Governing knowledge

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04.TRADE-0FFS AND SYNERGIES IN J0INT KN0WLEDGE CREATI0N F0R C0ASTAL MANAGEMENT: INSIGHTS FR0M EC0L0GY-0RIENTED SAND N0URISHMENT IN THE NETHERLANDS

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(submitted)

Abstract

Establishing fruitful connections between knowledge creation and action is a critical issue in many domains of environmental management. Establishing such connections requires environmental research to produce legitimate, credible, and salient knowledge. Although trade-offs and synergies between these three attributes of knowledge have been argued to exist, little research has focused in detail on identifying them. This paper addresses the following questions: first, what trade-offs and synergies may occur in collaborative research for environmental management? Second, what lessons may be learned from this for organizing environmental research that balances these three attributes? This paper is empirically informed by a case study on a collaborative and management-oriented research program on the ecological effects of coastal protection by means of sand nourishment. Our findings suggest that the legitimacy and salience of knowledge creation for environmental management, particularly in an interactive governance context, may be mutually complementary. Furthermore, we identify two key trade-offs: one between practical relevance and fundamental knowledge creation, and one between issue diversity and the depth and quality of scientific inquiry. Based on our findings we formulate several recommendations for balancing legitimacy, credibility, and salience in environmental knowledge creation.

4.1 INTRODUCTION

A key issue in various domains of environmental management is how to create and mobilize knowledge that can fruitfully inform collective action with respect to the environment. In an influential paper Cash et al. (2003) have argued that in order to fruitfully link environmental knowledge and action, knowledge creation efforts must be respectful of disparate concerns and values of involved actors, meet standards of scientific and technical quality, and be relevant for decision-making and management. These three attributes are respectively called *legitimacy*, *credibility*, and *salience*. The triad of legitimacy, credibility, and salience has been widely applied in studies of environmental knowledge-policy interactions (Tuinstra et al., 2006; e.g., Runhaar et al., 2016). Moreover, in line with Cash et al. (2003) various authors have argued that trade-offs between these three attributes may occur, as efforts to strengthen one of them may come at the cost of the others (White et al., 2010; Sarkki et al., 2014). Furthermore, some authors have argued that besides trade-offs also synergies between these attributes may emerge (Hegger et al., 2012). However, little research has examined in detail what kinds of trade-offs and synergies may occur and what the factors and conditions are that are of influence on their occurrence. The aim of this paper is to further insight into the occurrence of trade-offs and

synergies between legitimacy, credibility, and salience. We deem insight into this matter important as it may help to identify the difficulties and opportunities of balancing these three attributes. This in turn may inform how to give shape to successful knowledge creation efforts in the context of environmental management.

The empirical part of this paper is a case study of a collaborative research program on the ecological effects of sand nourishment (Ecology-oriented Sand Nourishment, ESN, 2009-2015). In the Netherlands, sand nourishment is applied as a key means of coastal engineering that aims at countering coastal erosion and facilitating coastal adaptation by making use of the natural dynamics of sand and water along coasts. However, there are still many uncertainties and knowledge lacunae regarding its ecological effects. The program on which our case study focuses has aimed to inform the sand nourishment practice while addressing the concerns of environmental conservation NGOs and meeting standards of scientific quality. The two main research questions that this paper will address in this case study are the following. First, what trade-offs and synergies may occur between legitimacy, credibility, and salience in collaborative research for environmental management? Second, what lessons may be learned from this for organizing environmental research that balances these three attributes?

The next section provides a review of the environmental management literature that focuses on legitimacy, credibility, and salience. Section 4.3 outlines the methods and materials, after which section 4.4 describes the broader coastal policy and management background within which our case is situated. Sections 4.5 and 4.6 provide the results and analysis of the case study. Finally, section 4.7 draws conclusions and discusses how trade-offs may be dealt with in organizing collaborative and management-oriented environmental research.

4.2 LEGITIMACY, CREDIBILITY, AND SALIENCE: LITERATURE REVIEW

Legitimacy "reflects the perception that the production of information and technology has been respectful of stakeholders' divergent values and beliefs, unbiased in its conduct, and fair in its treatment of opposing views and interests" (Cash et al., 2003: 8086). This notion of legitimacy concerns a form of procedural fairness and trustworthiness in dealing with disparate standards and perspectives (Bauler, 2012; Holden, 2013). Credibility "involves the scientific adequacy of the technical evidence and arguments"; thus, it is a measure of scientific and technical quality (Cash et

al., 2003: 8086). In the literature various attributes have been connected to the notion of credibility, which include the accuracy, reliability, validity, and authoritativeness of knowledge (White et al., 2010; Koetz et al., 2012; Cook et al., 2013). Salience "deals with the relevance of the assessment to the needs of decision makers" (Cash et al., 2003: 8086).[67] It may involve responsiveness to policy or management needs and the capacity to influence policies or management practices (Heink et al., 2015).

The triad of legitimacy, credibility, and salience has been applied in studies of science-policy interfaces within various domains of environmental policy and management, such as air pollution (Tuinstra et al., 2006), climate change (Shaw et al., 2013), nature conservation (Hauck et al., 2013), coastal and marine management (Röckmann et al., 2015; Runhaar et al., 2016), biofuel policy (Schut et al., 2013), and landscape planning (An and Powe, 2015). These studies generally acknowledge that legitimacy, credibility, and salience need to be combined in order to successfully mobilize knowledge for decision-making, policy-making, or other forms of collective action concerning the natural environment. Moreover, it has been oftentimes argued that trade-offs between these three attributes may occur, as "efforts to enhance any one normally incur a cost to the others" (Cash et al., 2003: 8086; see also Pietri et al., 2011; Sarkki et al., 2014; Runhaar et al., 2016). Therefore, combining the three attributes can be seen as a "balancing act" (Kunseler et al., 2015: 2). This balancing act is challenging for several reasons; for instance, the three attributes may be "perceived differently by different actors"(Sarkki et al., 2014: 195). Moreover, how to reach an appropriate balance between them may vary according to various contextual factors such as the stage of the policy cycle and the type of science-policy interface (Sarkki et al., 2014).

Balancing legitimacy, credibility, and salience is often seen as a matter of boundary management between knowledge creation and decision-making. For instance, Cash et al. argue that "those systems that made a serious commitment to managing boundaries between expertise and decision making more effectively linked knowledge to action than those that did not. Such systems […] more effectively balanced salience, credibility, and legitimacy in the information they produced" (Cash et al., 2003: 8089). Such boundary management has been suggested to involve the establishment of boundary organizations that serve as intermediaries between science and policy, and the deployment of boundary objects that accommodate the concerns and demands of various groups of actors (Cook et al., 2013; van Enst et al., 2016).

67 Some authors prefer to use the term "relevance" instead of salience (Tuinstra et al., 2006; Sarkki et al., 2014; e.g., Heink et al., 2015). In this paper we use the terminology as introduced by Cash et al. (2003), which includes salience.

Although it is widely acknowledged that trade-offs may occur between legitimacy, credibility, and salience, little scholarship has explicitly focused on identifying such trade-offs. A notable exception to this is the work of Sarkki et al. (2014), which identifies four trade-offs based on empirical research on biodiversity-related science-policy interfaces. Firstly, scientists and policy-makers have to deal with a "personal time trade-off", because they have to choose whether they invest their time in participating in science-policy interfaces or in their core activities (Sarkki et al., 2014: 198). Secondly, a clarity-complexity trade-off may occur; presenting "simple, strong and clear messages" in order to enhance salience may come at the expense of the "thorough treatment of uncertainties and ignorance and diverging values" in order to enhance credibility and legitimacy (Sarkki et al., 2014: 199). Thirdly, a "speed-quality trade-off" may occur; providing "rapid responses to policy needs" to enhance salience reduces time for quality assessments and consensus building processes, thus reducing credibility and legitimacy (Sarkki et al., 2014: 200). Fourthly, Sarkki et al. identify a "push-pull trade-off" that occurs between supply-driven strategies that foster credibility and demand-driven strategies that focus on salience (Sarkki et al., 2014: 201). Trade-offs between credibility and legitimacy are not addressed by these authors. Several scholars have argued that besides trade-offs, also synergies between legitimacy, credibility, and salience may occur (Hegger et al., 2012; Sarkki et al., 2014). For instance, exploring a broad range of views in order to achieve legitimacy may also be conducive to quality assessment in the form of "extended peer review"; thus, in this sense a synergy between legitimacy and credibility may emerge (Sarkki et al., 2014; see also Funtowicz & Ravetz, 1993). However, little empirical research has explicitly focused on identifying synergies between the three attributes.

The identification of trade-offs and synergies between legitimacy, credibility, and salience may contribute to insight in how to give shape to knowledge creation processes that meet the concerns and demands of various groups of actors involved. However, creating generalized knowledge on such trade-offs and synergies is challenging because, as argued above, the ways in which they come about and may be dealt with are often context-specific. Hence, in order to contribute to insight in trade-offs and synergies, more insight in process- and context-specific factors that are of influence on trade-offs and synergies is needed. In this paper we take such factors into account by examining both how a collaborative research practice is constructed in order to achieve legitimacy, credibility, and salience, and the broader setting in which this construction work is situated.

4.3 METHODS

This paper is empirically informed by a case study on the Ecology-oriented Sand Nourishment (ESN) collaborative arrangement and the research program that is part of this arrangement. It reconstructs the establishment of this arrangement and the efforts that have been made to achieve legitimacy, credibility, and salience on the empirical basis of interviews and document study. In a first round, a broad investigation was made of policy-related and societal developments concerning "ecological" or "natural" approaches to coastal defense in The Netherlands. This investigation was made on the basis of a study of scholarly literature, research reports and "grey" literature such as policy documents. In a second round, which zoomed in on the ESN arrangement, 15 semi-structured interviews were conducted with actors who have been actively involved in this arrangement. The interviewees include researchers who coordinated and executed the research and monitoring, the key representatives of the NGOs involved, and civil servants who were involved in the coordination and management of the program. The main interview topics included the establishment of the collaborative arrangement on sand nourishments, the programing of the research, the interactions between the actors involved, the main issues concerning coastal protection by means of sand nourishment, and the salience, legitimacy, and credibility of the research program. Most of the interviews lasted between 45 min. and 2 h. The interviews were recorded, transcribed verbatim, and analyzed with software for qualitative data analysis (Nvivo 10). In the analysis we combined two coding strategies. Firstly, we used an inductive coding strategy involving setting-specific codes that were constructed on the basis of the issues that were brought up by the respondents (Lofland et al., 2006). Secondly, we used credibility, legitimacy, salience, and the trade-offs and synergies between these attributes as analytic codes in the analysis of the interviews (Lofland et al., 2006). This analysis was bolstered through triangulation with written sources that were produced in the context of the collaborative arrangement, such as research plans, legal documents, workshop reports, and research reports.

4.4 BACKGROUND: THE DYNAMIC PRESERVATION OF THE DUTCH COAST

The Netherlands, with almost one-third of its territory below sea-level, has a long history of protecting its inhabitants and land from flooding (Van Koningsveld et al., 2008). The Dutch coastline is over 400 km long

and 75% of the coast is protected by sandy structures and dune areas; the remainder is protected by hard structures such as dams, dikes, and storm surge barriers (De Ruig, 1998; Mulder et al., 2011). Thus, sand plays a crucial role in the coastal defense of the Netherlands. Due to an imbalance between sediment supply and sea level rise, the sandy coast has been subject to erosion during at least the last centuries, and presumably for up to 1500 years (Bakker et al., 2012). This has resulted in land loss and threats to e.g. drinking water supply and ecological, residential, and industrial functions in the coastal zone (Van Koningsveld & Mulder, 2004).

Before 1990, the Dutch coastal defense policy aimed at countering only the most urgent erosion problems and at stabilizing the defensive structure of the sandy coastline through fixating and restoring dunes and creating sand dikes (De Ruig, 1998; De Jong et al., 2014). However, by 1990 a political consensus had come about that this policy would not suffice for safeguarding the Dutch coast in the long run (Hillen & Roelse, 1995). Therefore, a new policy was implemented that aims at fully countering coastal erosion, thus maintaining the Dutch coastline at the position in which it was in 1990 (Rijkswaterstaat, 1990). This is accomplished by means of an ongoing program that encompasses monitoring the position and sediment volume of the coast and applying sand nourishments in locations where the actual situation deviates from the 1990 reference (Bakker et al., 2012). This program is executed by Rijkswaterstaat (RWS), the national governmental organization responsible for maintaining the Dutch coast and executing coastal defense policy. Sand nourishment entails collecting sand from the deeper parts of the North Sea (outside the 20 m isobath) and depositing it on the shoreface or the beach where water and wind have free play in its further transport and accumulation in the coastal zone (Hillen & Roelse, 1995; De Jong et al., 2014). The new policy is called "dynamic preservation" because it aims to preserve the coast by making use of and stimulating the natural dynamics of sand and water; for this reason, it is also characterized as "building with nature" (Van Koningsveld & Mulder, 2004; Kabat et al., 2009b; De Jong et al., 2014). Various evaluations have pointed out that the policy has succeeded in maintaining the coastline at its reference position (Mulder et al., 2011). Moreover, the policy is thought to be sustainable in the long run as it allows the coast to grow along with sea-level rise (Kabat et al., 2009b).

4.5 EFFORTS TO ACHIEVE LEGITIMACY, CREDIBILITY, AND SALIENCE IN THE ESN PROGRAM

4.5.1 The establishment of the ESN program

The Ecology-oriented Sand Nourishment (ESN) program originated in discussions about the regulation and unknown ecological effects of sand nourishment. Since 1990, Rijkswaterstaat (RWS) has been executing its program of sand nourishments along the Dutch coast. Initially, it perceived these nourishments as "regular" maintenance activities that were comparable to other forms of regular infrastructural maintenance. Therefore, it deemed requesting permits for sand nourishments unnecessary. An RWS employee for instance argued:

> "RWS was of the opinion that it fell under the regular maintenance of the system. […] We do not need to request a permit for replacing a layer of asphalt on the freeway either."

However, by the mid-2000s a group of nature conservation NGOs had become critical of this practice. The main points of criticism were that the execution of sand nourishment was unregulated and that there was little known about its ecological effects. One of the representatives of the NGOs who was involved at that time stated:

> "We had no problem with dynamic preservation as such, but we did have a problem with the way it was executed, its unregulated character, the lack of research underpinning its execution, and also the lack of knowledge on its optimization with regard to nature."

Consequently, four NGOs (the Wadden Sea Society, the Society for the Protection of Birds, the Dune Conservation Foundation and the North Sea Foundation) formed a coalition aiming to address these issues. They argued that RWS should request permits for sand nourishments under the Nature Conservation Act (NCA). Doing so would impose a formal decision-making and consultation procedure on sand nourishments. Moreover, it would impose the requirement to create and apply knowledge concerning the ecological effects of sand nourishments, as the NCA prescribes that a scientific assessment of such effects is to be part of the decision-making.[68] However, RWS initially did not intend to meet the demands of the NGOs. One of the NGOs' representatives for instance recalled:

68 This assessment is called an "appropriate assessment".

> "We put quite some pressure on RWS to request an NCA-permit for the nourishments […]. That was extremely laborious […]. There were people at RWS who absolutely did not feel like doing so and who thought that they as a governmental organization were not obliged to."

This incited the NGOs to take various formal actions, including issuing comments in the consultation procedure concerning the yearly sand nourishment program and filing "enforcement requests" at the province of Fryslân and the Department of Agriculture, Nature, and Food Quality (LNV).[69] The latter two are competent authorities under the NCA. In reaction to these formal actions, RWS started requesting NCA permits for sand nourishments in 2008. The permits requests that were filed since then were granted by the competent authorities. However, the NGOs were critical of these initial requests; in consultation procedures concerning the first permits they argued that the permit conditions and impact assessments of the intended sand nourishments were inadequate and that integrated research on large-scale and long-term ecological effects was needed.[70]

In order to find a way out of this complex situation of knowledge lacunae and formal procedures RWS proposed to enter into an agreement with the NGOs; this "Collaborative Agreement Sand Nourishments" was signed on March 24, 2009. The crux of this agreement is that RWS and the NGOs collaborate in a research and monitoring program that aims at "gaining more knowledge on the influence of the execution of sand nourishments on natural values, and on possibilities of optimizing the sand nourishment program and its execution regarding the conservation and development of natural values".[71] Moreover, the agreement states that the NGOs "exercise restraint in taking recourse to legal remedies" with respect to sand nourishments.[72]

The research program called Ecology-oriented Sand Nourishment that emerged from this agreement (ESN, 2009 - 2015) is executed in collaboration between RWS, the four NGOs, and the research organization Deltares.[73] The fieldwork is executed by several specialized research agencies who work in annual contracts under the authority of Deltares.[74] The ESN

69 An enforcement request is a message to a competent authority that points out a possible breach of a regulation and requests the enforcement of this regulation.

70 E.g., Province of Fryslân (2008) Permit Nature Conservation Act 1998, for sand nourishment near Texel, North Sea Coastal Zone, 00781007; Wadden Sea Society (2008) Objection Against the Permit Nature Conservation Act 1998 Sand Nourishment, AWo/AW/08099.

71 Collaborative Agreement Sand Nourishments Nature Conservation Organizations and Rijkswaterstaat (2009): 2.

72 Collaborative Agreement Sand Nourishments Nature Conservation Organizations and Rijkswaterstaat (2009): 3.

73 Deltares is a merger of various water and civil engineering research organizations including several former research departments of RWS; it serves as one of the principal "knowledge suppliers" of RWS.

74 These are mostly privately owned research agencies that are specialized in ecological monitoring and fieldwork. They include the Belgian agency eCoast and the Dutch agencies EGG Consult and The Fieldwork Company.

program is embedded in the larger research program "KPP Management and Maintenance Coast" (KPP Coast), which aims at providing RWS with the knowledge required for optimizing the dynamic preservation of the Dutch coast.[75] Through introducing ESN in KPP Coast, an ecological subprogram has been added to a research program that previously solely focused on coastal morphology. KPP and its subprograms are coordinated by RWS and Deltares.

Since 2009, various research activities have been executed within the scope of the ESN program, including:

- A study on the ecological effects of sand nourishment on the dunes along the Dutch coast, in collaboration with the research network for nature management O+BN (Arens et al., 2012).[76]
- A literature study on where and when effects of sand nourishments on birds may be expected (Jonkvorst et al., 2013).
- A case study on the effects of sand nourishments on the ecology of the foreshore and beach of the island of Ameland.[77] This case study forms the principal part of the ESN program. One of its key research questions concerns the speed of ecosystem recovery after sand nourishments. It has an experimental character inasmuch as these sand nourishments were designed, based on the input of the program participants, to have a limited ecological impact (Holzhauer et al., 2014).

4.5.2 Efforts to achieve legitimacy

Through their initiatives, the nature conservation NGOs have had a strong influence in placing ecology on the knowledge agenda for coastal protection. In a sense, the ESN research program that emerged from these initiatives is inherently legitimate as it is a materialization of the ecological concerns of the NGOs. However, the parties to the agreement have done more than just starting an ecological research program in order to produce legitimate knowledge; in fact, much efforts have been made by RWS and Deltares to ensure that the content of the research program reflects the various concerns of the NGOs.

Although many of the NGOs' concerns fall under the general category of "ecology", they also differ to some extent. For instance, the Wadden Sea Society is interested in the effects of sand nourishments on the ecological

75 KPP stands for "Knowledge for Primary Processes". The wiki site of this program can be found at https://publicwiki.deltares.nl/pages/viewpage.action?pageId=72844168 (last accessed 1-25-2016).

76 O+BN is a Dutch acronym for Development and Management Nature Quality. It is a research network that aims to create and disseminate application-oriented knowledge for environmental management.

77 Ameland was chosen as a case study for pragmatic reasons; at the time the research program was started up, there were already plans for sand nourishments near Ameland that could serve as a case study.

and morphological systems of the Dutch Wadden Sea, The Society for the Protection of Birds is interested in the effects on the coastal food web, and the Dune Conservation Foundation is interested in the possible contribution of sand nourishments to the restoration of dune ecosystems.[78]

The creation of a legitimate research program has been a process in which the concerns of the NGOs and the focus of the research practice have been aligned in several ways. First, tentative research questions were formulated on the basis of the concerns put forward by the NGOs. These questions were based on the comments that the NGOs had provided in the consultation procedure concerning the sand nourishment program. An RWS program manager for instance said about this:

> "As a basic source we had the comments that had been submitted. They included an appendix with […] a big pile of questions and concerns and doubts about sand nourishment […]. Together with IMARES and Deltares […] we analyzed how we could turn those doubts and concerns into research questions."[79]

Subsequently, the further specification of the focus, the questions and the set-up of the research were discussed in three workshops in the summer of 2009, in which representatives of RWS, the NGOs and research organizations participated. The results of these workshops served as input for the 5-year research plan that was finalized in late 2009 and that served as the basis for subsequent yearly research plans.[80] The 5-year research plan contains 31 research questions on the ecological effects of sand nourishment that are distributed among five themes that roughly cover the concerns of the NGOs (Holzhauer et al., 2009):

1. Large-scale ecological and morphological systems, specifically those of the Wadden Sea.
2. Three types of habitats:
   a. Offshore (i.e. the deeper parts of the North Sea where sand is collected)
   b. The foreshore and the breaker shore.
   c. The beach and the dunes.
3. Food web relations.

Furthermore, the program leaders have aimed to ensure the legitimacy of the program by means of regular deliberation between RWS, the NGOs, and the researchers. Notably, interim results and possible adjustments to

78 The Wadden Sea is a protected intertidal area that stretches from the northern coast of the Netherlands to the western coast of Denmark.

79 IMARES, the Institute for Marine Resources & Ecosystem Studies, was involved in the initial stages of the research program.

80 Workshop Report Effects of Sand Nourishments on Dunes (Knowledge Lacunae and Research Questions), June 29, 2009, Harlingen.

the yearly research plans have been discussed by the parties to the agreement in yearly workshops. However, in recent years this process of "legitimation through deliberation" has come under pressure due to the decreasing involvement of the NGOs in the research program. The NGOs have to divide their limited time and manpower among the various issues and processes in which they are involved. Once the issue of the ecological impact of sand nourishments had been placed on the agenda and solidified in the collaborative agreement, other issues started demanding more attention of the NGOs. Thus, limited time and resources and shifting priorities confronted the NGOs with the personal time trade-off that has also been identified by Sarkki et al (2014). One of the representatives of the NGOs for instance argued about the shifting priorities:

> "Such is […] the fate of these kinds of covenants […]. In the build-up they take priority and everyone is strongly involved. Once they have been settled […] they become less primary on the agenda. There is a risk to that. […] It then becomes quite difficult to keep a finger on the pulse."

4.5.3 Efforts to achieve credibility

Throughout the programming and the execution of the research, researchers from Deltares and the other research organizations have made various efforts to create a credible research program. Deltares has had the prime responsibility for the technical and scientific quality of the program (Holzhauer et al., 2009). As a first step towards creating credible knowledge, the tentative questions were transformed into a set of researchable questions that fitted within the five main themes of the program. A program manager for instance stated about this:

> "We tried to fit the directly answerable questions into the components that we had, and to adjust the questions that required very long or expensive research or that we simply could not answer [by asking]: what is the question that we should ask instead?"

As a result of this process of filtering and adjusting, a further focus in the research program came about. For instance, researching the large-scale cumulative effects of beach nourishments has a high priority for the NGOs; however, it was decided to focus on the local effects of beach nourishments in a case study as research on cumulative effects was deemed too complicated (Holzhauer, 2010).

Furthermore, quality control was employed to achieve a credible research program. For instance, a peer-review process was organized to assess the scientific quality of the 5-year research plan. In this process several experts, notably from Ghent University, reviewed the research plan. The key conclusion of this review was that the program insufficiently linked fundamental research and practical applications of the research; this resulted in the further adjustment of some of the research questions (Holzhauer, 2010).

Moreover, the credibility of the program has in part relied on the specialized expertise of the research agencies involved. Notably, several specialized ecological research and monitoring agencies have been involved in the execution of the monitoring; these agencies have produced detailed methodological designs and fieldwork reports on both the case study on Ameland and the research on the ecological effects on dunes (e.g., Everts & De Vries, 2010; Vanagt et al., 2011). A Deltares program manager for instance stated:

> "We handle a part of the questions ourselves but we work together with many other parties who do parts of the research, with an eye to doing research that has a broader foundation than something that was simply and solely contrived between these four walls. […] Oftentimes there are portions of the research for which we don't have the best and highest credentials; in that case other parties are better fit for the job."

Some of the involved researchers have called into question the validity and the representativeness of the Ameland case study. Because the foreshore is a dynamic system that quickly recovers from interferences, the ecological effects of sand nourishments may be small and difficult to measure. Whether the statistical power, the set-up and the execution of the monitoring have been adequate to measure such effects has been called into question. For instance, the latter aspect was hampered because the contractor of the sand nourishments had a flexible planning for executing the work. Therefore, the researchers were not able to work according to a predetermined sampling plan (Holzhauer et al., 2014: viii). Furthermore, the representativeness of the case study has been questioned in various respects. Various interviewees pointed out that because of its spatial and temporal limitations the case study has a limited representativeness with respect to the effects of sand nourishment on a larger scale, on a longer term and in other parts of the Dutch coast. Consequently, the involved researchers have called for a nuanced interpretation of the results of the program.

4.5.4 Efforts to achieve salience

As stated in section 4.4, the ESN research program that stems from the collaborative agreement is to provide knowledge for the optimization of sand nourishments with respect to "natural values".[81] Therefore, the research program is strongly aimed at producing salient knowledge for the practice of dynamic preservation. As a first step in achieving salience, the notion of what constitutes salient knowledge for dynamic preservation was redefined. Before the NGOs' initiatives and the collaborative agreement, sand nourishment was not regulated under the Nature Conservation Act (NCA), and research and monitoring in the KPP Coast program focused on geomorphological aspects of the coast. Thus, ecological knowledge was not officially considered to be salient for dynamic preservation. Through the initiatives of the NGOs, sand nourishment became regulated under the NCA. Consequently, ecological effects were officially to be taken into account in the decision-making on the permissibility of sand nourishments. This created a situation in which it was in principle possible for ecological research to be salient for dynamic preservation. As a second step, the parties to the agreement gave shape to the salience of the ESN program by programing the research in such a way that specific sub-projects served as sources of knowledge for the decision-making on sand nourishments under the NCA permit regime. Within the program, several short-term research projects were executed, e.g. on the behavior of seals and sanderlings (*Calidris Alba*) in relation to sand nourishments, with the explicit aim of providing knowledge for permit requests.[82]

Furthermore, the salience of the ESN program has been given shape through the institutional design of the program. By embedding the ESN program in the KPP Coast program, it became a part of the already existing management-oriented research infrastructure in which RWS and Deltares collaborate. As the ESN program follows the institutional logic of the KPP Coast program it is, like other subprograms of the latter, coordinated in close collaboration between the program managers of RWS and Deltares. Consequently, RWS is involved on an ongoing basis in assessing and safeguarding the salience of the research that is done. For instance, an RWS program manager stated about this:

> "One of the research questions concerns the effects of sand quality. […] We concluded that addressing that question might produce results, but we would not be able to apply them in the execution [of sand nourishments], so we let that rest for the time being. […] It is aimed at improving sand nourishments, not just at knowing more."

81 Collaborative Agreement Sand Nourishments Nature Conservation Organizations and Rijkswaterstaat (2009): 2.

82 Report of results workshop 2010 (2011).

Finally, the program aims to provide salient knowledge through contributing to design principles or a guideline for ecologically sound sand nourishment, also referred to as "green sand nourishment". Such principles may for instance concern the intensity, phasing, and sediment composition of sand nourishments.[83] However, such principles have not yet been formulated. For instance, one of the NGOs' representatives stated:

> "The research's aim is to produce a guideline for ecological nourishment. The results are now known. […] As yet we haven't thought out: how are we going to do things differently than in the past?"

This may be explained by the current results, which as yet do not give cause to radical adjustments to the current sand nourishment practice. One of the program managers said about this:

> "[The research] does not indicate that we have to do things radically differently. Either we don't know enough yet about the relations between sand nourishments and dynamics, or the recovery time [of the ecosystem] is not much longer than the repetition time of the beach nourishments."

4.6 LEGITIMACY, CREDIBILITY, AND SALIENCE: TRADE-OFFS AND SYNERGIES

4.6.1 Legitimacy – salience: synergy between addressing concerns and informing decision-making

A synergetic relation between legitimacy and salience has emerged within the ESN research program in the following ways. Firstly, the ecological concerns put forward by the NGOs have gained a structural position within knowledge creation and decision-making on the dynamic preservation of the coast. This has for instance occurred by making sand nourishments fall under the NCA permit regime, which implies that addressing ecological issues has become inevitable in decision-making about the conditions under which sand nourishments are permissible. Moreover, ecological research appears to have gained a structural position in the KPP Coast program that provides knowledge for the practice of dynamic preservation. A program manager from Deltares for instance argued about this:

83 Meeting Report, Designing an Ecological Sand Nourishment, August 25, 2009.

> "For 25 years we have been working on how we manage our coast, what we see there and what we can learn from it. The ecological part that has entered now is still in its infancy. It is starting to stand on solid ground, […] we will continue to work on it in a structured way"

Thus, both in the context of the NCA permit regime and the KPP Coast program, addressing the ecological concerns of the NGOs has resulted in a positive impulse for the substantive underpinning of the decision-making on the execution of sand nourishments.

Secondly, a governance arrangement has emerged in which the boundary between the "stakeholders" and the "decision-makers" has become more permeable. For instance, the NGOs have exerted a strong influence on the way decisions are made on sand nourishments by inciting RWS to apply permits under the NCA. Furthermore, RWS and the NGOs are working towards the shared goal of optimizing sand nourishments with respect to ecology and the latter are consulted in early stages of decision-making on the sand nourishment program. In this sense, addressing ecological concerns and making decisions on the execution of sand nourishments have become more tightly coupled in the context of the collaborative agreement and the ESN program. For instance, one of the representatives of the NGOs stated:

> "We are involved even before the formal consultation procedure […]; a big advantage of the collaborative agreement is that we sit round the table much more often, so we are involved in an earlier stage."

4.6.2 Salience – credibility: practical relevance versus scientific considerations

The ESN research program provides a setting in which there is room for safeguarding both the scientific adequacy and the relevance of the knowledge it creates. This is exemplified by the expert review of the 5-year research plan, which among other things resulted in a stronger focus on the practical relevance of the program's results for coastal management practice (Holzhauer, 2010). Therefore, the program has to some extent enabled fruitful combinations of credibility and salience. However, trade-offs between the two have also occurred, notably due to the institutional design and embedment of the program.

The ESN program is geared towards providing salient knowledge for the executive practice of dynamic preservation. This salience has been given shape by making the program a part of the already existing management-oriented knowledge infrastructure of the KPP Coast program. However, the drawback of this institutional design from the perspective of credibility is that the program is subject to the institutional rules and mechanisms of the KPP program. One of these mechanisms is a contracting model under which research projects are put out to tender on a yearly basis. Thus, multi-year research projects are sometimes executed by contractors that vary from year to year; this has also occurred in the case of the ESN program. This yearly contracting model is in tension with the formation of a stable community of researchers and the continuity of long-term research. In this sense, a trade-off exists in the KPP Coast program between achieving a scientifically ideal research practice and embedding the program in a management-oriented knowledge infrastructure. One of the interviewed researchers argued about this issue:

> "The way [the research] was contracted out in many different ways, resulting in a lack of a logical continuity of its […] execution, is definitely a point for improvement"

Another researcher said about the contracting model:

> "It takes away the continuity of your project and moreover it completely removes the zest, the cooperation and the mutual goodwill of the researchers."

Moreover, the management-oriented institutional design of the program has been argued to be in tension with the current state of ecological knowledge, i.e. the many scientific knowledge lacunae concerning the ecology of the foreshore and the beach in relation to sand nourishments. Some of the interviewed researchers argued that fundamental and long-term scientific research is first needed before more applied research can be done. Such research has for instance been argued to include basic research on the ecology of the foreshore and research on the long-term and large-scale effects of sand nourishments. One of them for instance stated:

> "[The research] is actually so fundamental because it purely concerns knowledge creation about an almost unknown area; therefore, I wonder whether it should be done in a program like this, or be led in a much broader setting, or placed with NWO."[84]

84 NWO is the Netherlands Organisation for Scientific Research; it funds scientific research at public research institutions in the Netherlands.

4.6.3 Legitimacy – credibility: issue diversity versus depth of inquiry

The translation work that molded the concerns of the NGOs into researchable questions has resulted in a focus of the program that to some extent meets the requirements of both legitimacy and credibility. However, there is no full complementarity between these two aspects; rather, the translation work resulted in a compromise that reflects the trade-offs between them. On the one hand, spreading the resources of the program among the various research themes that reflect the concerns of the NGOs has imposed limits to the depth of inquiry. In other words, the democratization of the research programing in order to achieve legitimacy has drawn on the credibility of the research. One of the interviewed researchers for instance argued about this:

> "One expects that in such a dynamic area […] the differences are subtle. This means that measurements should have high [statistical] power, which they hadn't. That is because […] the scientific arguments are not the most important. There are people at the table with different backgrounds and interests."

On the other hand, the translation work towards researchable questions has also resulted in a research focus that only partly reflects the concerns of the NGOs. Thus, the parties involved were also confronted with a trade-off between researchability and the accommodation of various concerns. Notably concerns about the impacts of sand nourishments on a large-scale systems level were left unaddressed due to perceived limits to their researchability. For instance, an NGO representative argued:

> "The most difficult to address […] has been the impact of sand nourishments on the Wadden Sea itself. This had a technical motivation; for a very long time it was maintained that this impact was unmeasurable […] either because of background noise, or because it concerns such a small amount of sand. I have never chosen to fully believe that."

Finally, the ESN program rests on the implicit assumption that it can achieve a synergy between creating credible and legitimate knowledge by facilitating regular in-depth discussions between researchers and representatives of the NGOs about both the programing and the results of the research. However, this has proven difficult in practice due to different

levels of scientific expertise and the limited time and resources of the NGOs (see also section 4.5.2). One of the interviewed researchers for instance stated:

> "What I always miss a bit is a clear input from the NGOs with respect to content. […] The flaw is that they lack substantive research knowledge. But meanwhile they were the ones to whom account was given. Now and then I thought that was a bit complicated."

4.7 DISCUSSION AND CONCLUSIONS

It has often been argued that successful environmental management demands fruitful linkages between knowledge creation and action. Research within various domains of environmental management suggests that in order to bring about such linkages, knowledge creation efforts need to balance legitimacy, credibility, and salience. Although trade-offs and synergies between these three attributes have been argued to exist, little research has focused on identifying specific trade-offs or synergies that may emerge. This paper has aimed to contribute to insight into this matter by mapping the efforts to achieve legitimacy, credibility, and salience in the context of a collaborative research program on ecology-oriented coastal defense, and by identifying the trade-offs and synergies that have emerged in the context of this program.

Our findings suggest that the legitimacy and salience of knowledge creation for environmental management, particularly in a governance context with strong interactions between societal and governmental actors, may overlap and be mutually complementary. In the case examined here a synergy has come about between legitimacy and salience as addressing the ecological concerns of NGOs in the ESN research program has provided knowledge for decision-making under the permit regime of the Nature Conservation Act; moreover, addressing these concerns is to contribute to the optimization of the beach nourishment practice with respect to nature conservation. Interestingly, this synergy between legitimacy and salience was in part enabled by reframing the notion of salience. Through the initiatives of the NGOs ecological knowledge has become indispensable for decision-making on the conditions under which beach nourishments may be allowed. A lesson that can be drawn from this is that enabling salience need not merely entail attuning research efforts to the needs of decision-makers; it may also entail redefining what the decision-making is about, how such decisions may be reached, and what knowledge forms or disciplines may be relevant for decision-making. The same point may be

made *mutatis mutandis* for legitimacy and credibility. For instance, efforts to achieve legitimacy may involve a reorientation on who the stakeholders are, and efforts to achieve credibility may involve rethinking the standards that are used to assess the quality of knowledge. Thus, our results suggest that legitimacy, credibility, and salience are not standards that are set in concrete, but rather fluid and negotiable attributes.

Besides this synergy our analysis has identified two main trade-offs that both involve credibility. Firstly, the ESN research program has been confronted with a trade-off between salience and credibility. The research has been executed in a practice-oriented setting that is geared towards short-running applied research projects. This institutional design has been at tension with the demand for creating fundamental knowledge on the ecology of the foreshore in long-term academic research. This trade-off between practical relevance and fundamental knowledge creation involves both the clarity-complexity and push-pull trade-offs that have been identified by Sarkki et al. (2014). In the case examined here, RWS and the NGOs have expressed a demand for clear results that can be translated to management practice, while researchers have argued from a knowledge supply perspective that a more thorough understanding of the ecosystem and the long-term effects of sand nourishments is needed before clear practical conclusions can be drawn. Furthermore, a trade-off in this case has occurred between legitimacy and credibility. Addressing a diversity of concerns has imposed limits to the depth of inquiry; simultaneously, efforts to achieve scientific researchability have come at the cost of addressing some of these concerns. This is a trade-off between issue diversity on the one hand and the depth and quality of scientific inquiry on the other.

The work of Cash et al. (2003) and other authors suggests that the occurrence of trade-offs between legitimacy, credibility, and salience is inevitable. However, how and which trade-offs manifest themselves has been argued to be contingent upon process- and context-related factors. Consequently, a highly relevant question concerns what the factors and conditions are that may be of influence on the manifestation of particular trade-offs and synergies. We will now turn to a brief discussion of such factors and conditions based on a comparison of our results with the findings of Sarkki et al (2014). Based on this discussion, we will formulate recommendations on how various trade-offs may be dealt with.

Firstly, both our findings and those of Sarkki et al. suggest that in a context in which there is a demand for practically relevant knowledge and in which at the same time there are uncertainties or fundamental knowledge lacunae, trade-offs between salience and credibility are bound to exist. Such trade-offs may be dealt with by making an explicit distinction

between the knowledge questions that can be addressed in a practice-oriented research setting, and those that are better addressed in an academic research setting that is relatively independent of the context of application. Secondly, both our findings and those of Sarkki et al. indicate that the personal time trade-off is contingent upon the availability of resources. In our case this trade-off notably played a role for the NGOs due to limited resources in combination with shifting priorities. This trade-off may be dealt with by focusing attention on how to ensure sustained commitment among the various parties involved, for instance through incentives, resources, and the formalization of commitment in collaborative agreements. Moreover, it may be dealt with by focusing attention on how to efficiently and effectively organize the representation of actor groups in the collaborative process, for instance through delegation. Our findings highlight the importance of such commitment-building efforts as they may enable synergies between legitimacy and salience. Thirdly, the speed-quality trade-off as identified by Sarkki et al. did not play a major role in our case. This may be explained by the fact that the ESN program was expressly organized as a research program for the medium range (2009-2015), while in its first years it also addressed urgent knowledge questions related to permit requests that could be answered quickly. Thus, the program was able to both provide timely responses to urgent demands and accommodate longer-running research efforts. This indicates the importance of taking into account the diverging time frames and degrees of urgency of various research efforts in the organization of joint research programs. Finally, as indicated above we have identified a trade-off between issue diversity and the depth of inquiry, which has not been addressed by Sarkki et al. This trade-off is contingent upon the number of actors involved and the diversity of their perspectives and concerns. Dealing with this trade-off may involve clearly delineating who the key actors are, investigating what their concerns of these key actors are, and finding ways of prioritizing those concerns that are shared among various actors.

If we look at this case from a broader perspective, additional conditions may be identified that are likely to have facilitated the emergence of the ESN research program. For instance, the program has emerged in a governance setting that is characterized by a strong tradition of network-building, collaboration, and deliberation between governmental organizations and environmental protection NGOs (Turnhout et al., 2008). Furthermore, the program emerged in a context in which an established management-oriented research infrastructure that links research to coastal management was already in place. Finally, the program emerged in a legal context in which a legal framework was already in place (i.e.

the NCA) that requires scientific assessments of the ecological effects of human interventions in nature. Thus, our findings suggest that broader contextual factors such as governance traditions, research infrastructures, and legal frameworks may be of influence on the emergence of joint research for environmental management.

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