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Productive science–policy interactions for sustainable coastal management: Conclusions from the Wadden Sea area

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ABSTRACT

In this paper we synthesise the findings from the papers in this special issue on Organising productive science–policy interactions for sustainable coastal management. Lessons from the Wadden Sea. We first briefly discuss some relevant theoretical debates, and then present our main insights and lessons from the empirical evidence reported in the papers. We conclude the paper with suggestions for further research.

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1. Introduction

In this concluding paper, we take stock of the main lessons from this special issue. The aim of this special issue is to “(...) provide more insight into the dynamics of (joint) knowledge production and how, and under which conditions, specific arrangements for organising science–policy interactions contribute to scientifically and societally robust – i.e. credible, salient, and legitimate – knowledge” (Van Tatenhove et al., 2016). All contributions to this special issue focus on how science–policy interactions and arrangements affect decision-making and its outcomes. Most of the papers share an empirical focus on the Dutch Wadden Sea; an interesting coastal area to analyse science–policy interactions because of intense use, conflicting interests, the intensity in research, the number of governance structures and processes and the attention which is already paid to the improvement of science–policy interactions. These interactions are often seen as fruitful but also frequently as problematic. One paper of this special issue focuses on the German part of the Wadden Sea (Döring and Ratter, 2016) and one on both the Wadden Sea and the North Sea, with an emphasis on the latter sea (De Jong, 2016); coastal areas which have strong ecological – and socio-economic – interactions with the Dutch Wadden Sea, and facing similar challenges regarding science and policy.

In this concluding paper, we present some general observations from the different contributions in this special issue about science–policy interactions for coastal management. For this purpose, we will first briefly discuss some relevant theoretical debates, in particular concerning coastal management. Subsequently, we distill some main insights and draw some lessons from the empirical evidence reported in the papers. Eventually we formulate some final thoughts on research and applications.

2. Reflections on science–policy interactions

In coastal management literature and literature focusing on science–policy interactions (e.g., science and technology studies (STS), socio-ecological systems literature, environmental science, applied ecology, policy science, political philosophy), scholars have elaborated on a wide range of questions and approaches related to science–policy interactions. These vary from theoretical studies how to distinguish science from policy (e.g., Gieryn, 1983), to empirical studies about science–policy interactions (e.g., Bremer and Glavovic, 2013), and normative contributions on specific roles of scientists and non-scientists in policy (e.g., Pielke, 2010).

To understand and improve science–policy interactions, the focus is often on the role and nature of science. Ecologists and environmental NGO's complain about the misuse and underestimation of science by policy makers, while social scientists and philosophers stress the need for a more socially robust science, or as they call it, post-normal or Mode 2 science, in contrast to normal or Mode 1 science (Funtowicz and Ravetz, 1993; Jasanoff, 1987; Nowotny et al., 2001). This influential discourse about the role of

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science in modern society defines socially robust science as widely accepted by politicians, stakeholders and citizens as appropriate for the framing and/or solution of a certain societal problem. During the development and implementation or application of socially robust science, relevant actors are experts and scientists from different disciplines, governmental institutions, users of the knowledge and affected people. In addition, knowledge production requires the ability and willingness of all parties, scientific and non-scientific alike, to respect and cope with the knowledge and demands of other parties, looking for common grounds (see also Lentsch and Weingart, 2011). This implies interactive, integrative and reflexive knowledge production, in which basic science is not just applied to a new context, but where the context itself is part of the scientific process. Social robustness does not mean that more traditional scientific standards do not make sense anymore, but it emphasizes the tensions between social and scientific robustness, and between unambiguity versus a certain vagueness to bind together knowledge, values and actors (Van der Windt and Swart, 2007).

A related discourse is expressed by Cash et al. (2003). Their line of thinking is that science (and technology) have a major role to play in sustainable development. Science is “effectively linked to action” if it has an impact on how problems are defined and framed and on the set of alternative options that are considered. This ‘idealised’ role of science in the governance of sustainable development is echoed by other authors such as Van den Hove (2007) and (McNie, 2007).

Cash et al. (2003), in their search for a science for sustainable development, regard credibility, salience, and legitimacy,¹ as key terms which in turn enhances the chance of being used to inform decision-making. A key question however is *who* should promote the production of science that is salient, credible, and legitimate, and *how*? Cash et al. (2003) suggest that institutional mechanisms are needed that fulfil three core functions: communication, translation and “mediation across boundaries” (Cash et al., 2003, p. 8086). These functions can be fulfilled by various organisational arrangements and procedures or by specific boundary organisations. Important conditions for the effective fulfilment of the three functions are that boundary management is taken seriously; that there is dual accountability;² and the use of so-called boundary objects that facilitate the coproduction of knowledge (e.g., models, scenarios, assessment reports; collaborative efforts/outputs). Yet, Cash et al. conclude “How such knowledge systems for sustainability can best be structured remains a question for scholarly research, practical experimentation, and comparative learning” (Cash et al., 2003, p. 8090). This special issue aims to contribute to the need for more empirical research in this area.

Over the last 10–15 years many publications have identified, developed, and assessed a range of ‘knowledge systems’, governance approaches and science–policy interfaces that aim to enhance science–policy interactions. There is a growing body of

empirical literature that addresses specific elements of how to enhance science–policy interactions. A variety of arrangements that aim to bring together science and policy has been described, including among other things scientific advisory bodies such as ICES, boundary organisations that have been established with the main task of forming an interface between science and policy, knowledge brokerage, knowledge co-production or other participatory methods, or principles or requirements for governing the science–policy interactions (e.g., Bremer and Glavovic, 2013; Hegger et al., 2012; Huitema and Turnhout, 2009; Lidskog, 2014; Linke et al., 2014; McNie, 2007; Partidario and Sheate, 2013; Van den Hove, 2007). Evidence of the performance of science–policy arrangements is mixed (see e.g., Koetz et al., 2012; Hegger and Dieperink, 2014). Some cases are considered successful in terms of contributing to the production and use of credible, salient, and legitimate knowledge, whereas others are not or to a lesser extent. Hegger and Dieperink (2014) explain the performance of joint knowledge production arrangements in terms of success conditions regarding the design of such arrangements, derived from the literature (e.g., include a broad range of stakeholders). The literature remains relatively silent about what science–policy interaction arrangements seem to suit what particular situations or problems best (e.g., McNie, 2007). Although contextual factors that render science–policy interaction arrangements successful or not have been addressed in some studies (Runhaar and Driessen, 2007; Hegger and Dieperink, 2014; Van Kerkhoff and Lebel, 2015), a systematic and thorough understanding of the importance of ‘context’ in the feasibility and functioning of science–policy interaction arrangements is still scarce). Several studies focus on two relevant developments within the (European) governance context that affect science–policy interactions. Firstly, politicians, policy makers and civil society actors are ambivalent about the role of science in policy-making. Policy makers are both willing to look for better policy–science interactions and to improve the absorptive capacity of policy institutions for scientific information and advices, and ignore parts of scientific information, link these to certain specific political aims or consider these as just viewpoints (EC, 2009). Secondly, responsibilities changed as a result of the double shift: from national policy to international policy and from national policy to regional authorities, stakeholders and citizens (Keulartz and Leistra, 2007). Consequently, there might be more space for new arrangements for scientific-governance at regional levels, but international legislation might proclaim restrictive legislative frameworks.

3. Insights from the papers of this special issue

The papers in this special issue provide rich empirical evidence by identifying, comparing and designing specific science–policy arrangements. We evaluated their performance in terms of contributing to the salience, credibility and legitimacy of knowledge and in terms of impact on decision-making, and the identification of contextual factors that influence the way in which these arrangements work as well as their outcomes.

3.1. Science and types of arrangements for science–policy interactions

Although the science–policy interaction arrangements and the way science is used and developed differ in a number of ways, the papers and the case studies show the following similarities:

- *The actors and their interactions.* In all cases, scientists and policy-makers were involved. In the Delfzijl coastal zone case (Seijger et al., 2016) and the recreation case (Van der Molen et al., 2016), the direct involvement of other parties in knowledge development contributed to a common accepted outcome. In the cases of

¹ Credibility is defined as the scientific adequacy of information, salience as the relevance to the policy debate, and legitimacy to the perceived degree to which the production of knowledge has been respectful to the values and interests at stake. Of course there may be different interpretations of what salience, legitimacy and credibility mean (Kunseler et al., 2015) and Cash et al. (2003) indicate trade-offs may have to be made between the three criteria.

² This implies that science and policy remain separate to be two worlds. McNie for instance emphasises the careful management of the boundary between science and policy in order to “mitigate[s] the chances that the science becomes politicized or the decision making becoming ‘scientized’” (2007: 32). Other authors however advocate a blurring of boundaries and a hybridisation of the worlds of science and policy, e.g., under the umbrella term of transdisciplinary science (see also Turnhout et al., 2013). In this paper we take an empirical approach and observe that in the Wadden Sea, at least in the cases reported in this special issue, science and policy are predominantly separate worlds.

the establishment of national parks in the German Wadden Sea (Döring and Ratter, 2016) and the case of eutrophication in the North Sea (De Jong, 2016) other actors were excluded from the science–policy interactions. De Jong illustrates how relationships between scientists and policy-makers changed from direct to indirect ones due to the interference of what he calls ‘civil servant scientists’, resulting in a less productive science–policy interaction;

- *Regulation context.* In several papers the need of regulation of science–policy arrangements or organisations is discussed. In some cases we find a formalised and permanent kind of regulation regarding the production, assessment, and use of knowledge (e.g., the boundary organisations Wadden Academy and the Netherlands Commission for Environmental Assessment, NCEA) discussed by Van Enst et al. (2016) or the Appropriate Assessment procedure central to the paper by Floor et al. (2016). In other papers more voluntary, temporary and flexible arrangements for knowledge production and use exist (e.g., the coproduced Environmental Management Systems (EMSs) for ports discussed by Puente Rodríguez et al., 2016).
- *Constructing knowledge and evidence.* In almost all papers knowledge is constructed by scientists and other actors. The construction process, the main actors, the role of evidence and the degree of transdisciplinarity may vary. The EMSs, central to the paper by Puente Rodríguez et al. (2016), are mainly voluntary; the scope of these systems in terms of what indicators are included, the quality of data, and how they are used in port management therefore are mainly determined by the port actors themselves. In contrast, proponents of particular economic activities in the Wadden Sea that are subject to the Appropriate Assessment procedure (paper Floor et al., 2016) face a stricter regime with respect to the delivery of knowledge regarding these activities and, moreover, are subject to a ‘reversed burden of proof’. The paper by Giebels et al. (2016) describes four science–policy arrangements in which ‘evidence’ (which involves more than scientific knowledge alone) plays various roles: providing factual knowledge from one source to inform policy decisions; selecting inputs from a variety of knowledge sources; the ex ante evaluation of policy options; or joint fact-finding and learning. The EMSs discussed by Puente Rodríguez et al. (2016) aim in part to offer transparency to stakeholders outside ports, in order to secure the ‘social license to operate’. The paper by De Jong (2016) shows that knowledge needs can vary according to the stage of the policy process. The cases show differences in the robustness of the knowledge, in the emphasis put on credibility, salience, and legitimacy; in the EMSs analysed by Puente Rodríguez et al. (2016) legitimacy seems a predominant criterion, while in the case of the Appropriate Assessment (paper Floor et al., 2016), mainly credibility and salience (in terms of formal conservation objectives) are important. The three boundary organisations analysed by Van Enst et al. (2016) address different types of problems in science–policy interactions (more ‘operational problems’ such as a misfit in the demand for and supply of knowledge versus more ‘strategic problems’ related to for instance purposefully ignoring particular evidence).

3.2. How do science–policy arrangements work?

The cases show how boundaries between the worlds of science and that of policy – including stakeholders as part of the policy process – are managed in different ways, with different objectives and with different outcomes. Regarding the latter, several papers illustrate that the credibility, salience, and legitimacy of knowledge are no necessary conditions for ‘informing social responses’,

as the literature seems to suggest. The paper by Döring and Ratter (2016) perfectly illustrates this observation. This paper describes a classical arrangement where science informed decision-making. The knowledge at issue seemed credible and salient, and influenced the decisions, but the legitimacy of the knowledge (and the decision) was questioned (see also Van der Molen et al., 2016). This raises the question of what should be the ultimate goal of science–policy interactions: informing decisions, or credible, salient and legitimate knowledge?

In addition, Giebels et al. (2016) state that it is an illusion that in each situation the ideal outcome of credible, salient, and legitimate knowledge can be achieved. In fact, several of the papers in this special issue (e.g., Floor et al., 2016; De Jong, 2016; Van der Molen et al., 2016) reveal trade-offs between credibility, legitimacy, and salience. This raises the question of what a proper balance is between these criteria, and whether that is the same for every situation. In particular, it is unclear how much legitimacy is needed, and in what situations – particularly in cases where the decision as well as the knowledge at issue are contested, as Van Enst et al. (2016) suggest? A related and more fundamental question is what degree of blurring of boundaries between science and policy are acceptable or appropriate in what situations.

How do science–policy interaction arrangements perform? The contributions of this special issue present a variety of science–policy arrangements, but two broad categories of arrangements can be distinguished: classical arrangements, where interaction takes primarily place between scientists and policymakers (whether or not on a formal basis), and the transdisciplinary arrangements. Classical arrangements, as discussed by Döring and Ratter (2016), De Jong (2016), and Floor et al. (2016) are aimed at the production and provision of credible and salient knowledge and these arrangements were successful in influencing decision-making. In addition, the knowledge seemed rather salient and credible (except for the case discussed by De Jong, 2016). Yet, all these cases showed problems regarding the legitimacy of the knowledge as well as the decision at issue.

The cases of Puente Rodríguez et al. (2016) and Seijger et al. (2016) are examples of knowledge production in transdisciplinary arrangements, involving researchers from multiple disciplines, policy-makers and stakeholders. In these cases, legitimacy seems less of a problem. However, it is less clear to which extent these arrangements have produced credible knowledge. Puente Rodríguez et al. (2016) for instance note that the knowledge produced has a subjective character. Van der Molen et al. (2016) points out, that along with the interaction between different stakeholders, the knowledge and related governmental arrangements change and are accepted as credible and legitimate knowledge.

Next to the more classical way of bringing science and policy together by means of communication and organising conferences for scientists, policy-makers, and stakeholders, the use of boundary objects (Star and Griesemer, 1989) is a strategy that often appears in the cases examined. Boundary objects employed include reports, matrices that provide overviews of knowledge needs and available knowledge, models that rank main threats to Wadden Sea ecology, and concepts or notions such as ‘flexible zoning’ (Van der Molen et al., 2016), ‘significant effect’ (Floor et al., 2016), or ‘Heimat’ (Döring and Ratter, 2016). The diversity in boundary objects suggest these have to be fitted to the specific context in which they are employed but also to the aim of the science–policy interaction: providing credible knowledge, salient knowledge, and/or legitimate knowledge.

According to the literature, the translation of scientific findings to policy-makers and stakeholders is an important activity at the boundary of science and policy. What we learn from the papers by

De Jong (2016) and Floor et al. (2016) is that the simplification of science or of the question at issue does *not* work in these contexts. For instance in the North Sea environmental policy process analysed by De Jong (2016), civil servants selected and presented scientific evidence that was considered salient to policy-makers. However, they 'simplified' the evidence and the framing of the eutrophication problem, which may have helped to make decisions but was at the same time criticised by scientists. Floor et al. (2016) made a similar observation. The precautionary principle within the Appropriate Assessment as a basis to decide whether or not new or ongoing activities in the Wadden Sea can be licensed, simplified the decision to a 'yes' or 'no' question. Environmental NGOs did not seem to consider the knowledge basis of not permitting licenses very legitimate, as they seemed to have preferred a debate on the license. It also excluded the opportunity of a more adaptive management and learning approach. This is similar to the 'hand on the tap' approach introduced for regulating gas mining in the Wadden Sea, and is nowadays also applied for other issues such as mussel fishery: the activity would be allowed, but had to be stopped once there would be signals of significant effects. This shows that the decision whether or not something is 'significant' cannot be left to scientists alone, and that it is questionable whether the precautionary principle is always the best way of dealing with uncertainty in (in this case) coastal management.

Regarding the question of how science–policy interactions should be organised, we obtained the following insights from the papers in this special issue. The first insight regards the actors involved. A crucial condition for robust knowledge production seems the involvement of a diversity of actors and their information (Puente Rodríguez et al., 2016; Seijger et al., 2016), who are able and willing to cooperate (Döring and Ratter, 2016). The second insight is that the availability of facilitators who are perceived as neutral is an important condition for fruitful cooperation (Floor et al., 2016; Puente Rodríguez et al., 2016). A third insight concerns the specific relationship between the involved actors. Seijger et al. (2016) show the importance of a close connection between scientists and the evolving project, stimulated by boundary spanners, while Floor et al. (2016) and Puente Rodríguez et al. (2016) emphasize the importance of (active and passive) trust among the participants and facilitators. Also past relationships between the actors (Seijger et al., 2016; Van der Molen et al., 2016) are relevant factors. A fourth insight is that during knowledge production processes, there should be room for experiments, reflection and normative debate (Floor et al., 2016; De Jong, 2016; Van der Molen et al., 2016) and for testing of knowledge on social, cultural, economic, and cultural aspects (Seijger et al., 2016; Döring and Ratter, 2016). The fifth and final insight is that tensions and dynamics can be productive. Institutionalisation of science–policy interfaces, as is shown by De Jong (2016) may even inhibit proper communication between policy-makers and scientists. Moreover, it is sometimes inevitable that conflicts arose, and that knowledge coalitions develop around certain issues (Floor et al., 2016).

3.3. Contextual factors

The performance of science–policy interaction arrangements is enabled and constrained by contextual factors. The papers in this special issue suggest that the 'appropriateness' of arrangements depends on its main purpose: producing credible knowledge, salient knowledge, legitimate knowledge. In Section 3.2 we already observed that trade-offs between these criteria may have to be made.

The papers in this special issue also show that formal arrangements such as Appropriate Assessment (Floor et al., 2016) or the Netherlands Commission for Environmental Assessment (Van Enst et al., 2016) seem adequate for producing primarily credible knowledge that is directly fed into decision-making, although, as said, this may go at the expense of the legitimacy of the knowledge (production process). In more contested situations (or 'unstructured' or 'wicked' problems), however, legitimacy may be more important and other, more transdisciplinary approaches (or organisation – Van Enst et al., 2016) may be more appropriate that leave room for conflicting knowledge claims and a debate about what knowledge should be produced and why. On the other hand, many degrees of freedom may enhance the emergence of conflicting knowledge coalitions (see e.g. Van Buuren and Edelenbos, 2004). Other important contextual factors that emerge from the papers in this special issue as being of importance to the nature and performance of science–policy arrangements are the international political mood (De Jong, 2016), legislative frameworks (see for instance Van der Molen et al., 2016) and political or societal pressure on actors involved to cooperate (Van Enst et al., 2016).

Policy–science arrangements may act and evolve in specific and often dynamic institutional contexts. The protection of the Wadden Sea is regulated by European, national, and local legislation. Other characteristics of the Wadden Sea area are the complex governance and knowledge production processes, in which many actors are involved, the complex interactions between all parties and their resources, and a long history of science–policy interactions. The paper by Van der Molen et al. (2016) emphasises the importance of a co-evolution of the science–policy arrangement and the governance arrangement of the project at issue. Also the paper of Floor et al. (2016) suggests a link between institutional context and knowledge governance.

4. Final thoughts

The papers in this special issue illustrated how diverse science–policy interactions in the Wadden Sea are in terms of their composition, aims and problems that they address, their functioning and their embeddedness in different contexts. The insights and lessons we formulated in this concluding paper are probably illustrative rather than representative of science–policy interactions in other coastal areas or in other subfields of environmental governance, because the importance of the socio-political contexts. We presented a wide variety of formal or less formal arrangements for science–policy interactions, how they work, how they compare one another, and – particularly – how their performance is enabled and constrained by the specific context in which they operate, and what specific factors or conditions are important. We also presented some more general insights into the role of various actors and their perspectives, the need of experiments, reflection and facilitating agencies and the problem of balancing between legitimacy, salience and credibility. Based on our insights we are able to present some preliminary advices for policy makers as well as researchers (see Van der Molen et al., 2015). One of the advices is, because of the importance to include several types of knowledge, to employ participatory processes focusing on producing relevant knowledge that is widely shared by the actors involved or at least by the most involved and affected parties. Furthermore we think a greater exchange of information and experiences will be helpful, between and within certain problem areas. The experiences with for instance 'the hand of the tap' principle, or with knowledge co-creation in the domain of mussel fishery can be very useful for other domains, such as recreation. In fact, we suggest to strengthen the learning capacity of different organisations involved in different aspects and stages

of coastal management. This can be done through adaptive management, in which learning is an explicit goal or during design workshops. In collaborative processes, relevant parties may conduct a step-by-step search for solutions by regularly making connections between knowledge development, decision-making and execution. Finally we suggest to build-in stages of reflection during science related decision making, reflection on the expectations about what role knowledge may and can play in policy-making, and about the relationship between knowledge and values. In addition, reflection on the different interpretations of knowledge or its applications maybe useful to guarantee diversity and discussion.

We encourage more research into the variety and patterns concerning science-policy interactions. Conceptual work should be performed on the meaning of and the relationship between salience, legitimacy and credibility and between these criteria and the impact of science on decision-making. The present empirical literature tends to focus mainly on specific science-policy interaction arrangements and largely ignores the context in which they emerge and function. We also invite other scholars to complement our work with comparative analyses of other science-policy interaction arrangements in coastal areas and elsewhere, in order to come to a better understanding of these processes and eventually to have a better idea on 'what works where and why?' concerning science-policy interactions.

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