfing conditions in the area and saw the pilot as an opportunity to contribute to this goal (van Slobbe and Lulofs 2011; van Slobbe, de Block et al. 2012).

Fig. 4. Location of Lake IJssel in the Netherlands

A definition study was initiated to investigate possibilities (in terms of hydro-morphology, ecology and legal impediments) to start a pilot. Although the study showed that uncertainties remained (mainly related to wave dynamics and the influence on sand transport to the coast), the decision was taken to initiate three sand engine pilots. Sand would be deposited in shallow water 200m from the coast. Wave dynamics would then move the sand into the direction of the coast where a process of sedimentation would take place and pioneer vegetation would emerge. The experimental nature of the pilots was emphasized by all parties involved; moreover, the pilot was framed as an experiment that might fail (van Slobbe 2010). It was decided to implement sand engines at three locations (see figure 5). Each location would focus on different spatial functions. The first pilot at the Workummerwaard aimed at revitalization of a nature area. The second pilot at Hindeloopen would improve the beaches for recreational purposes. The third pilot at Oudemirdummerklif would experiment with a shallow foreshore to absorb wave energy as alternative to dike reinforcements.

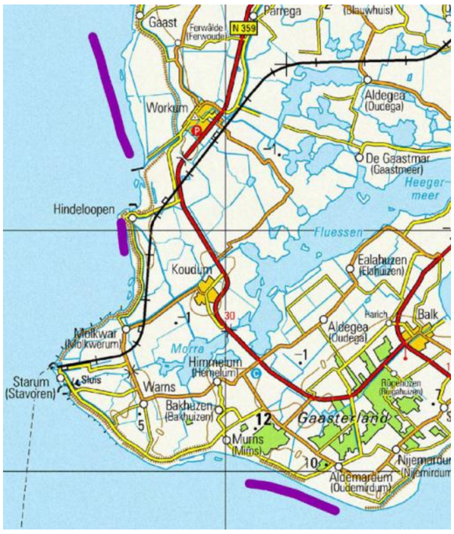

Fig. 5. The three proposed locations for the sand engine pilots.

The first step in the project plans was the implementation of the pilot at the Workummerwaard. Since the area is owned by It Fryske Gea and as a Natura 2000 site no other interests are at stake, it was expected that this pilot would be the easiest to implement. Indeed, legal permits were acquired relatively easy and in the summer of 2011 the sand engine was constructed. The ecological and morphological processes taking place are monitored and the results serve as input for the lake level strategy formation process in 2013. A Community of Practice (CoP), consisting of 20 experts in the field of ecology, hydraulic engineering, dredging, governance, policy development and local stakeholders, visited the pilot to learn lessons and reflect on it. The most important conclusion following this visit was that the communication with local stakeholders should be improved.

Implementation of the second experiment at Hindeloopen proved to be more difficult. Although a local recreational entrepreneur suggested this location for the pilot, it turned out that other entrepreneurs did not agree. Based on their observations of the Workummerwaard pilot, where 27.000 m^3 of sand was supplied, they were afraid that sand nourishments at Hindeloopen would result in less favourable conditions for swimming and surfing as the coast is already shallow. A representative of the Building with Nature consortium invited the stakeholders during a meeting in April 2011 to join the design process and to include their knowledge and visions. This proved to be a successful strategy, as the recreational entrepreneurs actively participated and contributed with their local knowledge. Based on the outcomes of this meeting, expert studies were conducted to study the feasibility of the pilot. These studies showed however that further research was needed on the characteristics of sand transport along the whole Frisian coast, thus encompassing the scale of the Hindeloopen experiment. This, in combination with a municipal master plan which also focused on a larger scale, led to the decision to cancel the pilot at Hindeloopen and to search for an alternative (van Slobbe, de Block et al. 2012). Figure 6 presents a schematic overview of the pilot process in Lake IJssel based on the innovation process as explained earlier in this paper.

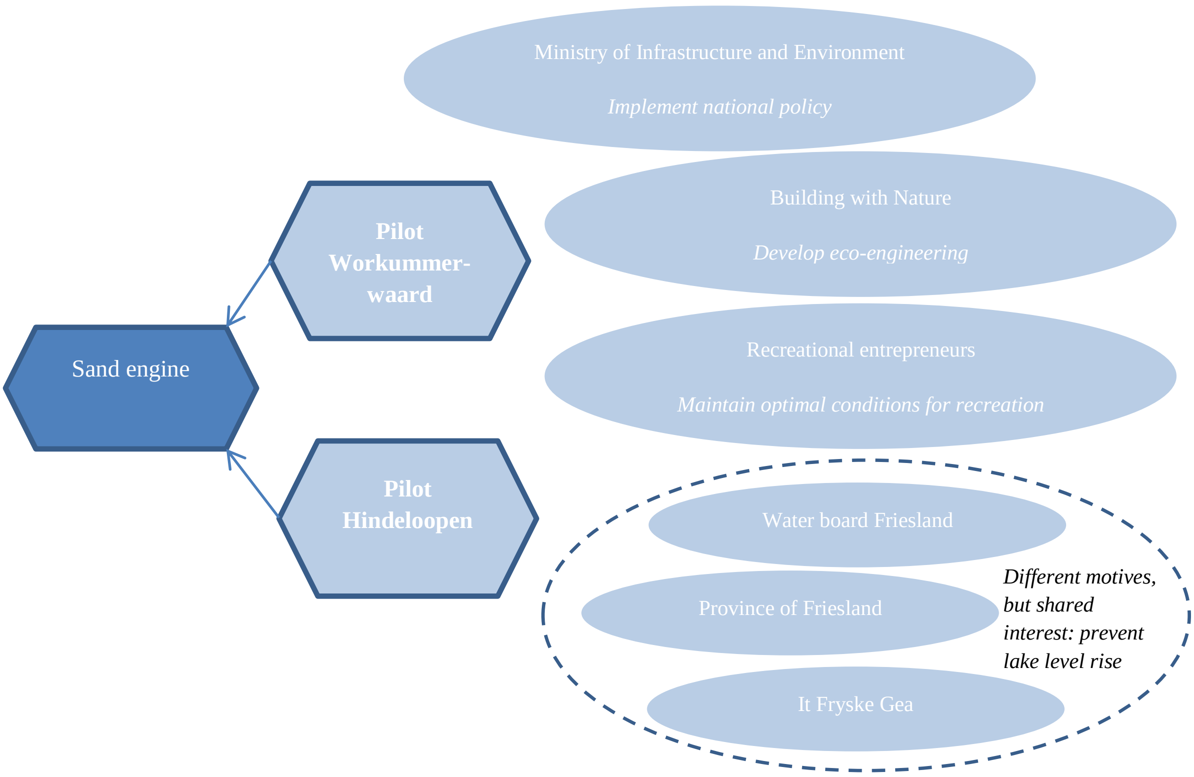

Fig. 6. Different actor groups and their interests as identified in the sand engine pilots

Discussion

By framing the Building with Nature pilot project in the Lake IJssel area as an ecosystem-based adaptation initiative and linking it to innovation literature, a number of observations have been made which are discussed in this section.

Learning from a 'failed' pilot

The pilot at Hindeloopen serves as an example of the statement made earlier in this paper, namely that the success of an experiment should not only be measured on the basis of reaching the formal objectives, but also in terms of learning experiences. The skills, knowledge and experience gained during a pilot contribute to the development of the final product, independent of whether the formal objectives have, or have not, been reached. When we look to the pilot in Lake IJssel, we see that based on the input from local actors, more research has been conducted and thus knowledge has been acquired about the hydro-morphological conditions along the shore. The outcomes of this study was one of the reasons for the decision to cancel the project. As such, one can argue that the pilot failed as the objective to improve the beach for recreation has not been reached. However, knowledge is collected about the physical system and its dynamics, which could contribute to subsequent pilots or projects in Lake IJssel. Moreover, lessons have been learned about the governance process. The case shows that experience from previous projects (e.g. the pilot at Workummerwaard) can greatly influence the attitude of participants towards a new project. Also, invitation of local actors to actively participate in the process can be a successful strategy in a situation of emerging conflict. The lessons learned from a 'failed' pilot can thus provide valuable input for next pilots, contributing to further development of the artefact.

Pilot as instrument for dealing with uncertainties

The pilots in Lake IJssel were carried out to cope with uncertainties related to physical dynamics (e.g sediments, wave and wind patterns) and to learn more about the potential contribution of sand engines to respectively nature development, beach improvement and shallow foreshores. While at first, the emphasis was mainly on the physical aspects, later on the importance of the governance process became more important. Epistemological uncertainties related to the physical processes were accompanied by ambiguity related to different perspectives of actors involved. Both types of uncertainties were addressed during the pilot. A stakeholder meeting brought together actors with different perspectives on the design of the coast which resulted in the execution of expert studies to learn more about the sand transport characteristics along the coast. The pilots were thus instrumental in addressing different types of uncertainties in the social-ecological system.

Pilots as low threshold opportunity

Pilots can serve as a 'low threshold' opportunity for actors to become involved in a process.
In the case of Lake IJssel, several actor groups did not agree with the lake level rise policy. The pilots offered an opportunity for them to become involved in the process and even influence it. Despite their opinion about the lake level rise, they were aware of the necessity to do something about the situation themselves. As the pilot was framed as an experiment and no formal implications were attached to it, the threshold to participate became lower. Moreover, it was emphasized that the pilots were 'allowed to fail'. These characteristics lowered the risks of being involved, which could contribute in persuading people to take part in the process.

Voluntary versus obligatory involvement
The sand engine pilot allowed actors to work together despite differences in motives and interests. In this 'allowance' lies a major difference with regular projects. Actors in the Lake IJssel area were invited to join the process, which was a deliberate choice of each actor. In principal, they were thus free to join the process or not. This is in contrast with regular projects where actors are often obliged to participate as their values and interests are under pressure. The interdependencies often present in regular projects forces them to cooperate. Although the sand engine pilots in Lake IJssel need a more thorough analysis, it might be that the voluntary involvement of actors in pilot projects contribute to the formation of unconventional actor coalitions, but also to the innovation process as actors are less bound to their conventional project partners and existing power relations are less prominent.

Conclusion

This paper presented governance experiences from an ecosystem-based pilot project in the Netherlands. Ecosystem-based adaptation in water management covers a range of existing approaches next to new initiatives. The latter explicitly include the use of ecosystem services for climate change adaptation. An example of EbA is the Dutch Building with Nature innovation programme which aims to find solutions to deal with rising sea levels and increased flood risks under climate change making use of ecosystem dynamics. A number of pilot projects are currently carried out to gain experience with this approach, amongst others in the Lake IJssel area in the Netherlands. Here, experiments with sand engines should increase knowledge about their potential contribution to the development of natural and recreational areas as well as to creation of shallow foreshores. One of the experiences from the sand engine pilot discussed in this paper is that the success of a pilot is not only dependant on reaching the formal project objectives, but also on the learning experiences that take place. When looking to success from this point of view, 'failed' experiments or pilots do not exist as the lessons learned during the process can be incorporated in the further development of the product. Further, pilots can be instrumental when it comes to dealing with uncertainties in social-ecological systems, especially under a changing climate. Also, pilots can serve as an opportunity for actors to become involved in the process as less risks are involved compared to regular projects. Framing the pilot explicitly as an experiment which is allowed to fail could further lower the threshold to become involved. Finally, voluntary involvement in pilot projects as opposed to the more obligatory involvement of actors in regular projects could lead to unconventional actor coalitions.

A number of questions for further research have been formulated based on the findings from this paper:

- *In what way do experiments that do not reach the formal objectives influence the innovation process?*
- *How can 'learning' be included as a criterion to assess the success of ecosystem-based pilot projects, and how can this be assessed?*
- *How do pilots in ecosystem-based adaptation contribute to addressing different types of uncertainties under climate change?*
- *What are the implications of the explicit statement that pilots are 'allowed to fail' for the design, implementation and monitoring process of a pilot?*
- *What are the effects of a more voluntary involvement of actors in pilot projects in contrast to a more obligatory involvement of actors in regular water management projects?*

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