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Evaluating Knowledge Management Parallel to Nature-Based Solutions-Project Marker Wadden

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Abstract

Marker Wadden follows the Nature-Based Solutions (NBS) concept to tackle multiple challenges in freshwater lake Markermeer (The Netherlands). NBS presents opportunities for knowledge management practices in the fields of engineering, ecology, and governance, which is a specific goal of the project. Therefore, Knowledge and Innovation program Marker Wadden (KIMA) was established. KIMA enabled knowledge management practices, such as monitoring, fundamental and applied research, parallel to the construction phase. Transferring knowledge back to the construction project and to other NBS-projects and -programs is regarded as a necessity to ensure scale-up. We argue that internal and external alignment can remove or bridge barriers between knowledge management, and application in ongoing construction activities and other NBS-applications. In this research we evaluate the internal alignment of KIMA with the construction project Marker Wadden, and its external alignment with other applications of NBS. Our data indicates that KIMA was only partially capable of realizing internal and external alignment. Absence of the consortium leader in the research program, a suboptimal financial construction, the belated start of research activities, a lack of incentive in the construction contract to engage in knowledge management, unstructured connection to system-level projects and major research programs were restraining factors.

Keywords: Nature-Based Solutions; Knowledge management; Knowledge transfer; Alignment; Governance

1. INTRODUCTION

The Intergovernmental Panel on Climate Change (IPCC) stated, based on recent studies, that human influence on rapid climate change is indisputable. Often, the different impacts of climate change are imposed on society through water in its different forms (IPCC, 2021). Freshwater ecosystems, such as lakes and wetlands, play a vital role in society as they provide highly valued ecosystem services, such as water supply and water quality control, unique habitats, food supply, recreational possibilities and more (Millennium Ecosystem Assessment, 2005). Despite their vital function, freshwater systems are among the most threatened ecosystems on our planet, and deal with major resource management and infrastructural challenges. Development of our changing climate, and high demands of ecosystem services are putting pressure on the provision of ecosystems services and retaining biodiversity and sustainability of the essential ecological processes (Medema et al., 2014). Freshwater lakes are threatened by climate change through increasing temperatures and sea level-rise, local changes of precipitation, and a changing variability of water quantities (Vári et al., 2021). Economic developments such as dam construction, overexploitation and more, pose a threat to freshwater lakes as well. These developments are interconnected and interact with each another, which makes implementing interventions a complex challenge (Dudgeon, 2019). This calls for an integrated approach that can address a range of climatic impacts, provide additional ecosystem services, such as biodiversity and human well-being, and can be implemented and managed over a long period (Seddon et al., 2020).

Nature-Based Solutions (NBS) is an integrative approach that can simultaneously address multiple societal challenges such as climate adaptation and mitigation, conserving biodiversity and improve human health and well-being. It is a collection of established ecosystem approaches, such as ecosystem restoration and green infrastructure. NBS connects these approaches to be able to work integrative with ecosystems (Cohen-Shacham et al., 2016; European Commission, 2015; Raymond et al., 2017). The European Commission (2015) defines NBS as “solutions that are inspired and supported by nature, which are cost-effective, simultaneously provide environmental, social and economic benefits and help build resilience. Such solutions bring more, and more diverse, nature and natural features and processes into cities, landscapes and seascapes, through locally adapted, resource efficient and systemic interventions”. Implementing NBS helps to nurture innovations in

structures, mind-sets and practices that involve actors from different sectors. It does so by engaging in co-design and co-implementation (Nevens et al., 2013). A multidisciplinary and cutting-edge approach, such as NBS, has the potential to facilitate cooperation between sectors and contribute to a more holistic approach to tackling socio-economic and environmental challenges (Van Ham, 2017).

To achieve the potential benefits this approach offers, NBS must overcome barriers such as uncertainties about long-term maintenance, performance, and cost-effectiveness. Knowledge management can play a vital role in overcoming these barriers by developing knowledge on the design, implementation, and performance of such projects throughout the lifecycle. Making valuable data and lessons learned from existing NBS-projects widely available will support a larger uptake (Kabisch et al., 2017). To understand, discuss and steer NBS towards a scaling-up, parties from public, private, and academic sectors and civil society need to work together in interdisciplinary fashion. Furthermore, interdisciplinary work across scientific domains of engineering, ecology and social sciences is needed, where both fundamental and applied research disciplines must be involved (Nesshöver et al., 2017). Due to involvement of multiple sectors and disciplines, knowledge that is acquired from NBS-projects result from interactions and relationships between the different parties and researchers that are involved (Medema et al., 2014). Mutual learning processes amongst these different parties and researchers, can be enhanced by implementing a research program that serves as an intermediary platform (Cortinovis et al., 2022; Droste et al., 2017; Fastenrath et al., 2020).

This research reviews knowledge management and knowledge transfer in the case of NBS-project Marker Wadden and emphasizes on how this was organized and practiced, and how involved parties reviewed this process. Parallel to construction of Marker Wadden, the knowledge and innovation program Marker Wadden (acronym: KIMA) was established with the purpose to develop, manage and transfer acquired knowledge in the fields of engineering, ecology, and governance. The results were used in evaluating construction and optimizing subsequent construction phases. Furthermore, the results were made generic for other NBS-projects, both nationally and internationally. We use the concepts internal and external alignment to explore if the practice of knowledge management and transfer in KIMA, has achieved a strategic fit with the construction activities on Marker Wadden, and with other NBS-projects to promote implementation and scaling-up of this approach. The research contains valuable insights regarding knowledge management in NBS-projects, illustrated by how KIMA has functioned according to involved parties.

2. THEORETICAL FRAMEWORK

To understand the process of knowledge management, practice of knowledge transfer, and the internal and external alignment, a brief theoretical framework is described.

Knowledge management is defined as: “a process of continually managing knowledge of all kinds to meet existing and emerging needs, to identify and exploit existing and acquired knowledge assets and to develop new opportunities” (Quintas et al., 1997). Its practice involves setting up an environment that allows workers in organizations to create, capture, share, and leverage knowledge to improve performance and decision-making (Hlupic et al., 2002, Kwan & Balasubramanian, 2003). Knowledge management activities and practical use in policy frameworks or practice, happens in separate worlds, with different cultures, codes, rewarding systems and rules. Inevitably, boundaries will emerge when transferring knowledge. The ‘science-policy gap’ is such a boundary which represents “the difference in levels of confidence for a given scientific finding, expressed by the scientific community and society” (Bradshaw & Borchers, 2000). In literature, there is an important perspective on knowledge management that emphasizes the relationship between the sender and the receiver to enable knowledge transfer. For knowledge to be transferred successfully, both sender and receiver must perform knowledge sharing and seeking behavior, so that they are able and seen as willing to transfer knowledge in an interactive process (Duijn et al., 2021). The sender produces knowledge and “wraps it up” in a product that will be “unwrapped” by the receiver (Brown & Duguid, 1991). For the sender, it is important to consider the perceived quality and consequent usability of the knowledge for the receiver, which is affected by relevance, reliability, and legitimacy (Cash et al., 2003). Furthermore, the characteristics of the receiver are important to consider for the sender. The absorptive capacity is an important concept and consists of routines and processes of an organization to translate and gain new knowledge and to assimilate the knowledge. If this capacity is well developed, the receiver is better at absorbing new knowledge and embedding it within the organization (Zahra & George, 2002)

Successfully transferring knowledge is perceived as an enabler for implementation of NBS. This can be accomplished by bridging barriers or removing barriers between the sender and receiver. Other enablers for implementation of NBS are partnerships, effective monitoring, financial instruments, supporting legislation, education and training, combination with grey infrastructures, open innovation and experimentation, and appropriate planning and design (Ershad Sarabi et al., 2019). Because at NBS-projects, knowledge management and application of this knowledge take place in separate worlds, we argue that to successfully

transfer knowledge, alignment is necessary to bridge or remove boundaries between them to support contribution to shared goals. Alignment facilitates the achievement of strategic goals by removing (internal) barriers to cooperation and performance that would otherwise reduce the efficiency and effectiveness of work towards those goals (Semler, 1997, p. 28). Alignment can be separated into internal and external alignment. Both internal and external alignment are necessary to realize a strategic fit (Duijn et al., 2019, p. 388). Internal alignment reflects the degree to which design, strategy and culture of an organization can cooperate to achieve the same desired goals (Semler, 1997, p. 23). A high degree of internal alignment refers to a systematic agreement among design, strategy and goals; a low degree indicates conflict. Indicators of internal alignment are shared understanding, coordination, cooperation, goal conflict and information asymmetry. External alignment reflects the strategic fit between the demands of the external environment and the selected vision, goals, and tactics of the organization. External alignment is perceived as inter-organizational, referring to coordination, cooperation and synchronization of efforts and resources between different organizations. Moreover, external alignment depends on the outward orientation of the organizations involved. Indicators of external alignment are the ability to acquire additional resources (budget, knowledge), be proactive regarding external dynamics, innovate core tasks and responsibilities, create some freedom to act or slack and take risks. These indicators reflect the ability of organizations to make connections and whether they can deviate from existing tasks to achieve productive interplay with other organizations (Duijn et al., 2019, pp. 388-389).

In this research, alignment of knowledge management activities in KIMA with construction activities on Marker Wadden can be understood as internal alignment. Internal alignment is key to achieve corresponding goals between KIMA and Marker Wadden. Alignment of results from KIMA with different NBS-projects and -programs can be understood as external alignment. KIMA needs to meet the knowledge demands and needs of the external environment to help scale up NBS. This research explores whether indicators of internal and external alignment can be identified. This helps to value and interpret KIMA's alignment with Marker Wadden and if it can meet external needs from different NBS-projects and -programs.

3. METHODOLOGY

3.1 Case Description: NBS-project Marker Wadden

Marker Wadden lies in one of the largest freshwater lakes in Europe, called Markermeer. This lake used to be part of an inland sea called the Zuiderzee. After the Afsluitdijk was constructed in 1932, the Zuiderzee was cut off from the sea by this new dam, and became a freshwater lake called IJsselmeer. Part of the lake was reclaimed, to become a new Dutch province called Flevoland. There were plans to also reclaim the southwestern part of IJsselmeer, and therefore the Houtribdijk was constructed in 1976. This dike created the Markermeer. Plans to continue land reclamation and transform Markermeer into Markerwaard were eventually set aside and the freshwater lake remained (Dutch Parliament, 2004).

Markermeer is a Natura2000-site, and an important habitat for numerous bird and fish species (Rewilding Europe, 2019). Since the construction of the Houtribdijk, water quality and other ecological values in Markermeer have degraded, due to the accumulation of lake sediment (Lammens et al., 2008; Noordhuis, 2014; Van Riel et al., 2019). The downward trend of the ecological values in the lake, resulted in a long-lasting societal wish to come up with a solution to address this challenge, without compromising the ecological services it then provided (Van Leeuwen, 2021). This is often challenging (Higgs et al., 2018). Governmental bodies on national level had been developing ideas and plans to tackle the issues in Markermeer, which did not result in a breakthrough, partly due to high costs (IJff et al., 2018). In 2012, an NGO, the Dutch Society for Nature Conservation (further: Natuurmonumenten) initiated a solution that uses the creation of an archipelago for nature development, which would contribute to restoring the ecosystem of Markermeer and recreational values. Important enabling factors in this process were that Natuurmonumenten secured funding from the national lottery and that the national and regional governmental bodies were convinced to collaborate and co-fund the project. Other than Natuurmonumenten, key parties involved were the national water authority (further: Rijkswaterstaat), two ministries and the regional governmental body, the province of Flevoland. The consortium that was selected to perform the construction of the islands consisted of Boskalis, Witteveen+Bos and Arcadis. Construction of Marker Wadden started in 2016 (Willems et al., 2021).

The objective of Marker Wadden is to improve the water quality of Markermeer by capturing the sediments in the lake and to provide a new habitat for birds, fish, and plants whilst remaining accessible for recreational purposes. Until now, the archipelago consists of five islands which contain (reed) marshes and mud flats, which is currently being expanded with two additional islands. Marker Wadden is generally perceived as a large scale NBS-project which follows a rewilding approach to restore natural processes, using engineering to do so. The project with all its facets could serve as an example for other freshwater lakes or ecosystems that deal with declining ecological values and deterioration of water quality. Development, management, and transfer of

knowledge for future national and international applications received special attention in this project through KIMA.

3.2 Knowledge and Innovation program Marker Wadden (KIMA)

Research by KIMA did not start simultaneously with the initiation and construction of Marker Wadden, although the involved parties had set out for knowledge development to be a key pillar of Marker Wadden (IJff et al, 2020). Before the start of the construction phase, initial steps were taken to explore the possibilities to establish a research program. In 2016, the same year construction started, Rijkswaterstaat, Natuurmonumenten, EcoShape and Deltares made a formal start with programming and organizing the research themes, mobilizing financial resources to fund the research activities, and designing the organization behind the program. This process was formally completed in 2018 by signing a letter of intent (Rijkswaterstaat et al., 2018). With its signing, all four parties made a financial or in-kind commitment to KIMA. The partnership, financial commitment and staff deployment was herewith established. The primary goal of KIMA is to develop, manage and transfer gained knowledge about Marker Wadden. The intention was to use the knowledge in KIMA to support potential follow-up phases, and to make acquired lessons applicable for similar (NBS) projects, both in the national and international field.

In terms of content, KIMA consists of three overarching research themes: building with lake sediment, ecosystems of value and adaptive governance. Within each theme, both fundamental and applied knowledge are being developed and managed. Each theme has an appointed theme leader who coordinates research activities and addresses connectivity between fundamental and applied research, plus the monitoring and evaluation program. KIMA itself is governed by a steering committee and a core team, where the four key parties are represented equally. Eventually, an operational team was added as well. The steering committee decides on research funding and programming matters, presented to them by the core team, who prepare decision-making for the steering committee and guide KIMA in terms of programming and adapting if necessary. The operational team is responsible for the practical coordination of the research activities and promotes alignment between research and construction activities. The research project 'Nature in Production' by the Netherlands Institute for Ecology was added to KIMA in 2019 and is solely represented in the steering committee. The actual execution of research activities is performed by a broad range of knowledge partners from universities, applied research institutes, and engineering firms. Transferring knowledge happens through an annual congress, the website, social media channels, newsletters and (scientific and practical) publications. The execution of research activities stops in 2021. In the following year of 2022, KIMA will publish the final results and organize a concluding congress. Furthermore, all relevant and valuable results from the three themes will be evaluated and integrated into a synthesis report (IJff et al, 2020).

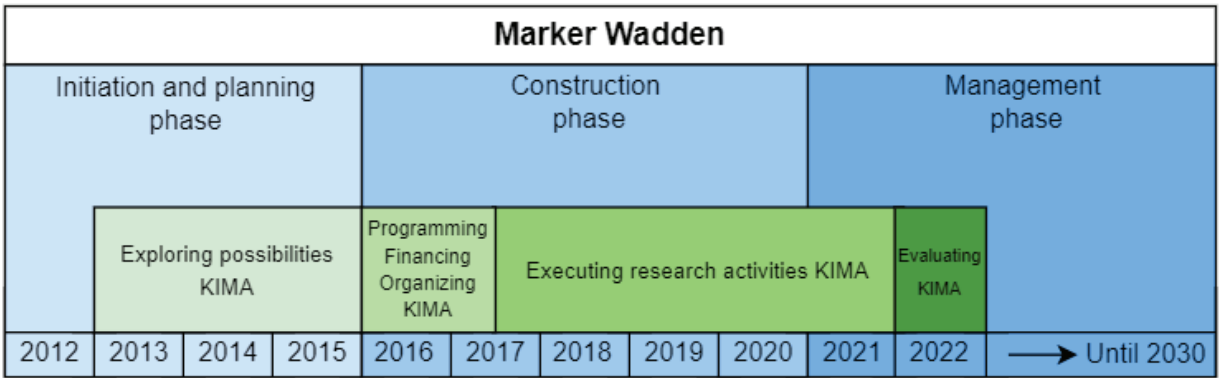

Figure 1. Global timeline that integrates the construction phases of Marker Wadden and research phases of KIMA.

There are three design principles which make KIMA a novel research program. First, research activities in KIMA run parallel to the construction phase. Therefore, lessons learned from the program could potentially flow back more quickly to the ongoing construction project. From this perspective, KIMA can be defined as a 'community of practice' regarding engineering, ecosystem development and governance: "groups of people who share a concern or a passion for something they do and learn how to do it better as they interact regularly" (Wenger & Wenger-Trayner, 2015). A 'community of practice' is informal, self-organizing and based on trust, hence different from other organizational structures (Steins et al., 2021). Second, KIMA applies a multisector (public and private sector, knowledge institutes and NGOs) and interdisciplinary (engineering, ecology, and governance) approach for knowledge development, management and transfer. This can be defined as: "a new

form of learning and problem-solving involving cooperation among different parts of society and academia in order to meet complex challenges of society" (Aram, 2004, p. 382). Third, KIMA integrates both fundamental and applied knowledge disciplines to let strengths of both approaches complement each other. This corresponds with Nesshöver et al., (2017) who argues both disciplines must be involved in NBS-projects.

3.3 Research Methods

The presented results in this research are based on a case study analysis (IJff et al., 2020; Duijn & Stouten, 2022) and performed with case study methodologies (Flyvbjerg, 2006; Yin, 2008). A case study analysis is an accepted qualitative research method to unravel complex knowledge systems where rationality, power and intuition shape each other in decision-making (Flyvbjerg, 2006). IJff et al., (2020) researched the governance of the construction of Marker Wadden, with emphasis on collaboration, adaptivity and continuity. For the research of IJff et al. (2020), 22 in-depth interviews were conducted with involved parties. This research contains insights that constitute the context of KIMA. As follow-up research, KIMA itself was researched to evaluate its performance, and to collect specific experiences about the knowledge management processes in KIMA and around the Marker Wadden project. For this research by Duijn and Stouten (2022), 11 in-depth interviews were conducted with respondents involved with governing KIMA, respondents that functioned both in knowledge management and construction of Marker Wadden, and respondents that are involved with knowledge management in other research programs in the field of water management. The total dataset of this research thus consists of 33 in-depth interviews.

Various complementary methods were used in Duijn and Stouten (2022) such as document analysis, and participation at the annual KIMA-congress in 2021, where preliminary results were presented, and group discussions were held. The researchers have been involved with the research activities on Marker Wadden since the formal start of KIMA in 2016. This means they experienced the whole process of knowledge development and management in KIMA and knowledge transfer from KIMA to Marker Wadden and beyond. In this research we analyzed the results using the concepts of internal and external alignment. We conclude by exploring the internal alignment of KIMA and Marker Wadden and external alignment of KIMA with other NBS-projects.

4. RESULTS

4.1 Strengths of KIMA

Our dataset provides perspectives that highlight the strengths of KIMA, being a research program parallel to the construction of an NBS-project. Here, we report these strengths regarding knowledge management activities, alignment with the construction project Marker Wadden, and alignment with other NBS-projects and -programs.

4.1.1. Knowledge management activities for NBS

For Marker Wadden, knowledge management and innovating for practice were set as specific goals. KIMA was designed to have a multisector and interdisciplinary character to accomplish this task. This had substantial advantages according to our research. First, both the public and private sector perspective on knowledge management has been involved in KIMA. From the perspective of the public sector, there is an emphasis on using knowledge for accountability, monitoring the effects of the intervention, and future management and maintenance of the intervention. The perspective of the private sector emphasizes on whether they can apply the acquired knowledge in a different national and international context, and how they can use it to gain an advantage in their respective market. These two perspectives complement each other and leaving room to incorporate both knowledge-oriented interests has ensured commitment from both sectors to the knowledge management activities. Second, involvement of both fundamental and applied research parties in KIMA helped to develop practical knowledge, which is scientifically viable and vice-versa.

According to those involved, it helped that knowledge management activities in KIMA were linked to a physical location. This provided direct feedback on the developments in the fields of engineering, ecological restoration and governance of an NBS-project. In this sense, Marker Wadden served as a living lab for fundamental and applied researchers.

4.1.2. Internal alignment with the construction project Marker Wadden

Knowledge management parallel to an NBS-project like Marker Wadden asks for a pragmatic design. Performing research activities during the construction phase of an NBS-project requires pioneering and flexibility from researchers to align research practices with the construction activities. Apart from this challenge, research during the construction phase has advantages with respect to applying the lessons in the construction practice of the NBS-project and is different compared to research and evaluation after construction is finished. The knowledge that is acquired during construction can potentially flow back and be used more quickly. If knowledge transfer can overcome barriers between knowledge management and construction, desirable modifications in construction and for management can be accommodated. For KIMA, this took some time to figure out. As time went by and coordination was improved, applicability of the knowledge improved.

Running a research program parallel with an NBS-project provides not only practical knowledge for construction and management. Our research identifies other purposes. First, knowledge management can help to objectively justify choices that have been made in the project. Due to uncertainties surrounding the development of an NBS-project and the effect on its environment, our respondents argue that implementing a research program can create more safety. Monitoring and other research activities display the progress of the project in construction, the effects of the interventions on the ecological environment and helps to build accountability. Second, appealing research results can be used for strategic communication to society. Involvement of Natuurmonumenten (NGO) contributed to the elaboration of this strategy which helped to positively frame the project and raise public good-will for Marker Wadden. Often, disclosure focused on insights regarding the ecological development of Marker Wadden and its attraction of unique species.

4.1.3. External alignment with future NBS-projects and programs

The involved parties in KIMA have the ambition to apply the concept of Marker Wadden in a different national and international context. Some argue this would be the ultimate achievement of knowledge development, management and transfer. However, this is not the sole determinant of whether knowledge management and transfer were successful. Acquiring and spreading knowledge that can be applied on specific elements of future NBS-projects can also mean a lot in terms of engineering, ecology, and governance. These incremental improvements can contribute to eventual scale-up of the NBS-approach. Furthermore, our research indicates that establishing a research program parallel to the construction phase of an NBS-project is pure profit, compared to the traditional approach in which lessons were not evident until after a project was completed. This approach fits well with today's requirements of being accountable for the spending of public funds from governments and NGOs. As such, knowledge management supports the alignment of construction activities and processes with the strategic goals of governments and NGOs regarding the development of sustainable habitats.

4.2 Areas of concern for KIMA

Our dataset provides perspectives that highlight areas of concern for a research program, such as KIMA, parallel to an NBS-project. Here, we report these areas with concern regarding knowledge management activities, alignment with the construction project Marker Wadden, and alignment with other NBS-projects and programs.

4.2.1. Knowledge management activities for NBS

In an NBS project, ecological development is an ongoing process which continues long after construction activities are finished. Therefore, long-term monitoring is relevant and necessary to gain insight in effective design principles, management and maintenance, and service delivery of NBS-projects. Involved parties should make a long-term commitment, aligned with the lifecycle expectations of the project, to ensure long-term monitoring. This includes comprehensive baseline measurements, monitoring developments during the construction phase and monitoring developments during the operation phase, where adaptations can be made if needed. In KIMA, a full baseline measurement at and around the islands was not possible, because research activities started when construction had already commenced. Furthermore, there is no funding available for a follow-up of the KIMA-program. This implies that at this point, it is uncertain whether sufficient monitoring can be carried on and if valid conclusions can be drawn about the effects of Marker Wadden on the ecological system. Due to the limited time scope of KIMA, proper knowledge management in the future has not been captured which is seen as a missed opportunity.

Multiple objectives have been linked to NBS-project Marker Wadden. The archipelago is intended to be a bird paradise, improve water quality, develop aquatic nature and landscape above and below the water and to serve as a recreational area. Positive effects, such as involvement of multisector parties have been previously mentioned. But there are also non-desirable side-effects. Addressing multiple objectives and incorporating them

into knowledge management can cause a lack of focus in knowledge development, dilution of available research budgets or result in high transaction costs to combine sectoral budgets. This seems to have happened in KIMA, which made a structured and integrated approach to knowledge management more difficult.

4.2.2. Internal alignment with the construction project Marker Wadden

Construction activities of Marker Wadden occasionally disrupted KIMA's research because, especially in the beginning, coordination between these two activities was inadequate. Although this situation was eventually fixed by establishing operational coordination, construction activities have always prevailed over research activities. Our research reflects on the contract for construction and its influence on knowledge management. In case of Marker Wadden, a public-private partnership was established, and the consortium was responsible for design, construction, and maintenance (DBM-contract) of the project (Hüsken, 2021). According to respondents involved in knowledge management and construction, the contract was too rigid and lacked incentives for the consortium leader to participate in knowledge development and management through KIMA and engage in knowledge sharing behavior. Consequently, the consortium leader had no seat in the steering committee or core team. This made responding to evolving knowledge needs, practicing openness and transparency by sharing data and sharing experiences between the construction team and KIMA researchers challenging. Although other consortium partners did participate in KIMA, practical knowledge and relevant data obtained by the consortium leader proved difficult to access for researchers in KIMA, barring exceptions. This was a disadvantage for KIMA as knowledge management in an NBS-project requires a cooperative attitude to balance knowledge management and construction activities.

The financial construction that was picked for KIMA has had consequences for the ability of the program to adapt to evolving knowledge needs. KIMA used a financial structure in which the program management had no full mandate to allocate the financial resources for research. Knowledge management activities were structurally financed by annual financial and in-kind contributions by the signing parties, plus a one-time contribution from the involved ministry of Infrastructure and Water Management. Because the program management (steering committee and core team) had no budget of its own, it was difficult to adapt to urgent and evolving knowledge needs. As mentioned earlier, research activities ultimately started later than the construction of the islands. This happened because achieving sufficient financial commitment for KIMA and programming took a lot of time and effort in the exploration phase. According to our results, this contributed to the observation that KIMA has stood beside Marker Wadden, instead of becoming an integral part of the project. Our research indicates that a lack of governing possibilities within a research program can detract from the integral character. In addition, belated start of a research program creates challenges in terms of internal alignment.

4.2.3. External alignment with future NBS-projects and programs

Several projects that are aimed at improving the ecological values on system level of Markermeer and IJsselmeer have started. Examples are Oostvaardersoevers, Wieringerhoek (part of the Programmatic Approach to Large Waters) and Nieuw Land National Park. Exchange of knowledge between KIMA and these projects does happen, but often coincidently or in a pragmatic way according to our research. The exchange of knowledge seems not guaranteed or organized. It is important to establish a more structured way to connect the insights from these projects to measure effects on the ecological system and integrate research funds and results. The external alignment of knowledge generated in KIMA needs further attention. Both flora and fauna do not restrict themselves to Marker Wadden or Markermeer but use the wider system as their habitat as well. The effects that Marker Wadden has on this wider system, need to be further explored to make sense of the ecological impact, trade-offs, and value of this man-made intervention.

5. CONCLUSIONS

A research program, such as KIMA, that practices knowledge management activities, and an NBS-project where construction activities take place, have different objectives that need to be aligned to enable them to work towards shared goals, and to deliver public services in networked settings (Andrews et al., 2011). Our case illustrates that internal and external alignment of knowledge management and NBS can be challenging. Both knowledge management and construction activities involve different sectors and organizations, with different objectives and motives, time horizons, resources and skills which cannot be easily aligned. Both activities can be perceived as demanding, requiring the most of those involved. This puts pressure on alignment, which is reflected in the degree of shared understanding, coordination, collaboration, acquisition of additional resources and acting proactive to changing external dynamics and demands etcetera can be identified. Regarding both internal and external alignment, our study reveals a mixed situation.

In terms of internal alignment, our research identifies better coordination that was achieved over time between knowledge management activities and construction activities. Furthermore, knowledge transfer between KIMA and Marker Wadden improved the creation of shared understanding in some instances. However, the contract used in construction, the absence of the consortium leader in KIMA, and financial construction that was used had a negative impact on internal alignment. We can conclude that the challenges imposed on internal alignment meant that internal alignment was not fully accomplished.

In terms of external alignment, it is important to align knowledge management practice with the demands of the external environment, in this case scaling-up implementation of NBS-projects and filling the knowledge needs to support this ambition. Developed knowledge in KIMA is seen as a valuable addition in the field of NBS for engineering, ecology and governance. This helps implementation of NBS-projects, setting incremental steps towards scaling-up this approach. Furthermore, parallel acquisition of knowledge, which includes involvement of multisector and interdisciplinary parties, and inclusion of both fundamental and applied research activities, can serve as an example for knowledge management in other NBS-projects. Our case shows that external alignment of KIMA-activities with the needs of its environment has happened on a coincidental, rather than an organized basis. Connecting with external resources in the ecological system or connecting to larger research programs (Horizon Europe, etcetera) to develop long-term commitment for knowledge management in the Markermeer and IJsselmeer system has not been realized. How knowledge acquired in KIMA will find its way to application in other NBS-projects is difficult to say and conclude from our data. This question remains to be answered in the future.

We can conclude that KIMA can be considered as a largescale effort of learning how to design and organize knowledge development, management and transfer parallel to an NBS-project, striving for implementation in ongoing construction and application in other NBS projects. The design of KIMA is based on scientific principles such as involvement of multisector parties, working across multiple scientific domains and research from the perspective of both fundamental and applied institutes. However, this research program is only partially capable of spanning the boundaries between the outcomes of its knowledge management activities, ongoing construction activities and application in other NBS-projects in a national and international context. Our research hints that the absence of the consortium leader, suboptimal financial construction, belated start of research activities and lack of incentive in the construction contract to engage in knowledge management had influence on this process. This has posed challenges for internal alignment and put KIMA figuratively beside construction of Marker Wadden. Regarding external alignment, we can conclude that research activities beyond 2022, and knowledge sharing with similar projects in its ecological system have not been structurally organized. As both internal and external alignment were not fully achieved, and both are necessary to accomplish a strategic fit, we can conclude that alignment with the construction project Marker Wadden and application beyond on system level and in national and international context needs attention to realize a strategic fit.

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