SCIENCE–POLICY INTERFACES FOR ENRICHED ENVIRONMENTAL DECISION-MAKING:

A RESEARCH INTO THE STRATEGIES OF BOUNDARY WORK, ILLUSTRATED BY CASE-STUDIES IN THE DUTCH WADDEN SEA

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Kennis–beleid interfaces voor verrijkte milieubesluitvorming
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geïllustreerd met cases uit de Waddenzee

(met een samenvatting in het Nederlands)

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TABLE OF CONTENTS

List of figures

List of tables

Voor Friso en Olivia

Chapter 1

INTRODUCTION

1.1 | Science–policy interactions for sustainable development

For the promotion and achieving of sustainable development, the production and use of scientific knowledge is of great importance when informing policy-making processes (Cash et al., 2003). However, in reaching sustainable development, various challenges can be encountered which negatively influence the interactions between science and policy and thus hamper the informing of policy-making processes. First of all, addressing unsustainable practices and situations confronts society with enormous and complex tasks. Secondly, the fulfilment of these tasks takes place in a multi-actor, multi-level and multi-sector setting, increasing the procedural complexity of policy-making processes. Finally, the use of science is not only crucial but also complex, since science is often contested, or is surrounded by uncertainties. The combination of these challenges results in the interactions between science and policy often being surrounded by difficulties such as the strategic use and production of knowledge, which frustrates the handling and solving of unsustainable practices and situations.

This dissertation addresses these often troubled interactions between science and policy and the possible ways in which they can be improved or enhanced by means of science–policy interfaces. It has often been suggested that these interfaces (e.g. boundary organisations or knowledge brokers) enhance these multifaceted interactions by promoting and facilitating the production and use of credible (scientifically adequate), legitimate (unbiased and respectful of stakeholders' divergent values and beliefs) and salient (relevant to the need of decision-makers) knowledge (e.g. Cash et al., 2003). However, there appears to be little empirical evidence on which science–policy interfaces are most useful in solving which science–policy interaction problems. Via this dissertation, I aim to provide a better understanding of science–policy interfaces by providing conceptual and empirical clarity on how, when and why they work. Before doing so, however, it is necessary to further explain the three previously discussed challenges in reaching sustainable development, to clarify the setting in which science-policy interactions take place.

1.1.1 Substantive complexity: the sustainability challenge

The 15 years between the publication of Limits to growth in 1972 and its political response Our common future by the Brundtland Commission in 1987 can be understood as the period in which the concept of sustainable development ("development that meets the needs of the present generation without compromising the ability of future generations to meet their own needs") originated. Although the process was slow, at the turn of the millennium, in response to (amongst others) a continuously growing environmental crisis (e.g. climate change, global warming) the international community (of policy-makers, scientists and society) adopted sustainable development as a leading development model (Waas et al., 2011). However, in recent decades, the issues related to sustainable development have become increasingly complex, for various reasons related to the manner in which the concept of sustainable development can be approached. In their article, Waas et al. present an extensive literature review from which they distil four fundamental principles on sustainable development: 1) the normative principle; 2) the equity principle; 3) the integration principle; and 4) the dynamism principle (2011:1645). In order to explain why unsustainability confronts society with complex tasks, I will focus on two of these principles: the normative principle, and the integration principle.

The normative principle sees 'sustainable development' as a socially constructed or subjective term: "[S]ustainable development always implies societal and normative choices, which are ultimately based on the values we maintain" (Waas et al., 2011:1645). The problem this approach brings with it is that each actor (e.g. scientist, policy maker, private individual, societal organisation) might have its own perspective on what 'sustainability' means. Clearly, such differences in understanding and framing can complicate the interactions between actors. The integration principle is explained from the perspective that sustainability should "harmoniously integrate various traditional (including socio-economic and institutional) development objectives with environmental ones." (Waas et al., 2011:1646). In the early years of sustainability thinking, it was thought that a desired ecological value could be established, a formal indicator would measure the current situation as opposed to the pre-industrial situation, and differences could be detected. In the 1990s, however, social scientists and economists started to interfere: they argued that more factors should be included in the evaluation of sustainability (De Vries and Petersen, 2009). Yet sustainable development is a much more 'holistic' process, in which socio-economic development and environmental development are linked and interdependent (Waas et al., 2011), and should therefore be integrated. The difficulty this brings along, however, is that a balanced and equal integration between environment, economy and society is only possible in theory. In practice, different perspectives often give greater priority to one or two of these three (Giddings et al., 2002). Furthermore, these different domains entail often opposing norms and values which complicate integration and thus hamper sustainable development.

Although the foregoing presents not even the tip of the iceberg of the literature on sustainable development, it does, however, briefly demonstrate why issues on sustainable development can cause problems in the interactions between science and policy: the integration between, for example, the ecological and economic domains could cause difficulties due to contradictory norms and values, but so too could the different understandings of concepts such as 'sustainable', 'sustainability' and 'development'. Added to this, scientific knowledge from one domain might have negative implications for other domains and therefore hamper its possibility to enrich decision-making processes and thus policy.

1.1.2 Shift from government to governance

Another, more process-oriented, change which contributes to the problematic interactions between science and policy (or scientists and policy-makers) is the apparent shift from government to governance. In their article on the concept of 'governance' Van Kersbergen and Van Waarden (2004) give a thorough literature review of nine different approaches to the meaning of governance. They conclude, however, that all these approaches have major characteristics in common: the approach of governance is polycentric (instead of unicentric), networks play an important role in organising relations between autonomous but interdependent actors. Furthermore, "the formal government may be involved, but not necessarily so, and if it is, it is merely one – albeit an important – actor among many others" (2004:152). Also, there is emphasis on processes of governing, such as negotiation, accommodation, and cooperation. Lemos and Agrawal define governance as a process which includes not only actions of the state, but also "encompasses actors such as communities, businesses, and NGOs" (2006:298). This shift from government to governance is attributed to, on the one hand, the clear limitations

of the governing processes by the state, and on the other hand, to the increasingly important and influential role private sector organisations and civil parties claim. Together with growing globalisation, privatisation and individualisation, a new manner of governing was required. These changed relations between the government and society have resulted in a 'multi-actor' and 'multi-level' setting in which policy decisions are made. Furthermore, as Runhaar et al. (2006) state, this setting is also 'multi-sector' due to the integration of environmental objectives in non-environmental governance.

In addition to having benefits, such as more inclusive decisions, this multi-actor, multi-level and multi-sector context in which issues of sustainable development have to be addressed brings challenges which influence the interactions between science and policy. For example, in line with the normative and integration principles on sustainable development discussed previously, Runhaar et al. (2006) argue that in relation to the multi-sector context, policy-makers have to attempt to optimise three values (i.e. ecological, social, and economic) at the same time. Furthermore, the multi-actor policy context causes issues relating to (for example) successful policy implementation. Resources (such as information and support) "tend to be spread over actors other than (central) government. (…) Given the state's dependency on these actors, governments often have to negotiate with them and engage them in processes of policy development, implementation and evaluation (…). Yet the actors from various domains typically perceive a given problem differently." (2006:34,35). So, consequently, the multi-actor context could generate conflicting values, which in their turn could impact the acceptance of knowledge. The knowledge produced and used, which is to inform a policy-making process, should acknowledge and justify the ambiguity and the plurality of values: knowledge should therefore not only be credible, but also legitimate and salient (Cash et al., 2003). Credibility in this sense is to be understood as "the scientific adequacy of the technical evidence and arguments" (Cash et al., 2003:8086). 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" (ibid). And finally, salience is defined as "the relevance of the assessment to the needs of decision makers" (ibid). Finally, in relation to the multi-level context, the development and use of knowledge can also be complicated, because the knowledge-based procedures of one level, might not match the decision-making processes on another level. For example, the EU develops multiple directives on various environmental subjects. These directives are legislative acts requiring member states to achieve a particular result but not stipulating the means of achieving that result. Examples of such directives are the European Water Framework Directive, and the Birds and Habitat Directives. All member states are required to develop and implement policies based on these directives. Floor et al. (2016) discuss how in 2011 a permit was issued for the World Championship powerboat races in the Dutch Wadden Sea after an assessment of significant effects (under the Dutch Nature Conservation Act such an assessment is mandatory when applying for a permit). In their article, they show how knowledge-based procedures do not necessarily link to the local context, or in other words, how the multi-level context could complicate the development, use and acceptance of scientific knowledge.

Based on this brief explanation of the concept of governance, it can be argued that although governance has a more inclusive, participatory and horizontal approach, the multi-actor, multi-level and

multi-sector characteristics of governance, which bring with them a variety of interests, 'truths' and processes, contribute to the complexity of interactions between science and policy.

1.1.3 The changing demands of and for science

A consequence of the foregoing discussion on the multi-actor and multi-level context in which the debates on sustainable development take place is that the demand for knowledge changes. Classic policy science assumes that "political goals can unproblematically be translated into measurable quantitative terms, and that the policy process is a linear, rational process conducted top–down by a decision-making authority" (Wesselink et al., 2013:3). This line of reasoning conceptualised the interactions between science and policy as linear and unidirectional. However, this perception of linear relations between science and policy and of the linear development of science has changed. The interactions between science, policy and society are complicated. The scientific messages on issues such as climate change are highly complex: a variety of scientific disciplines is required to solve the resulting societal problems (Driessen et al., 2010). The level of uncertainty introduced by problems such as climate change further adds to this complexity. Issues that deal with sustainable development are substantively complex due to the amount of uncertainties, the often problematic interactions between scientific disciplines, the short-term focus of society, and the complicated connections between the social and physical systems. To address these issues, in recent decades the idea of developing science in a more collaborative manner between various actors has flourished. The most important reason for this interest is "that knowledge is of limited use to practitioners when researchers develop knowledge in relative isolation from the societal context where the problem should be solved" (Seijger, 2015:4). Seijger describes this shift as the "opening up of processes of knowledge production", and links to it concepts such as Mode 2 knowledge (Gibbons et al., 1994), post-normal science (Funtowicz and Ravetz, 1993), transdisciplinary research (Pohl, 2005), joint knowledge production (Hegger et al., 2012) and knowledge co-production (Edelenbos et al., 2011). (For a complete overview: see Seijger, 2015.) Although all these concepts might differ in their characteristics, they share the idea that in modern science room should be created for questions (including on policy), lay and expert knowledge, and the interests of stakeholders. Furthermore, these stakeholders (such as policy-makers and other societal actors) should be given the opportunity to participate during the research, for example by reflecting on the preliminary results.

However, as noted above, the various actors involved in governance processes on sustainability issues often have different interests, beliefs and values. And more often than not, these interests are backed up by knowledge (which could be understood as scientific in its fundamental form or its strategic and application-rich form, but also as local, indigenous or implicit knowledge: Driessen et al., 2010). Thus on sustainability issues, science is no longer 'speaking truth to power', due to the complexity of topics such as climate change. "Scientific knowledge on climate change, its causes, mechanisms, and effects, as well as about the strategies for mitigation and adaptation, is dispersed and even fragmented – across disciplines, over places and countries, among government agencies, the market, and civil society" (Leroy et al., 2010:24). However, as Cash et al. (2003) argue, in order for science to have an impact on decision-making processes, it has to be perceived as credible, legitimate and salient by the actors involved.

1.1.4 Conclusion

In summary, on the one hand, there is the large substantive complexity of the issues that are addressed in sustainable development. On the other hand, there is a more process-oriented complexity to be noted, due to the shift from government to governance and the accompanying increasing number and influence of all actors involved. Finally, and as a consequence, the demands made of science and for science have changed: science has to be not only credible, but also legitimate and salient to all actors involved. These three challenges, thus, contribute to the complexity of the interactions between science and policy.

The next section of this introductory chapter will discuss science–policy interfaces by explaining what these interfaces are, and in relation to these interfaces, the defined problem and knowledge gap my dissertation will address. The third section will discuss the aim and questions that led the research for this dissertation, and will explain the scientific and societal relevance of this research. The fourth section will present the empirical focus (the Dutch Wadden Sea) that is central to this dissertation, outline the structure of the dissertation, and briefly explain the research methods used. The chapter will end by outlining the rest of the dissertation.

1.2 | Science–policy interfaces explained

As briefly touched upon in the previous section, the scholarly literature suggests that science–policy interfaces (hereafter SPIs) can be considered to enhance the interactions between science and policy, with the ultimate aim of enriching decision-making processes. In the last decade, the literature on, for example, environmental governance, increasingly placed emphasis on these science–policy interfaces. From this expanding literature it is becoming apparent that in order for science to have an influence on decision-making processes (and thus enrich these processes) there is an increased need for science to be perceived as credible, legitimate and salient by all actors involved. In turn, this leads to more and more emphasis on enhancing these interactions between science and policy. In this body of literature, SPIs often take central stage (e.g. Heink et al., 2015; White et al., 2010; Cash et al., 2003). But what are these SPIs? Based on the reviewed academic literature, two complementary approaches can be identified: on the one hand, an SPI can be considered as a physical or virtual place where the boundaries between science and policy meet or connect (or do not, resulting in a gap between science and policy; e.g. Wesselink et al., 2013; Guston, 2001). On the other hand, SPIs are considered to be solutions to various science–policy interaction problems (e.g. Hegger et al., 2012; Van den Hove, 2007). In order to develop the definition of the problem regarding SPIs that underpins this dissertation, a brief explanation of these two approaches is required.

The first approach finds its starting point in the word 'interface'. The Oxford Dictionary defines interface as "a point where two systems, subjects, organisations, etc. meet and interact". Janse used this definition as a starting point for his definition of an SPI: "the point at which science and policy meet and act on each other" (2008:184). In relation to this, Gulden (2003) states that the fundamental

concept of an interface is a boundary between two systems which are typically quite different. Wesselink et al. (2013) discuss scientists who work at the SPI. Guston (2001) describes so-called boundary organisations which work at the SPI. These statements or manner of framing already make it apparent that this approach identifies the interfaces as a boundary between two separate worlds (science and policy), where you can act or work to enhance the interactions between science and policy.

The second approach conceptualises SPIs as entities (such as organisations or individuals) which enhance science–policy interactions, by means of "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution and co-construction of knowledge with the aim of enriching decision-making. They are implemented to manage the intersection between science and policy." (Van den Hove, 2007:807). First of all, Van den Hove addresses SPIs in her definition as a means to an end: the use of SPIs should ultimately result in enriched decision-making. Although, in general, the literature does not explicitly explain what is meant by 'enriched decision-making', in this dissertation it is understood to be concerned with processes in which knowledge is used to gain a clearer picture of the problem-setting, underpin and implement policy and management measures, explore policy options, inform policy evaluations, and be used in learning processes between policy-makers, scientists and stakeholders (e.g. Van Tatenhove et al., 2016; Van de Riet, 2003). Van den Hove states that the interfaces should allow for "balancing issue- and curiosity-driven science and their articulation in knowledge for decision-making processes" and for "a reemphasis of the role of scientific explanation or understanding the issue, exploring options for action, and building justifications" (2007:815). Furthermore, she ends her article with a set of key research questions related to SPIs that give a clear overview of what an SPI should entail. To paraphrase Van den Hove, and link her approach to the framework of Cash et al. (2003), the following actions and characteristics could be ascribed to SPIs:

- enlargement and reinforcement of scientific quality (increased credibility)
- development of transdisciplinary research methods (increased credibility and legitimacy)
- translation of science-relevant knowledge into policy-relevant knowledge, and vice versa (increased salience)
- the inclusion of a diversity of knowledges and intelligences (increased credibility and legitimacy)
- further dissemination of scientific knowledge, specifically targeting the various potential user groups (increased salience)

In this dissertation, I understand SPIs to – hypotheticaly – be entities which develop and implement processes of social interaction, with the aim of enhancing the interactions between science and policy, and ultimately enriching decision-making processes (see Figure 1.1).

The boundaries between these two arenas are far less fixed than the first approach to SPIs would suggest, especially nowadays, when the decision-making processes involve so many more actors, due to the shift to governance. Of course, this will not be the first research to investigate SPIs. As stated earlier, the body of literature on this topic is expanding rapidly. Literature on boundary organisations,

for example, finds much of its origin in the work of Gieryn on boundary work (1995, 1999) and in the work of Guston (2001). Boundary organisations are often described as intermediaries which place themselves between the (environmental) science and policy-making arenas (e.g. Boezeman et al., 2013; Gulbrandsen, 2011; Hellström and Jacob, 2003; Cash, 2001; Guston, 2001). Besides these theoretical approaches, there are individual empirical case studies into, for example, the Dutch Delta Committee (Boezeman et al., 2013), and the Netherlands Environmental Assessment Agency (Pesch et al., 2012). However, as I will demonstrate in Chapter 3, these cases do not systematically discuss to what science–policy interaction problems boundary organisations respond, and why and how they do so. Just as in the case of boundary organisations, there is a range of articles on individual mediators (e.g. Wittmayer and Schäpke, 2014; Turnhout et al., 2013; Kinnie and Swart, 2012; Meyer, 2010; Pielke, 2007). As the literature review on knowledge brokers ("persons who facilitate the creation, sharing, and use of knowledge" (Sverrisson, 2001, as cited in Meyer, 2010)) in Chapter 4 will demonstrate, although various authors discuss knowledge brokers, little attention appears to have been paid to the specific goals and strategies they use.

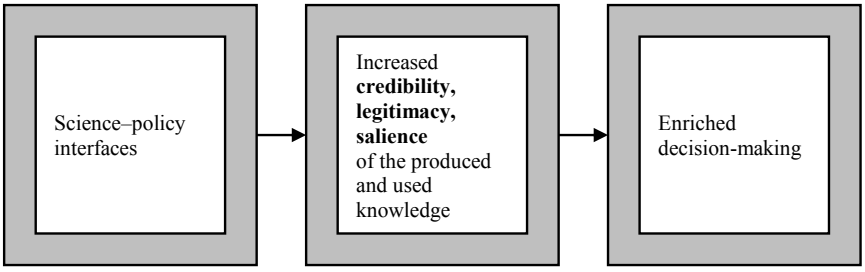

Figure 1.1. Hypothetical flowchart of the performance of science–policy interfaces in achieving enriched decision-making

Finally, understanding SPIs as a process of boundary work enables me to critically review which problems arise with the interactions between science and policy, and how SPIs aim to enhance these interactions and to enrich decision-making processes. I must emphasise that Chapters 3 and 4 of this research predominantly focus on the strategies used, to what extent the interactions between science and policy change due to the interventions of SPIs, and how SPIs influence the credibility, legitimacy and salience of the knowledge produced and used. Chapter 5, on boundary objects, discusses whether the researched boundary objects have enriched decision-making processes and, if so, to what extent.

1.3 | Research aim, questions and relevance

1.3.1 Problem definition and general aim of dissertation

The previous two sections have pointed out the relevance of studying the interactions between science and policy, and science–policy interfaces. They showed that the issues concerning sustainable development are becoming increasingly complex, due to the multifaceted character of the field: multiple scientific disciplines and a broad array of actors. Furthermore, the shift that has taken place from government to governance has made the playing field in which decisions are being made more complex, due to the broad spectrum of stakeholders (and thus interests) involved and the multi-level character of the field. The current scientific perspective is that the need for science has also changed, from a more linear perspective in which the credibility of science was of importance ('speaking truth to power' (e.g. Hoppe, 1999)) to an open knowledge development process in which scientists, policy-makers and other stakeholders are all involved, ideally resulting in not only credible, but also legitimate and salient knowledge. Combined, the multitude of pressing environmental issues, disciplines involved, stakeholders, conflicting interests, 'truths' and scientific insights can create multiple problems with the interactions between the actors involved, which frustrates and obstructs decision-making processes. The field in which science and policy (or scientists and policy-makers) interact has thus become complex in various facets.

This complexity leads to an array of difficulties science–policy interactions encounter. They range from 'simple' issues such as speaking different languages, or policy-makers experiencing difficulties obtaining scientific information, to more strategic issues: misinterpretation (deliberate or unintentional) of scientific results, or scientists advocating certain results or even certain policy directions (as an Issue Advocate (Pielke, 2007)). At the same time, the issues relating to sustainable development are becoming increasingly pressing. The use of resources is constantly being debated politically and publicly. The complexity these issues entail, due not only to the multi-actor and multi-level playing fields but also to their substantive complexity, leads to a pressing need to further understand these interaction problems and how to react to them.

As stated previously, both the scientific literature and practice acknowledge this complexity, and link the diminishing of these troubled interactions to the interventions or mediations of SPIs. However, there are no clear overviews of these interaction problems and of how and to what extent in practice SPIs contribute to solving them by increasing the credibility, legitimacy and salience of the knowledge produced and used. Without further insights into these matters, it becomes difficult to effectively anticipate these interaction problems and the need to enrich decision-making processes. The aim of this dissertation is therefore:

To increase our understanding of the interaction problems science and policy face, and the extent to which science–policy interfaces could contribute to eliminating these problems and enriching decision-making.

This dissertation intends to achieve this aim in three stages. The first stage involves a thorough literature analysis on the problematic interactions between science and policy, and attempts to categorise these problems. In the second stage, three types of science–policy interfaces are explored theoretically and empirically: boundary organisations, knowledge brokers and boundary objects. Finally, comprehensive conclusions on the research questions (posed in the following section) are drawn, and I reflect on the aim of this dissertation.

1.3.2 Research questions

Resulting from the overarching aim of this dissertation discussed above, the main research question is:

How do science–policy interfaces such as boundary organisations, knowledge brokers and boundary objects contribute to enhancing the interactions between science and policy with the aim of enriching decision-making processes?

The overarching research question will be addressed by means of a set of sub-questions:

SRQ1. What science–policy interaction problems are recognised in the scholarly literature, and how can they be categorised and characterised?

The aim of this theoretical research question is to develop a typology in which the array of theoretically discussed interaction problems between science and policy will be categorised into 'meta-problems'. Furthermore, an overview will be given of the possible science–policy interfaces which can be used or implemented to address these issues. This question will be addressed in Chapter 2 of this dissertation and reflected upon in Chapter 6.

SRQ2. In which cases and/or circumstances are science–policy interfaces used to enrich decision-making processes?

This research question addresses the link between SPIs and the science–policy interaction problems addressed in Chapter 2. Although the scholarly literature on SPIs discusses empirical examples of various interfaces, it rarely investigates to what extent specific types of interfaces focus on specific interaction problems. I argue that in order for practitioners to understand and act upon the complex relations between science and policy, further understanding of which interface to use in which situation would be of benefit. This question will be empirically addressed in Chapters 3, 4 and 5. Conclusions relating to it will be drawn in Chapter 6.

SRQ3. By means of what strategies do science–policy interfaces aim to enrich decision-making, and to what extent do they succeed in that respect?

The aim of this question is to understand which strategies SPIs use to enable the interactions between science and policy with the goal of enriching decision-making processes, and to what extent these strategies increase the levels of credibility, legitimacy and salience of the knowledge produced and used. Do the different SPIs use different or similar strategies? And if in practice SPIs predominantly focus on enhancing the production and use of scientific knowledge between the various stakeholders,

is this reflected in the strategies as well? Or do SPIs also encounter other difficulties (procedural or otherwise) which force them to develop strategies more focused on the process side of the interactions, rather than on the substantive side. This research question will be discussed in Chapters 4, 5 and 6.

SRQ4. What lessons can be drawn from the analysis and evaluation of individual science–policy interfaces in terms of general recommendations for the science and policy communities, and the opportunities for and limitations of combining science–policy interfaces?
Using this research question, I aim to build upon the three empirical case studies to develop general recommendations which can proactively guide situations in which there are science–policy interaction problems and thus a need for SPIs. Furthermore, this question also addresses whether SPIs can complement and reinforce each other, and if so, to what extent. This question will be addressed in Chapter 6.

1.3.3 Scientific relevance

The scientific relevance of this research lies in the contribution I aim to make to the scientific literature on science–policy interactions and SPIs related to sustainability issues, ranging from environmental governance and environmental sciences (e.g. McNie, 2007; Pielke, 2007; Cash et al., 2003) to science and technology studies (e.g. Jasanoff, 1990). The work on boundary work will in particular serve as the foundation of this research. By conducting empirical research on specific SPIs, our understanding on why and how these interfaces work in practice will be deepened. Furthermore, this research can be understood as one of the first attempts to systematically analyse and compare multiple boundary organisations, knowledge brokers and boundary objects. The existing literature on these topics mostly concerns individual cases (e.g. Floor et al., 2016; Döring and Ratter, 2015; Boezeman et al., 2013; Pesch et al., 2012).

1.4 | Empirical focus

1.4.1 The Dutch Wadden Sea

In the first section, I discuss the problematic interactions between science and policy in relation to sustainable development issues such as climate change, sea level rise, and loss of biodiversity, which include a broad range of actors, the change in the demands of and demand for science, and the changing stakeholder landscape. In order to research SPIs in relation to interaction problems which find their origin at least partly in the issues discussed here, the empirical research into different SPIs will be illustrated by case studies in the Dutch Wadden Sea: an area in which complex policy questions regarding sustainability issues exist and where various SPIs can be identified which aim to enhance the interactions between science and policy.

The Wadden Sea is a shallow estuarine sea considered to be a unique ecosystem due to its tidal dynamics: during low tides, large parts of the Wadden Sea fall dry and these tidal flats in particular

contain many shellfish, an important food source for migratory birds. It stretches from the Dutch town of Den Helder, to the town of Esbjerg in Denmark (see Figure 1.2), and is an area of specific national and international interest. In 2009 it was designated a UNESCO World Heritage site, because of (amongst others) its unique scenic value and the specific characteristics which make it an exceptional place as a staging post for many migratory birds. However, the area also hosts a number of industrial zones which make the Wadden Sea of great economic value as well. Industries such as gas extraction, transport, fisheries, salt extraction and recreation are of great importance to the area. The Wadden Sea can therefore serve as an example of a coastal area which is extensively used for a broad range of purposes: from industry to recreation. These activities, however, cause pressure on the ecosystem: coastal erosion, and loss of habitat are some examples of this (Van Tatenhove et al., 2016). Governing this area sustainably by finding a balance between the economic activities and use of resources on the one hand and, on the other, the protection of this unique ecological site, is one of the major challenges the Wadden Sea area faces (see for example Textbox 1).

Figure 1.2. The Wadden Sea World Heritage Site (derived from www.waddensea-worldheritage.org)

The production of scientific knowledge on the Wadden Sea is intensive. Various research institutes devote large parts of their research projects to this area, on themes ranging from geoscience and ecology, to history, economics and climate. However, as Runhaar and Van Nieuwaal show in their article (2010) on, for instance, the topic of gas extraction and the mechanical cockle fisheries in the Dutch Wadden Sea, the studies that "assessed the ecological effects of cockle fisheries and gas mining were disregarded or used strategically by stakeholders and decision-makers" (Runhaar and Van Nieuwaal, 2010:239). As they explain in their article, attempts were made to correct this: in relation to the cockle fishery debate, amongst others by creating an independent audit committee to assess the validity of the findings. However, "no consensus was reached on the findings of the study. Proponents and opponents of shellfish fisheries took certain elements of the report to justify their arguments – strategically making use of the uncertainties that were still present about the ecological

effects of shellfisheries." (2010:243). This is just one example of the issues related to the (changed) demands of and demand for science. The ways in which reports are disregarded, and uncertainties strategically used can have negative impacts on the interactions between science and policy, and are part of everyday life in the Dutch Wadden Sea area.

In relation to the multi-level and multi-actor contexts which could cause problematic interactions between actors, Van Nieuwaal (2011) gives an extensive introduction to the conceptual playing field that is the Dutch Wadden Sea. In his dissertation on mechanical cockle fishery and gas extraction in the Dutch Wadden Sea, Van Nieuwaal focusses specifically on the area's regulatory framework (which includes regulations such as the Nature Protection Act, the Flora and Fauna Act, the Birds and Habitat Directives and the Wadden Sea Key Planning Decision), and gives an overview of the network of actors ranging from industries, to government (national, provincial, and local), environmental agencies (e.g. the Wadden Association, Society for the Protection of Birds, Nature Monuments, Greenpeace), research institutes (e.g. the Royal Netherlands Institute for Sea Research, University of Groningen, Wageningen IMARES), the Wadden Sea Council and the Council of State). From this very brief summary of Van Nieuwaal's analysis it can already be concluded that the institutional landscape of the Dutch Wadden Sea is highly complex. This complexity of opposing interests between economic stakes and ecological interests, the vast amount of scientific research, number of governance structures and processes and the attention already being paid to the improvement of science–policy interactions makes the Dutch Wadden Sea a fit empirical area for research on SPIs (Runhaar et al., 2016). To this it needs to be added that the Wadden Sea serves as an empirical focus in this research. It goes without saying that there are similar places in the world with similar issues, where research on SPIs would be similarly interesting.

1.4.2 Societal relevance

The societal relevance of this research is multifaceted. First of all, by researching and academically addressing how SPIs can contribute to enhancing the relations between science, policy and society, I wish to enhance awareness of these issues and possibilities among scientists and policy-makers. By actively assisting both scientists and policy-makers to understand the obstacles and also the possible solutions, this research can serve as guidance when proactively responding to possible interaction problems. Secondly, by proposing recommendations for both the field of science and the field of policy, possible guidance into how to manage the interactions between science and policy is given, which could be of use for practitioners working at this boundary, particularly (but not exclusively) in the Dutch Wadden Sea region. Finally, due to its focus on the Dutch Wadden Sea, this research will demonstrate that there are also contextual factors which influence decision-making processes other than only the interactions between science and policy. For all actors involved, this awareness is of importance.

Textbox 1. Science–policy interfaces addressing governance challenges in the Wadden Sea

Although often discussed in the scholarly literature on science–policy interactions in the Wadden Sea region, the case of the gas mining and cockle fishery activities remains a good example of how scientific knowledge concerning the impact of these activities on the ecological state of the Wadden Sea became contested due to the broad range of stakeholder interests. Articles by Runhaar and Van Nieuwaal (2010), Floor et al. (2013) and the dissertation by Van Nieuwaal (2011) are examples of this literature. Briefly, this case played out as follows. At the end of the 1990s, after decades of gas mining in and around the Wadden Sea, the Dutch government refused to approve new gas mining. Even though independent non-partisan scientific studies had demonstrated that subsidence due to mining had no significant morphological or ecological effects, the political lobbying by environmental NGOs, who argued that in this 'untouched' nature area there was no room for new industrial activities, prevailed. Phrases like 'Hands off the Wadden Sea' and 'No drilling in case of doubt' were used by political parties in the debate on further gas mining.

Meanwhile, substantial scientific research was conducted on the ecological effects of mussel and cockle fishery activities (again, independently), proving that the mechanical harvesting of these shellfish would result in a loss of e.g. sea grass fields, mussel beds, sediment and fish stocks. These activities, however, were allowed to proceed. So there were two activities, with opposing policies and scientific insights which did not did not justify either the policy of prohibiting new gas mining or the policy of allowing cockle fishery. At the start of the new century an alternative discourse was advocated: allow gas mining and use part of the revenue to restore the Wadden Sea ecology. Knowledge broker Wouter van Dieren and his company IMSA, in fact a boundary organisation, started discussions with stakeholders, mobilised politicians and organised meetings with and for decision-makers, stakeholders and scientists. In doing so, they launched an inclusive process in which there was room for a broad range of stakeholders. Furthermore, they developed a model to identify and rank ecological risks in the Wadden Sea. This model, a boundary object, showed, as was expected, that one of the main threats to the Wadden Sea ecology was the cockle fishery. Eventually, in 2004, the Dutch Parliament agreed to allow new gas mining (under the condition of the 'hand on the tap' principle), and to use the revenue this raises to buy out the mechanical cockle fisheries.

This brief example demonstrates the value of interactive science–policy relations, but also addresses the complexity of the Wadden Sea region: opposing interests, multiple stakeholders and multi-level governance.

1.5 | Research design, methods and selected case studies

This research was conducted following the research design shown in figure 1.3.

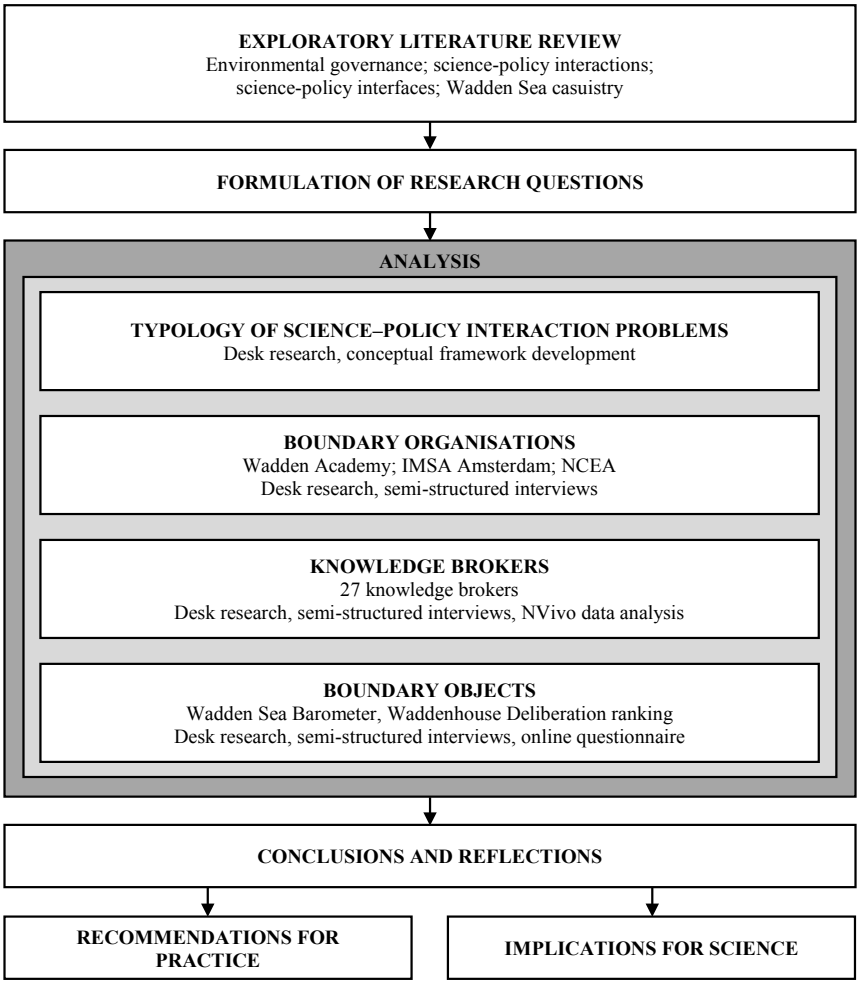

Figure 1.3. Overview of the full research design

In the first stage of the research I conducted an exploratory literature review, to capture the width and depth of science – policy interaction problems and SPIs discussed in the literature on environmental governance. Simultaneously I held exploratory interviews and informal conversations with an array of people – scientists, policy-makers and practitioners – in order to create a better understanding of the field and of the issues underpinning my research. This led to the development of the research questions presented in section 3 of this chapter. Following the formulation of these questions, the second

stage of this research entailed the development of a typology of possible science–policy interaction problems, based on a thorough literature review of SPIs, science–policy interactions and environmental governance. This typology, presented in Chapter 2, served as the foundation of the three empirical case studies, presented in Chapters 3, 4 and 5. Finally, in Chapter 6 the final conclusions and reflections are presented, and the recommendations this research yielded for practice and science.

1.5.1 Data collection and methods

In order to answer the research questions, empirical research was carried out using a mixture of research methods. This application of multiple methods increases the validity of research, because the data is collected from multiple sources and analysed in various ways (Onwuegbuzie et al., 2011), in a procedure also known as triangulation (Bryman, 2004). Validity and generalisability are considered to be important criteria for establishing the quality of scientific research. In qualitative research, these criteria are less straightforward than they would be in quantitative research, due to the difference in how the research is conducted. This, however, does not mean qualitative research cannot meet these criteria. For example, with regard to validity, in this research I aimed to collect data on a specific case (for example, the boundary organisations) from different perspectives (interviewees). Gathering insights into a specific organisation via the different individuals involved made it possible to obtain an inclusive picture of the organisation concerned. Additionally, I aimed to create respondent validation (Bryman, 2004:274) by offering each of the interviewees the opportunity of receiving the transcript of the interview, or a summary. Furthermore, during the interviews, questions for clarification were asked, to limit confusion and misinterpretation of answers. Finally, in relation to the generalisability of qualitative research Bryman argues: "whereas quantitative researchers want their findings to be generalizable to the relevant population, the qualitative researcher seeks an understanding of behaviour, values, beliefs, and so on in terms of the context in which the research is conducted" (2004:287). As I will argue further in the concluding chapter of this dissertation, I believe this research provides both the scholarly literature and practice with further understanding of the difficult relationship between science and policy within the field of environmental governance, and insights into how SPIs can contribute to the enhancement of these interactions.

The overall research applied four main research and data analysis methods, which are briefly described here. Since this dissertation is a combination of published and submitted articles which can be read individually without knowledge of the preceding or subsequent articles, a more elaborate explanation of the different methods (per case study) can be found in the individual chapters (2 – 5).

Desk research | An extensive literature review was performed in all cases. This was done to gain theoretical insights into concepts such as boundary organisations, and to review the empirical research already done on these concepts. Furthermore, in the case of the SPI 'boundary organisation', a content analysis of documents, reports, websites and news articles was also carried out.

Interviews | Almost 50 semi-structured (for overviews per case study: see Appendices), in-depth interviews were conducted during this research. The interviews provided insights into the interaction

problems between science and policy they come across, the goals and strategies of the researched SPIs, and other obstacles in decision-making processes. The interviewees were selected by researching websites and reports, and through snowball sampling. The interviews were digitally recorded, transcribed and stored by the researcher[1]. Interviewees were assured of confidentiality and anonymity.

NVivo data analysis | For the case of 'knowledge brokers', all transcribed interviews were coded for qualitative data analysis, using the software program NVivo. This happened in two stages: first deductively, based on my conceptual framework. The second stage was inductive coding based on the quotes in each category. For further explanation of this method, see Chapter 4.

Online questionnaire | For the 'boundary object' case (Chapter 5) I conducted two online surveys via questionnaires. Statements were posed regarding the development, validation and presentation of the specific ranking system. Respondents were able to respond to the statements by means of a 6-point sliding scale. The selection of respondents was based on the main documents on the ranking systems: all people involved (48 in the case of the Waddenhouse Deliberation ranking; 21 in the case of the Wadden Sea Barometer) were asked to fill in the questionnaire. The data arising from this was analysed quantitatively and qualitatively.

Further details on the methods used for each of the cases are described in the empirical Chapters 3, 4 and 5. In the appendices an overview can be found of the interviews, together with the different interview guides and topic lists.

1.5.2 Selected case studies

At the core of this research are three empirical case studies into different SPIs within the environmental governance arena in the Netherlands, predominantly within the context of the Wadden Sea. Critical cases "can be defined as having strategic importance in relation to the general problem" (Flyvbjerg, 2006:229), and can have "sufficient variation in them to advance in-depth knowledge in [sic] the phenomenon the researcher wants to study" (Boezeman, 2015:25). The use of critical cases allows for a phenomenon to be studied in its real-life context (Yin, 2003). The cases I studied vary in the type of SPI they are but are similar in terms of the types of research questions they attempt to answer. By taking a similar approach to different types of interfaces, the research into these interfaces should offer a rich and potentially contrasting understanding of the extent to which SPIs contribute to eliminating science–policy interaction problems and enriching decision-making. With these three case studies I do not aim to develop a blueprint on how to act when a specific type of interaction problem arises. However, they do offer an insight into the possible variation SPIs have to offer in enhancing science–policy interactions and enriching decision-making processes: both between the different interfaces, and within the different 'types' of interfaces. The three types of interface this dissertation will discuss are 'boundary organisations', 'knowledge brokers' and 'boundary objects'.

1: Several of the interviews were transcribed by student assistants who had been asked to keep the interviews confidential. If an interviewee did not want part of their interview to be recorded, the tape was paused. If specifically requested, interviewees were sent a report of the interview, for verification.

Case 1: Boundary organisations (Chapter 3)
The first case describes boundary organisations: organisations "that mediate interactions between the scientific community and climate change policy-making" (Niederberger, 2005:2). I examine three organisations: IMSA Amsterdam, the Wadden Academy, and the Netherlands Commission for Environmental Assessment (NCEA). IMSA Amsterdam was a commercial think-tank and consultancy firm, led by Wouter van Dieren, a founding father in the Dutch environmental movement. By means of (institutional) boundary-transcending activities, IMSA aimed to create common ground between stakeholders involved within a particular project. In the Wadden Sea arena, it is renowned for its key role in the cockle fishery and gas exploitation controversies (Floor et al., 2013). The Wadden Academy was established in 2008, with the sole intention of enhancing the interactions between science and policy in the Wadden Sea area (Van Enst et al., 2016). Predominantly led and guided by scientists, it describes itself as a "compact, facilitating organisation with scientific authority". The NCEA is a governmental organisation responsible for the preparation of mandatory and voluntary advisory reports for the competent authority (national, provincial and local) on the scope and quality of environmental assessments. All three institutions have close relations with the Dutch Wadden Sea area. Furthermore, their different ibackgrounds bring variation to the case studies, allowing for the development of further insights into the concept of boundary organisations.

Case 2: Knowledge brokers (Chapter 4)
The second case examines knowledge brokers: individuals who aim to steer policy-making processes through mediating processes. They are thought to be individuals who have obtained the skills and qualities to be analytical, think critically and think in terms of a whole system through cross-sector experiences, and who have influence due to "their access to information and control over its dissemination, and to their enhanced status from engaging with external stakeholders" (Williams 2013:19). For this case study I interviewed 27 knowledge brokers: amongst others, I selected key figures from well-known and well-documented cases (e.g. gas extraction and cockle fishery activities in the Wadden Sea; the transition towards sustainable mussel fishery in the Wadden Sea; Wadden Sea harbour activities), people who hold key positions as knowledge brokers within Dutch ministries and large governmental programmes and organisations, and private sector process managers who have specialised in facilitating processes between science, environmental policy-makers and other stakeholders. In selecting individuals with different institutional backgrounds (similar to Case 1: Boundary organisations), I aimed for the research not only to demonstrate similarities but also variation between the cases, generating in-depth insights into the goals and strategies of knowledge brokers.

Case 3: Boundary objects (Chapter 5)
The third case focusses on boundary objects. These objects can take different forms in practice – from maps, models, and scenarios, to rankings and reports. They are constructed via participatory processes and ideally are based on a broad range of knowledge (so not only on scientific knowledge, but also on expert knowledge). As a result, these objects are "hybrid constructs that integrate elements from scientific and political worlds to facilitate the negotiation and exchange of multiple types of

knowledge and action" (White et al., 2010:221), and "can be used to transfer or communicate complex scientific information into understandable and tailored information which is tacitly connected to the target group" (Van Pelt et al., 2015:42). For this case study, I examined two assessments, both of which aimed to assess the impact of human interference on the ecological state of the Dutch Wadden Sea. They were chosen based on their apparent similarities (aim, focal area, and initial (policy) questions), but also their notable differences (one boundary object followed a descriptive approach, whereas the second boundary object developed a ranking system). In order to establish their effectiveness in informing decision-making processes, I analysed these rankings, using the criteria credibility, legitimacy and salience. The collection of data was done by means of in-depth interviews with key stakeholders, and two online questionnaires which were sent to all stakeholders involved (ranging from scientists and policy-makers to stakeholders from various industrial sectors).

1.6 | Outline of dissertation

This dissertation includes four articles. Although the research questions posed in the articles do not entirely correspond to the main questions presented in this chapter, these four articles conjointly contribute to addressing these main questions.

Chapter 2 introduces the conceptual framework, which is based on scientific literature that provides the basis for the rest of the research. It discusses a broad range of science–policy interaction problems, which are classified into three 'meta-problems'. Furthermore, it presents an overview of SPIs and aims to link typical SPIs to distinct problems and the contexts in which they emerge. Chapter 3 addresses three boundary organisations. Its aim is to provide further insights into how boundary organisations work in practice, by analysing their goals, strategies and the interaction problems they focus on. In Chapter 4, the concept of knowledge broker is researched. It explores who these knowledge brokers are in terms of background and competences, and what their goals and strategies are. Chapter 5 discusses so-called boundary objects by addressing issues such as how they are developed, and to what extent they have been effective in informing decision-making processes. Finally, Chapter 6 contains the conclusions and discussion based on the main research questions of this dissertation, reflections on this research, recommendations for the future (both for practice and science), and some final thoughts.

Chapter 2

TOWARDS PRODUCTIVE SCIENCE–POLICY INTERFACES: A RESEARCH AGENDA

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Abstract

Science-policy interactions are often contested, due to strategic production and use of knowledge. This is problematic because the potential of science to enrich decision-making is underexploited. Scientific literature suggests that these problems are related to a lack of credibility, salience and/or legitimacy of knowledge. Science-policy interfaces (SPIs), such as knowledge brokers, are suggested to enhance science-policy interactions by promoting the production of credible, salient and legitimate knowledge. However, the current scientific debate provides little clarity on which SPIs are most useful in solving which science-policy interaction problems and what strategies should be employed. Based on a profound literature review, this paper aims to arrive at a better understanding of SPIs, by providing conceptual clarity and linking typical SPIs to distinct problems and the contexts in which they emerge. We suggest an empirical research agenda to test theoretical claims about SPIs and our own refinements thereof, and to identify best practices.

2.1 | Introduction

In recent decades, scientific knowledge has been extremely important in informing the policy-making processes to improve or solve environmental problems dealing with, for example, air and water quality (e.g. Ferranti et al., 2013; Totlandsdal et al., 2007; Quevauviller et al., 2005; Sundqvist et al., 2002; Ducrotoy and Elliott, 1997; Klabbers et al., 1996; Jasanoff 1990). Specific arrangements, such as Environmental Impact Assessment (EIA), were put in place to connect science and policy and enhance their interactions (e.g. Fischer and Onyango, 2012; Morrison-Saunders and Fischer, 2006; Bartlett and Kurian, 1999; Bailey, 1997; Caldwell, 1988). However, although in some cases scientific knowledge clearly plays a decisive role in solving these issues, the relationship between science and policy is often still a troubled and contested one (e.g. Holmes and Clark, 2008; Lackey, 2007; Pielke, 2004; Sarawitz, 2004; Ozawa, 1996), especially in the arena of environmental policy. This is explained by the complex and multi-layered character of the field and the involvement of an array of stakeholders with conflicting stakes and needs (Driessen et al., 2010).

2.1.1 Problems with science-policy interactions

Difficulties regarding the relationship and interactions between science and policy arise in both domains[1], and take the form of the strategic (mis)use of knowledge (e.g. Runhaar and Van Nieuwaal, 2010), the strategic production of knowledge (Pielke, 2007), a misfit of demand for and supply of knowledge (e.g. Jones et al., 1999), and issues with the handling of scientific uncertainties (e.g. Van der Sluijs et al., 2010). As a consequence, opportunities to enrich problem analyses and the exploration of policy options by means of scientific knowledge are not fully exploited (Pielke, 2007). Inspired by the influential paper by Cash et al. (2003), many authors have tried to explain knowledge use in decision-making and the above problems in science-policy interactions from a lack of credibility, salience or legitimacy of the knowledge at issue (e.g. Richardson, 2013; Bauler, 2012; Hegger et al., 2012). Salience refers to the relevance of information for the decision-maker and the problem at stake. Credibility refers to whether an actor perceives information as meeting standards of scientific plausibility and technical adequacy, and whether sources are trustworthy and/or believable. Legitimacy refers to the extent to which the produced knowledge has been respectful of the divergent values and beliefs of stakeholders, unbiased in its conduct and fair in its treatment of opposing views and interests (Hegger et al. 2012; Cash et al., 2003). Based on this discussion, we may expect that overcoming problems of misuse and mis-production of science require the production and use of science that is credible, salient and legitimate.

2.1.2 Solution: science-policy interfaces?

Literature suggests a variety of 'solutions' in the shape of so called 'science-policy interfaces' (SPIs) (e.g. Holmes and Clark, 2008; Van den Hove, 2007; Bradshaw and Borchers, 2000; Jones et al., 1999). SPIs aim at overcoming, amongst others, the previously mentioned science-policy interaction

1: With the concept of 'science' we mean a "body of research, where knowledge is the outcome of social processes and institutional guided actions of researchers" (Van Buuren and Edelenbos, 2004: 291); with the concept 'policy' we mean a course of action designed to resolve or mitigate problems in the political sphere (Fischer, 1997).

problems and contribute to enriched decision-making; decisions that are well-informed about the problems at stake and the range of available intervention strategies, which facilitates a better handling of those environmental problems (Pielke, 2007; Van den Hove, 2007), acknowledging at the same time that science is just one part of the complex decision-making processes (Lackey, 2007; Pielke, 2007).

Examples of SPIs can be process designs, such as joint knowledge production (e.g. Hegger et al., 2012; Edelenbos et al., 2011) or joint fact finding (e.g. Karl et al., 2007; Ehrmann and Stinson, 1999), but also institutions such as boundary organisations ("organisations that 'straddle the shifting divide between science and policy', mediating between science and policy and facilitating the interaction between actors on either side or who cross the boundary" (Cash, 2001:432)) or boundary work(ers) (e.g. Pesch et al., 2012; Huitema and Turnhout, 2009; Hoppe, 2009; McNie, 2007).

2.1.3 Knowledge gap

However, the descriptions of these interfaces are often highly abstract, and it is unclear how they differ from each other, and in which situation a specific interface could be used to enhance the science-policy interaction. Although literature provides us with some empirical cases of SPIs (e.g. Boezeman et al. (2013) and Huitema and Turnhout (2009) on boundary organisations; Hegger et al. (2012) on knowledge co-production), we argue that little focus is placed on the correlation between the used SPI and the interaction problems, and the possible strategies which the interfaces entail which ought to lead to a better science-policy interaction and thus into enriched decision-making. In particular still little is known about how different types of SPIs contribute to the production of knowledge that is credible, legitimate and salient – as discussed above, important requirements for the actual use of knowledge in decision-making. It leaves us wondering, which SPI works where, when and how?

2.1.4 Research aim

As a first step in answering the above question, the goal of this paper is to develop a more cohesive framework on the relation between the science-policy interaction problems and SPIs, which we feel is currently lacking. Not only do we aim to provide conceptual clarity and structure in the scientific literature about SPIs and science-policy interaction problems and the contexts in which they emerge, we will also propose a research agenda for further empirical research on SPIs. We argue that empirical research is needed to enhance our insight into when, where and how these SPIs work, by testing hypotheses and identifying best practices.

The following section will describe different problems as suggested by various authors with regard to the science-policy interaction. The research question of this section is: *'Which problems regarding the science-policy interactions are identified in the literature and what is their adverse influence on the effectiveness of scientific knowledge?'*. Based on a literature review, we will develop a new typology regarding the types of problems and will link this typology to the three criteria for scientific knowledge (salience, credibility and legitimacy) by Cash et al. (2003). In order to develop hypotheses about when the types of science-policy interaction problems occur we employ the typology of policy problems developed by Hoppe (2005). The third section will consist of the determination of a definition and typology of SPIs,

which will then be linked to the specific interaction problems that they, theoretically, solve. The main question addressed in this section is 'Which interfaces are predominantly suggested in the literature and how are they linked to the interaction problems?'. Finally, we will present a research agenda consisting of suggestions towards the next steps for empirical research on SPIs and our concluding hypotheses.

2.2 | Problems influencing the science-policy interactions

In this section, we identify specific problems which negatively influence the science-policy interactions which are most dominantly present in the literature. We sub-divide these problems into three different clusters, or 'meta problems': (1) the strategic use of knowledge by policy, (2) the strategic production of knowledge by science, and, finally (3) the operational misfit of demand for and supply of knowledge.

In this clustering (Figure 2.1), we make a clear distinction between strategic and operational problems. As we will demonstrate further on, literature clearly defines different SPIs with their own goals and strategies. In this context, 'goal' refers to the science-policy interaction problems that the interface (and its actors) aim/s to solve; 'strategy' refers to the specific actions taken by the actors involved. By making the differentiation between strategic and operational interaction problems, it will become apparent that, in order to resolve these problems, different strategies and thus SPIs are required. By presenting these relationships, we aim to get a step closer to answering the question: "What works where, when and how?"

By *strategic*, we mean the deliberate influencing of the relations between science and policy by both, scientists and policy-makers, often in controversial situations, for example in the case of environmental issues (Michaels, 2009; Pielke, 2007; Owens et al., 2006). This strategic behaviour is displayed in order to promote specific, selectively used and produced information, rather than to promote the production and use of salient, credible and legitimate knowledge in order to enrich policy decisions. A result of strategic use and production of knowledge might thus be that the policy decisions made are not based on and thus do not represent or entail all the available knowledge, which could lead to inadequate (i.e. less credible and legitimate) decisions. An example of a situation where knowledge was used in a strategic way can be found in the Wadden Sea case, discussed by Runhaar (2009). In his article he states that the knowledge derived from EIAs was "ignored for a long time. (…) environmental knowledge has been used in a strategic way, i.e. linked to stakeholders' objectives and interests. The Wadden Sea case demonstrates that the use of environmental knowledge fits into a dominant discourse", i.e. it is used at will (Runhaar, 2009:207). To place this case into the terminology of Cash et al., in this situation we would expect that the produced knowledge lacked salience – the information bared little relevance to the decision-makers.

The scientific literature that defines *operational* problems, such as differences in expectations regarding the speed with which scientific knowledge can be produced. However, we expect these problems to be less deliberate, as they are mainly caused by institutional differences between science and policy; no manipulative behaviour of actors (as described above) is involved.

Figure 2.1 depicts the specific problems in science-policy interactions associated with the above-mentioned general strategic and operational problems. These specific problems are derived from the literature and will be further explained below.

Meta level problems	Behaviour of scientists, policy makers and stakeholders	Adverse influence on the effectiveness of scientific knowledge	Implications for decision-making processes
Strategic use of knowledge by policy	Knowledge is contested by particular groups (e.g. Michaels, 2009; Sarawitz, 2004; Guston, 2001)	Legitimacy, credibility	Scientific information insufficiently forms the basis for policy-decisions
	Knowledge is deliberately ignored by policy makers (e.g. Wardekker et al., 2008; Owens et al., 2006; Oreskes, 2004)	Legitimacy, credibility, salience	
	Knowledge is selectively used (e.g. Owens et al., 2006; Cortner, 2000)	Legitimacy, salience	
	The use of counter-expertise in order to disqualify contested knowledge ('report wars') (e.g. Van Buuren and Edelenbos, 2004; Fenger and Kok, 2001)	Legitimacy, credibility, salience	
Strategic production of knowledge by science	Scientists selectively presenting knowledge ('Issue Advocate') (e.f. Lackey, 2007; Pielke, 2007, 2004; McCool and Stankey, 2004)	Legitimacy, credibility	
	Scientists joining competing knowledge coalitions (e.g. Lackey, 2007; Van Buuren and Edelenbos, 2004)	Legitimacy, credibility	
	Scientists deliberately produce incomplete knowledge in terms of other stakeholders (e.g. Turnhout et al., 2007; Bäckstrand, 2003)	Legitimacy, credibility	
Operational misfit between demand for, and supply of knowledge	Scientists and policy makers employ different timeframes and levels of abstraction (e.g. Strydom et al., 2010; Van Buuren and Edelenbos, 2004; Wiltshire, 2001)	Salience	
	Scientists, policy makers and other stakeholders encounter differences in discourses, goals and rewards (e.g. Strydom et al., 2010; Pohl, 2008; Wardekker et al., 2008; Elzinga and Jamison, 1995)	Salience	
	Policy makers insufficiently develop clear research questions (e.g. Derksen, 2011; Holmes and Clark, 2008; Sarawitz and Pielke, 2007)	Salience	
	Policy makers have insufficient access to knowledge (e.g. Sarawitz and Pielke, 2007; McNie, 2007; Ducroty and Elliott, 1997)	Salience	

Figure 2.1. Problems influencing the interaction between science and policy

2.2.1 Strategic use of knowledge by policy

The first set of problems arises from problems that concern the strategic use of knowledge by policy; oppositions and actors with conflicting interests or views using either existing knowledge or their own knowledge and reports in a strategic way, defending their interests, resulting in trade-off decision-making (e.g. Retief et al., 2013; Lackey, 2007; Sarewitz, 2004; Ehrmann and Stinson, 1999). Or, as Cortner states, "[W]e know that policymakers frequently call for research or form study commissions to postpone facing problems. They invoke science to speak when it is in concert with their preferred policy preferences and ignore it when it is not" (2000:23). This problem of the strategic use of knowledge consists of more concrete problems that influence the interaction between science and policy.

The first problem dealing with the strategic use of knowledge, concerns the situation that knowledge is contested by particular groups, and thus disputable, because the knowledge does not (fully) represent the interests or concerns at stake, and science becomes politicized (e.g. Sarawitz, 2004; Guston, 2001). Scientific knowledge on environmental issues becomes disputable because the environmental issues in themselves are disputable. Another point lies within the concept of 'uncertainty'. The existence of uncertainty in scientific knowledge is used by opposing stakeholders to claim that this knowledge is contested (Michaels, 2009). Knowledge, thus, is either being ignored or selectively used. Based on the framework by Cash et al. (2003), we would expect this is related to a lack of legitimacy and credibility.

This leads to the second problem: knowledge is deliberately ignored by policy-makers. Owens et al. refer to this as the 'problem of limited impact'. They argue that "policy-relevant, or even policy-oriented, knowledge is not deployed in policymaking and decision-making processes. (…) Many researchers have suggested that particular policies are pursued in spite of their efforts to convince policymakers to do otherwise", but also that knowledge can be controversial, or 'uncomfortable ahead of contemporary policy agendas' (Owens et al., 2006:636, 637). Therefore, although scientific knowledge is generated, when it comes to the use of knowledge by policy-makers, it is strategically ignored, because it is considered irrelevant or inconvenient (i.e. not in line with preferences or policy decisions) (Oreskes, 2004). Based on the three criteria for usable scientific knowledge by Cash et al. (2003), as first glance it would appear that in this case there is a lack of salience – decision-makers do not consider the knowledge at hand relevant to the decision at stake. However, it is our understanding that arguments could also be made that the knowledge does not only lack salience, but policy-makers could also perceive this knowledge as lacking legitimacy and credibility, due to problems with communication – especially on uncertainties.

A third issue is connected with knowledge being used selectively. This selective use may have different reasons, e.g. "politicians ask for advice only to legitimize their pre-formed decisions" (Hoppe, 2005). In terms of Cash et al. (2003), in this situation we would expect the problem with scientific knowledge lies not so much with its credibility, but rather with the lack of legitimacy and salience in the eyes of the decision-makers.

A result of the disputable character of knowledge presents the final example of the strategic use of knowledge: the production and use of counter-expertise in order to disqualify contested knowledge, leading to 'report wars' or 'knowledge fights' (Van Buuren and Edelenbos, 2004; Fenger and Kok, 2001). For the production of this counter-expertise two reasons can be identified. The first reason refers to situations where there is little agreement on the produced knowledge and where knowledge is misused or misunderstood by coalitions other than the one in which it is generated (Owens et al., 2006; Van Buuren and Edelenbos, 2004; Jones et al. 1999). Secondly, counter-expertise and reports may be produced in order to delay discussions and decision-making processes, leading to little recognition of the importance of certain (for example) environmental issues, resulting in little political will and involvement of stakeholders (Watson, 2005). Based on the criteria set by Cash et al. (2003), in the first case, we expect there is a lack of credibility and legitimacy due to the lack of agreement on the produced knowledge; in the second case there is a lack of salience of the knowledge to the decision-makers involved, because the produced knowledge is not relevant to the policy problem in itself, but because it is being used as a delaying technique.

2.2.2 Strategic production of knowledge by science

The second set of problems evolves surrounding problems with the strategic production of knowledge by science. In his article, Hoppe (2005) formulates a couple of clichés regarding the troubled science-policy relationship: "politics are safely 'on top' and experts are still 'on tap'" and "science advisors follow their own interests, unless better paid by other interests". What can be concluded is that scientists (either individual or within coalition-type groups) appear to strategically place their interests and agenda within research, possibly leaving out other valuable information. This will be shown in further detail through the explanation of the three problems we relate to the strategic production of knowledge.

One of the problems here can be found in the existence of so called 'Issue Advocates' (Pielke, 2007). These Issue Advocates are seen as scientists who selectively present or advocate certain aspects of information or knowledge that they find important and which fit their own agendas, "in order to participate in the decision-making process" (Pielke, 2007:15). This is in contrast to the Honest Broker, who is claimed to "engage in decision-making by clarifying and seeking to expand the scope of choice available to decision-makers" (ibid.:17). The Issue Advocates, for example, select what they consider to be policy-relevant indicators without involving other stakeholders (McCool and Stankey, 2004). This could also be traced back to so-called 'Mode 1'-science "characterized by the hegemony of theoretical or experimental science; by an internally driven taxonomy of disciplines; and by the autonomy of scientists and their host institutions" (Nowotny et al., 2003). The Issue Advocate thus produces and advocates knowledge in a strategic way, according to their own agendas or interests instead of presenting an honest review of the knowledge available. Or, as Strydom et al. (2010) state: "scientists keep science out of reach of policy-makers to ensure that they retain their control on the interpretation of science". Resulting from this strategic behaviour, we expect the produced knowledge lacks both legitimacy and credibility; legitimacy because the knowledge is far from biased and unfair in its treatment of opposing views, credibility because there is little clarification of the science available and expanding the scope of choice to the decision-makers (Pielke, 2007).

Similar to the Issue Advocates are scientists that deliberately produce knowledge that is incomplete in terms of addressing other stakeholders (Turnhout et al., 2007; Bäckstrand, 2003). By strategically not involving other stakeholders, knowledge can be kept out of the knowledge production process, with the risk of barriers appearing at the interaction and thus with the enrichment of policy by science, since the knowledge is far from holistic and integrated (Cortner, 2000). This can cause difficulties, especially in situations where decisions can have a large impact on civil society (Bäckstrand, 2003). Again, following Cash et al. (2003), this knowledge thus is expected to lack legitimacy (the knowledge does not contain all available views) and credibility.

The final issue related to the strategic production of knowledge relates to "scientists who join competing knowledge coalitions", involving the "departmentalisation of different knowledge coalitions that consist of both knowledge providers (scientists, advisors and so on) and users (such as policy-makers)" (Van Buuren and Edelenbos, 2004 :290). It links back to the Issue Advocate, but on a more collective scale; i.e. it not only involves scientists, but also other involved stakeholders, which form coalitions. As a consequence, Jasanoff (1990) suggests that the idea that advisory bodies 'speak truth to power' should be abandoned. Rather, the production of knowledge is "plural and contextual" as its outcomes will be (Van Buuren and Edelenbos, 2004:290). The implication this has for the usability of the produced knowledge (within the policy-making arena) is that it probably lacks both legitimacy and credibility, even though the produced knowledge is likely to be both legitimate and credible within its coalition.

2.2.3 Operational misfit of demand for and supply of knowledge

Finally there are the problems that are connected with the operational misfit of demand for and supply of knowledge. Here, we see a range of operational issues surfacing. These are often linked to the differences in culture, between the 'world of science' and the 'world of policy'.

Examples of such problems can be found where scientists and policy-makers employ different time frames and levels of abstraction. Van Buuren and Edelenbos (2004) discuss this issue based on Wiltshire's (2001) suggesting that the timeframe of research and policy, their language and mutual images and their notion of reality differ fundamentally, which could lead to problems regarding their interactions. This includes the delivery of knowledge science might take longer to produce the knowledge than policy is willing to wait for. This could result in so called 'policy-making on the run'; politicians making pre-emptive decisions without environmental knowledge or expertise (Crowley, 1997). Furthermore, the knowledge produced might not be as understandable to policy-makers as it is to scientists, due to the difference in language and abstraction levels. "The failure of scientists to relate to the decision-making context, and the policymakers' often limited understanding of science form obstacles in the communication process" (Strydom et al., 2010), leading to limited understanding of each other's research demands and produced knowledge. The implication this has on the usability of the scientific knowledge is that it appears to lacs salience.

Strydom et al. also point at the issue that scientists, policy-makers and other stakeholders encounter differences in discourses, goals and rewards. They claim that scientists and policy-makers experience

and understand the world differently. In this light, Elzinga and Jamison (1995) discuss four cultures within the field of trans disciplinary research; bureaucratic, academic, economic and civic policy culture. Pohl (2008:47) argues that "the bureaucratic culture is concerned with effective administration, coordination and organisation; the academic culture seeks to preserve autonomy, integrity, objectivity and control over the funding and organisation of science; the economic culture is interested in transforming scientific results into successful innovations to be diffused in commercial marketplaces; and the civic policy culture is concerned with the consequences and implications of developments in science and technology". In other words, the bureaucratic culture aims at salient knowledge, the scientific culture at credible knowledge and the economic and civic cultures focus more on legitimate knowledge. The fact that these 'cultures' or 'institutions' all have different discourses towards concepts like 'knowledge', but also 'policy', could lead to difficulties between them. All this does not mean that it is impossible to interact with each other, but those that do need to be aware of these problems (Strydom et al., 2010:2). If this awareness is lacking we argue that it is likely that the knowledge used in the decision-making processes might lack relevance, and thus salience.

A third issue regarding this operational misfit can be found with policy-makers who insufficiently develop clear research questions. The communication between what information is demanded and whether the information is already available or needs to be supplied can be difficult to achieve (Holmes and Clark, 2008; Sarewitz and Pielke, 2007). Derksen (2011) discusses the difficulty of constructing proper research questions from a policy point of view. He also argues that whilst the problem a (governmental) department can have is often clear, the right research question is not developed, resulting in the possible supply of knowledge which lacks significance to the policy makers and the problems at stake, or, according to Cash et al. (2003), salience.

Finally, policy-makers who have insufficient access to knowledge is also being mentioned as an issue in this operational misfit (Sarewitz and Pielke, 2007); policy-makers' decisions could be affected if they are unable to access the knowledge they need for their decision-making process because they are not aware of the existence of this knowledge. This results in a lack of available salient knowledge.

2.2.4 In which situations do problems occur?

Science-policy interaction problems are often associated with so-called wicked or unstructured problems. An unstructured problem can be defined as a societal problem for which there is no definite solution, as opposed to structured problems, for which both the formulation and thus the needed solution is clear (Rittel and Webber, 1973). Decisions made on these so-called 'unstructured problems' are often based on a range of values and interests of the (many) stakeholders involved (Karl et al., 2007), but that is also what makes the problem unstructured. As Fischer et al. (2010) and Hoppe (2005) show in a framework on policy problems, the level of 'structuredness' depends on two contextual factors; the level of certainty on relevant knowledge and the level of consensus on relevant norms and values (Figure 2.2).

		Certainty of relevant knowledge	
		No	Yes
Consensus on relevant norms and values	No	Unstructured problem	Moderately structured problem (ends)
	Yes	Moderately structured problem (means)	Structured problem

Figure 2.2. Types of policy problems (derived from Hoppe, 2005)

Relating this quadrant to Cash et al. (2003), we argue that the more unstructured a policy problem appears to be, the more there is a need for credible, salient and legitimate knowledge. We acknowledge, though, that this may be difficult to achieve. Using our key question, 'What works where, when and how?', in the development of a further (empirical) research agenda, we want to know in which situations problems occur – i.e. at which level of structuredness. Accordingly, we have analysed the science-policy interaction problems in relation to the policy problem quadrant. Based on the descriptions of these problems, we were able to categorise the problems as seen in Figure 2.3. We do not claim the figure is complete regarding typical problems in science-policy interactions. The figure represents the problems and associated circumstances found in the literature and, as we suggest, can serve as a hypothesis.We conclude that, in the case of structured policy problems, it is likely that only problems regarding the operational misfit between science and policy will occur. Furthermore, we see that the majority of interaction problems do not seem to be related to one specific policy problem and that the level of (un)structuredness appears to have little impact.

Finally, with regard to the three criteria that Cash et al. (2003) provide us with when determining the usefulness of the knowledge to form the basis for policy-decisions, our initial hypothesis is endorsed. In the case of structured policy problems, the scientific knowledge only lacks some salience. However, the more unstructured the policy problem becomes, due to higher levels of uncertainty regarding knowledge and less consensus on the norms and values, the more there appears to be a lack of legitimate, credible and/or salient knowledge.

		Certainty of relevant knowledge	
		No	Yes
Consensus on relevant norms and values	No	Lack of legitimate, credible and salient knowledge Types of interaction problems: Strategic use of knowledge - All specific problems Strategic production of knowledge - All specific problems Operational misfit - All specific problems	Lack of legitimate and salient knowledge Types of interaction problems: Strategic use of knowledge - Selectively used knowledge - Use of counter expertise Strategic production of knowledge - Issue Advocates - Competing knowledge coalitions Operational misfit - All specific problems
	Yes	Lack of legitimate and credible knowledge Types of interaction problems: - Strategic use of knowledge - Ignored knowledge - Selectively used knowledge Strategic production of knowledge - Deliberate production of incomplete knowledge Operational misfit - All specific problems	Lack of salient knowledge Types of interaction problems: Operational misfit - All specific problems

Figure 2.3 Policy problems linked to the science–policy interactions; table derived from Hoppe, 2005

2.3 | Science-Policy Interfaces; a typology

After depicting the problems that are discussed in the literature as the causes of interaction difficulties between science and policy, we suggest possible solutions. Those solutions presented in the literature often refer to the concept 'SPI'. The concept of 'interfaces' can have a variety of meanings and shapes, ranging from an interface being a process, an organisation, an individual or a collective understanding (e.g. Huitema and Turnhout, 2012; Pielke, 2007; Van Buuren and Edelenbos, 2004). In addition, a range of functions can be identified. Subsequently, the most dominantly discussed interfaces, as described in scientific literature are described. They are then categorized according to our typology. We will then connect these SPIs to the science-policy interaction problems, which we presented in section 2.2.

As we did in the previous section ('Problems Influencing the Science-Policy Interactions') with the science-policy interaction problems in section 2.2, we have tried here to characterise the interfaces into typologies, rather than describing all the interfaces which, in our opinion, often only have minimal differences between them. In order to provide such a typology, we used the definition Van den

Hove presents for SPIs: "social processes which encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and joint construction of knowledge with the aim of enriching decision-making" (Van den Hove, 2007:807). From this definition, we derived three variables which make up the arrangement of an SPI: initiating and participating actors ('scientists and other actors in the policy process'), presupposed goals ('the aim of enriching decision-making') and a strategy for steering the involved actors towards this goal ('exchanges, co-evolution, and joint construction of knowledge'). As discussed at the beginning of the previous chapter, 'goal' refers to the science-policy interaction problems that the interface (and its actors) aim to solve; 'strategy' refers to the specific actions taken by the involved actors. From the literature on interfaces, multiple variations can be derived. Subsequently, we will discuss the most frequently used.

2.3.1 A typology

Based on the above three variables (i.e. actors, goals and strategies), we have analysed interfaces and suggest the following typology on SPIs: i) individual science-policy mediators; ii) the process of participatory knowledge development; and iii) boundary organisations (see Table 2.1).

The first interface relates to the *individual science-policy mediators*. An example of such individuals serving as interfaces is the so-called 'Honest Broker', a knowledge broker or boundary worker (e.g. Meyer, 2010; Sheate and Partidário, 2010; Michaels, 2009; Pielke, 2007). Essentially, they are individual scientists or experts whose goal it is to facilitate the creation, sharing and use of knowledge (Pielke, 2007). Their strategy involves functioning as a bridge between science and policy through mediation in the development of research questions, explaining the visions, goals or ideas of both sides to each other, having knowledge of the different processes undertaken by both scientists and policy-makers and being able to create awareness and acceptance of these differences (Meyer, 2010). Pielke describes the Honest Broker as someone who 'engages in decision-making by clarifying and seeking to expand the scope of choice available to decision-makers. (…) [He] seeks to place scientific understandings in the context of a smorgasbord of policy options. Such options may appeal to a wide range of interests.' (2007:17). The goal of these mediators is thus to raise the level of salience and legitimacy of the scientific knowledge involved in the policy-making process, in order for the policy problem to be solved.

The second interface involves the *process of participatory knowledge development*, with which we mean processes such as stakeholder participation in, for instance, EIA. These processes aim at joint fact finding and knowledge co-production (Glucker et al., 2013; Hegger et al., 2012; Pohl, 2008; Karl et al., 2007; Van Buuren and Edelenbos, 2004; Bäckstrand, 2003; Ehrmann and Stinson, 1999). They also include more theoretical approaches such as post-normal science, Mode-2 and the process of hybridization (Nowotny et al., 2003; Van Den Kerkhof and Leroy, 2000; Hunt and Shackley, 1999; Ravetz, 1999; Funtowicz and Ravetz, 1993; Jasanoff, 1990). The actors involved in these processes range from scientists from different disciplines and policy-makers to civil society and the private sector. They include all stakeholders who have a stake in, or are influenced by, the decision-making process and want to be involved in the process of knowledge development. The goal of this interface

is essentially to create common understanding and knowledge in a participatory way. Or, as Nowotny et al. describe it: "socially distributed, application-oriented, trans-disciplinary and subject to multiple accountabilities" (2003:179). The strategy to do so is through participatory processes in which all stakeholders are involved and stimulated to develop research questions and exchange and produce knowledge (scientific, expert, lay). This exchange of ideas and knowledge should ideally lead to more legitimacy of the produced knowledge; creating a common understanding of the problem at hand, mutual understanding of individual stakes and insight into the available bodies of knowledge surrounding a problem (Van Buuren and Edelenbos, 2004). Although participation is often considered to promote the production of useful knowledge, Wassen et al. (2011) show that this is often the case but also that useful knowledge does not always translate into the actual use of it in decision-making.

Science–policy interface	Actors (I: initiating; P: participating)	Goal	Strategy
Individual science-policy mediators	Individual, renowned scientist or expert (I); scientists, policy makers (P)	Facilitate the creation, sharing and use of knowledge. Focus on identifying and producing salient and legitimate knowledge.	Function as bridge between science and policy through mediating, explaining and translating.
Processes of participatory knowledge development	Scientists from different disciplines, policy makers, other involved stakeholders (all both I as P)	Create common understanding and knowledge in a participatory way. Focus on the increase of legitimate and salient knowledge.	Through participatory gatherings and processes with all involved stakeholders, exchange of and negotiations on ideas, visions and knowledge take place.
Boundary organisations	Organisations consisting of e.g. scientists, (environmental) experts and/or policy related advisory boards members (I); scientists, policy-makers, other involved stakeholders (P)	Bridging the gap between science and policy. Focus on the salience and credibility of knowledge.	Collect and distribute scientific knowledge, structure research questions and knowledge demands, develop and translate scientific reports for policy makers.

Table 2.1. Typology of science–policy interfaces

The third type of interface we discuss here is the so-called *boundary organisation* (Pesch et al., 2012; Huitema and Turnhout, 2009; McNie, 2007; Niederberger, 2005; Cash et al., 2003; Guston, 2001; Gieryn, 1983). This can be described as formal institutions, often having a legal basis, which serve as an institutional bridge between the worlds of science and policy. An example could be the IPCC (Intergovernmental Panel on Climate Change). The driving actors in these organisations can be scientists, but also (environmental) experts or members of ministerial advisory boards, aiming at bridging the gap between science and policy by positioning their organisation at the (dynamic) boundary between the two 'worlds'. They do this by "employ[ing] various kinds of specialists, offer[ing] opportunities for interdisciplinary collaboration, and serve[ing] as a platform for addressing environmental issues" (Huitema and Turnhout, 2009:591). Their strategy is to collect scientific knowledge in order to make it available and/or distribute it to those who need it (policy-makers for instance). Furthermore, they help

to structure research questions and knowledge demands but also put scientific and political issues on research and policy agendas. They also develop reports for policy-makers, containing scientific knowledge from a variety of sources, which are presented in a less scientific manner (Niederberger, 2005; Guston, 2001). In doing so, they increase the level of salience and legitimacy of the scientific knowledge.

	Problems	Individual science-policy mediators	Processes of participatory knowledge production	Boundary organisation
Strategic use of knowledge by policy	Knowledge is contested	Meyer, 2010	Reed, 2008	
	Knowledge is deliberately ignored	Michaels, 2009		
	Knowledge is selectively used	Meyer, 2010; Michaels, 2009		
	Counter expertise is used to disqualify contested knowledge		Van Buuren and Edelenbos, 2004	
Strategic production of knowledge by science	Scientists selectively present knowledge	Pielke, 2007	Karl et al., 2010	Huitema and Turnhout, 2009
	Scientists join competing knowledge coalitions	Sheate and Partidário, 2010	Van Buuren and Edelenbos, 2004	Huitema and Turnhout, 2009
	Scientists deliberately produce incomplete knowledge	Meyer, 2010	Karl et al., 2010; Pohl, 2008; Bäckstrand, 2003	McNie, 2007
Operational misfit between demand for, and supply of knowledge	Scientists and policy-makers employ different timeframes and levels of abstraction	Meyer, 2010; Michaels, 2009		Niederberger, 2005
	Scientists, policy-makers and other stakeholders encounter differences in discourses, goals and rewards	Niederberger, 2005	Pohl, 2008	Niederberger, 2005; Guston, 2001
	Policy-makers insufficiently develop research questions	Michaels, 2009	Pohl, 2008	
	Policy-makers have insufficient access to knowledge	Michaels, 2009; McNie, 2007		Guston, 2001

Table 2.2. Problems with science-policy interactions and science–policy interfaces connected.

2.3.2 SPIs and interaction problems connected

In order to move further in our analysis of the SPIs, we need to connect the interfaces we have identified above with the interaction problems explained in the previous section ('Problems influencing the science-policy interactions'). In Table 2.2, we connect these two based on the scientific literature on SPIs. An important conclusion is that the authors who identify the problems with the science-policy interactions do not necessarily explain what interfaces can be used to overcome them. Furthermore, on multiple occasions, authors who do discuss the concept of SPIs appear to fail to connect interfaces with the problems and interactions they aim to solve.

One of the first questions which arises from this table is when to use or implement which interface. The literature provides little guidance on this.

Table 2.2 clearly shows that there still is no definite answer to our question 'What works when, where and how?', when linking the interaction problems to the SPIs. On the contrary, it shows us the complexity of the question and the scientific concept of SPIs, and even leads us to more questions; not only with regards to when you would use or implement a specific interface, but also whether or not you should even make a choice, or whether you could use multiple interfaces at the same time.

Before we can draw up our conclusions and develop hypotheses for guiding further research on this question, a final analysis needs to be made, by placing the SPIs into context.

2.3.3 Interfaces placed into context

In the previous chapter, we placed the problems regarding science-policy interactions in relation to the policy problems, as described by Hoppe (2005). We did so in order to show the circumstances, or context, in which these issues occurred; and whether they occurred in structured, unstructured or moderately structured policy problems. As with these problems, and with regards to our question 'What works where, when and how?', it is also important to look at contextual factors when analysing SPIs. In this paper, we have distinguished the following two; the level of structuredness of the policy problems and the presence of legal frameworks for knowledge production and use.

First, we discuss the level of structuredness of policy problems here. If we combine table 2.2, in which we connect the SPIs with interaction problems with figure 2.3 (interaction problems can be connected to one or more policy problems), it is possible to recommend on what interface to use. However, since the four different policy problems do not have specific interaction problems, (as various issues appear in multiple policy problems) and some of the problems may (at least in theory) be solved by multiple interfaces, this combination would likely add more confusion, rather than providing for a better insight. This is in line with the literature where the conditions under which the interfaces take place are hardly and not systematically discussed.

Furthermore, we suspect that the presence of legal frameworks may have an influence on the SPIs. If there are legal frameworks in place, such as for instance the need to perform an Environmental Impact Assessment (EIA) for a particular project, this is likely to have strong implications on the use of the knowledge that the EIA produces. Environmental knowledge namely needs to be produced and considered, and its use publicly justified. This could reduce opportunities for ignorance and / or selective use of such knowledge. However, even with regards to EIA, Runhaar et al. found that the actual use of EIAs often depends on whether or not the presented knowledge fits into the dominant policy discourse (Runhaar et al., 2010). We still expect the number of formal regulations to influence the existing room for manoeuvre for strategically producing and using scientific knowledge. The more formal regulations there are, the fewer possibilities there are to use knowledge in a strategic way. This, however, does not imply that the solution to the problem with regards to science-policy

interactions should be found in the number of formal regulations. The required outcomes of these formal regulations are often scientific reports, excluding possible other views or 'knowledges'. Whilst these can be credible and salient, they would lack legitimacy.

2.4 | Conclusion

As we have shown in this paper, the literature provides us with a variety of SPIs, but with little recognition of its best practices and answers to our main question 'What works when, where and how?'. This article is meant to be a first step towards further empirical research by providing a systematic overview of the literature on the concept of SPIs.

The concept of SPIs and the interaction between science and policy is discussed by numerous authors and in multiple ways. Based on these debates we developed a new typology for the science-policy interaction problems, in which we made the distinction between three 'meta-problems': i) strategic use of knowledge by policy; ii) strategic development of knowledge by science; and iii) the operational misfit between demand for and supply of knowledge. We argue that these problems are narrowly related to a lack of legitimacy, credibility and/or salience of the knowledge at issue. In turn, the relevance of each of these criteria depends on the structuredness of the policy problem in terms of certainty of knowledge and consensus about norms and values. A second contribution of this paper is a further conceptualisation of the concept of SPIs by elaborating three key dimensions (actors, goals and strategies) that make up SPIs and which has resulted in the identification of the three distinct SPIs : i) individual science-policy mediators; ii) the process of participatory knowledge development; and iii) boundary organisations.

The conceptual clarity offered in this paper and the linking of typical SPIs to distinct problems and the contexts in which they emerge in our view are important ingredients for empirical research on SPIs, centred round our wondering 'What works when, where and how?'. With which we started this paper. We therefore encourage researchers to apply and further refine our conceptualisation of SPIs and to identify best practices of the SPIs by means of empirical research. EIA and SEA can be an interesting empirical field of analysis. They can be seen as an example of formalised science-policy interactions that are in place in many countries worldwide (Arts et al., 2012), allowing for international comparative analyses. We expect various types of SPIs to be found in this field. Since participation is usually an important element of EIA and SEA, EIA and SEA can be considered what we called 'processes of participatory knowledge production' – one of the three types of SPIs identified in this paper. In the Netherlands, the well-known Netherlands Commission for Environmental Assessment (NCEA) could be understood an example of a 'boundary organisation', another type of SPI.

In our view, key questions for further research in the field of science-policy interfaces are:

1. What are the processes and strategies through which science-policy interactions take place and to what extent can they be influenced?
2. How are science-policy interfaces enabled and constrained by social, economic and political dynamics, and what other contextual factors influence the performance of science-policy interfaces?
3. In what manner can design principals be formulated for science-policy interfaces in addressing a diverse set of problems in specific contexts, and in particular to what extent can science-policy interfaces be complementary to each other?
4. To what extent does an increased level of credibility, legitimacy and salience in knowledge, established through the use of SPIs, indeed lead to enriched decision-making on environmental issues?

Chapter 3

BOUNDARY ORGANISATIONS AND THEIR STRATEGIES: THREE CASES IN THE WADDEN SEA

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Abstract

This article discusses three empirical cases of boundary organisations, within the context of the Wadden Sea: the Wadden Academy, IMSA Amsterdam and the NCEA. The research aims to provide further insights into how boundary organisations work in practice. The research shows that the role of a boundary organisation can be fulfilled by different types of organisations (not solely scientific). Depending on the science-policy interaction problem they face, a boundary organisation can have different goals and use different strategies. Furthermore, the strategic use of media outputs, and the degree of actuality and public debate can have a substantial influence on the practices of boundary organisations.

3.1 | Introduction

Within environmental governance, interactions between science and policy are often contested (e.g. Holmes and Clark, 2008). Causes can be manifold, e.g. scientists are being accused of 'advocacy' when presenting knowledge, or particular forms of scientific knowledge are being marginalised by coalitions of policymakers and scientists (Milkoreit et al., 2014). It is suggested that these interaction difficulties arise from the differences between the world of science and the world of policy. From the literature it becomes clear that boundary organisations (BOs) operate on the intersection between science and policy. They are of particular interest, because they explicitly recognize this boundary, and acknowledge differences between the two arena's (McNie, 2007), despite the current tendency of understanding these boundaries as blurred, and the relationship between science and policy as less rational.

Although scientific literature discusses individual examples of these organisations (e.g. Boezeman et al., 2013; Pesch et al., 2012; Pietri et al., 2011), little attention has been paid to the specific situations in which there is a need for BOs (when), as well as to the goals and strategies BOs employ (how). We argue that with more in-depth analysis on multiple organisations, further operationalization and insights in the how and when can be generated. This paper will therefore empirically analyse three organisations. The following research question will be central: *How can boundary organisations be characterised, in terms of goals, strategies and perceived performance?* Sub questions guiding the research to answer this research question are: i) What are the goals of BOs?; ii) What science-policy interaction problems do BOs address?; iii) Which strategies do BOs use to reach their goal?; iv) How do BOs perceive their performance?

In order to research these questions, we focus on the Dutch Wadden Sea, a shallow estuarine sea of great ecological and economic importance. As discussed in the editorial of this special issue, this region is known for its wide range of interests (economic and ecological) and a continuous debate on scientific knowledge. The sheer difference between these interests often results in difficulties in policy making. History shows us in various cases (e.g. shellfish and gas exploitation) that the strategic (mis)use of scientific knowledge often played an important role in these disputes (Van der Molen et al., 2015; Floor et al., 2013; Swart and Van Andel, 2008; Turnhout et al., 2008), but also how BOs can play a mediating role in these disputes (Runhaar and Van Nieuwaal, 2010).

The next section presents an overview of the literature, by, firstly, deducting the definitions used by different authors of a BO, secondly analysing the (theoretical) goals of BOs, thirdly identifying the science-policy interaction problems described, and finally by analysing the strategies used to research the goals. Section 3.3 outlines the methodologies used for our analysis. Section 3.4 discusses the results of our empirical analysis. Section 3.5 presents our main conclusions and points of discussion.

3.2 | Boundary organisations: a literature overview

3.2.1 Boundary organisations defined

Literature provides us with multiple definitions on BOs. Following up on Gieryns work on boundary work (1995, 1999), David Guston defines BOs as those organisations that place themselves between science and policy (2001). A further selection of definitions, provide us with a similar understanding:

- "Boundary organisations link science to decision-making and link science and decision-making across multiple levels" (Cash et al., 2001:450);
- "Organizations that mediate interactions between the scientific community and climate change policy-making" (Niederberger, 2005:2);
- "A new class of organisations that mediate between the fields of science and those of application" (Hellström and Jacob, 2003:235);
- "providing stability in the often contested boundary area between the political and the scientific domain" (Pesch et al., 2012:487).

It becomes clear from these definitions, but also in descriptions of BOs as "hybrid organisations which occupy an intermediate position" (Gulbrandsen, 2011), and as "an intermediate" (e.g. Boezeman et al., 2013; Pietri et al., 2011; Niederberger, 2005) that the literature understands these types of organisations as intermediaries, which place themselves between the environmental science and policy-making arenas. Furthermore, following the empirical research on BOs, they are predominantly considered to be scientific and/or governmental organisations/agencies (e.g. Pesch et al., 2012; Gulbrandsen, 2011; Huitema and Turnhout, 2009; Schneider, 2009; Miller, 2001). But, if there is a need for these intermediary organisations, which problems regarding the interactions between science and policy do they then address? With what goal, and by means of which strategies?

3.2.2 Goals

The literature is divided on the goals of BOs. On the one hand the focus lies on processes (either on the production, or on the use of knowledge), as is the case according to e.g. Pesch et al. who argue that BOs are "supposed to enable a more effective use of knowledge in political decision-making" (2012:487), and Kirchhoff et al.: "contribute to the coproduction of science and policy by facilitating the collaboration between scientists and non-scientists; and, by creating a combined scientific and social order", but also to "build capacity for information uptake, integrate multiple forms of knowledge, and manage the inequities in power between producers and users" (2013:399).

On the other hand focus lies with the actual impact of the BOs. Following e.g. Cash et al., who argue that BOs aim to "manage boundaries between knowledge and action in ways that simultaneously enhance the salience, credibility and legitimacy of the information they produce" (2003:8087) it could

also be understood that the goal of a BO is to enhance the level of salience, credibility and legitimacy[1] of the produced knowledge, in order for it to have an effective influence on the policy-making process (Van Enst et al., 2014; McNie, 2007).

3.2.3 Interaction problems

One of the main issues addressed by the literature on BOs, concerns the difficulties in communication between scientists and policy-makers, due to institutional and cultural differences between them (e.g. Pietri et al., 2011; Holmes and Clark, 2008; McNie, 2007; Owens et al., 2006; Guston, 2001), such as other timeframes (Hanger et al., 2012; Owens et al., 2006; Niederberger, 2005), dissimilar levels of abstraction and understanding of boundary objects (e.g. Star, 2010), and different languages, or jargon (Cash et al., 2003). Also the insufficient access to knowledge tends to be a problem (Guston, 2001; Hanger et al., 2012; Lee et al., 2014), as does the framing of questions which lead to knowledge which is either not applicable to the policy problem at stake, or might be "uncomfortably ahead of contemporary policy agendas" (Owens et al., 2006). Furthermore, problems with the selective use of knowledge are discussed (e.g. McNie, 2007). Or, to put it differently, "orchestrating science to support (or hinder) particular courses of action, (…), making people believe or disbelieve knowledge claims." (Lidskog, 2014:2). Knowledge can also be disputed by particular groups, or coalitions, leading to politicized science (Pietri et al., 2011; Tribbia and Moser, 2008; Guston, 2001).

In their article on science-policy interfaces, Van Enst et al. combined a broad range of science-policy interaction problems into three meta-problems: i) the strategic use of knowledge; ii) the strategic production of knowledge; and iii) the operational misfit between demand for and supply of knowledge (2014). Applying these meta-problems to the literature on BOs, especially the strategic use of knowledge, and the operational misfit seem applicable.

3.2.4 Strategies

One of the most dominant strategies[2] mentioned, is the production and use of boundary objects (e.g. Kirchhoff et al., 2013; Star, 2010; McNie, 2007; Cash et al., 2003; Guston, 2001). Following Star and Griesemer, boundary objects can be understood as "collaborative outputs that are both adaptable to different viewpoints and robust enough to maintain identity across them" (1989:387), such as artefacts, (conceptual) models, classification systems (Lidskog, 2014). According to Cutts et

1: For the purpose of this article we understand these three concepts as follows: "credibility involves the scientific adequacy of the technical evidence and arguments. Salience deals with the relevance of the assessment to the needs of decision-makers. Legitimacy reflects the perceptions 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 views and interest" (Cash et al., 2003:8086). We are aware of the broad discussions held in the STS literature on the understanding and conceptualisation of these three concepts. For example Koetz et al. (2012), but also Cutts et al. (2011), understand these three elements as characteristics of an SPI itself, not so much of the produced and used knowledge. However, for the purpose of this paper we have decided to follow the definitions Cash et al. provide us with, since their theory focusses on the output of the BO, rather than the BO itself.

2: 'strategy' is conceptualised following Mintzberg (1987) as a "consciously intended course of action, a set of guidelines to deal with a situation. (…) two essential characteristics: they are made in advance of the actions to which they apply, and they are developed consciously and purposefully" (1987:11)

al., BOs "engage in a variety of methods and processes to construct, deconstruct, and reconstitute scientific and political components of boundary objects" (2011:978), for example by means of multi-stakeholder engagement workshops, and participatory model development. The co-production of boundary objects is a dynamic process, resulting in objects which are "flexible enough to have meaning in both social worlds, and stable enough to travel back and forth between them" (Turnhout, 2009:405).

But, in order for these boundary objects to be produced and used, other strategies are discussed, which facilitate the co-production of these objects. For example, "both scientific and political actors, as well as professionals mediating the two, participate in these organisations", in order to produce objects which are accountable to both worlds (Boezeman et al., 2013:163). The active translation of research findings is also advocated, in order to create more legitimacy (Gulbrandsen, 2011; Tribbia and Moser, 2008). Furthermore, BOs mediate between stakeholders through the creation of "common rules, procedures and norms of accountability that serve to align perceptions with respect to these intermediate variables" (Niederberger, 2005:12), and by advising groups with diverging values on how to achieve their goals (Huitema and Turnhout, 2009). This active inclusion of the different stakeholders is also advocated by Schneider, who concludes from her research that the management style of the BO, for example being focussed on the development of trust, and collaboration among all stakeholders, is of crucial importance (2009:76,77). In addition, the creation of common ground by organising formal interaction arrangements (such as symposia, or conferences) to inform the various stakeholders on the status quo of a specific subject, in the hope that they henceforth refer to the same body of knowledge (Pesch et al., 2012:501), can be seen as a strategy of BOs.

In order to create more general typologies of the strategies that BOs can employ, and therefore construct intertextual coherence, we have clustered and interpreted the theoretical strategies in an iterative manner. This resulted in the following overarching strategies: i) the (co-)production and use of boundary objects; ii) proactive interaction with knowledge developers; iii) proactive interaction with knowledge users; iv) mediation between stakeholders; and v) translation of research findings. These five strategies will, combined with the categorisation of the interaction problems (into three meta-problems) and the goals (focus on process or impact) form the analytical framework which will be applied to our empirical research.

3.3 | Research design

3.3.1 Comparative case study and analysis

In order to answer our research questions, and to broaden our understanding of how BOs work, we have conducted empirical research in three organisations. The analysis of the data is organised in two steps. First the three organisations, and for each organisation a specific project, or case, which exemplifies the work of that BO, are analysed on the basis of the document research and interviews (transcripts), discussing the concepts central to this research. Secondly, a comparative analysis of the

three BOs is presented. Comparative analysis "embodies the logic of comparison in that it implies that we can understand social phenomena better when they are compared in relation to two or more meaningfully contrasting cases or situations" (Bryman, 53:2004). For this reason we research three organisations, with the objective to find and clarify the overlap and differences between them. In doing so, we can further contribute to theory building since the researcher is in a better position to establish the circumstances in which a theory will or will not hold (Bryman, 2004).

To increase the level of validity of the research, we analyse the organisations on two levels: by constructing a general analysis of the organisation, and by examining one specific project for each of the organisations, which, according to the organisation itself, exemplifies its work as a BO in practice. By doing so, it enables us to further understand what effect the strategies of the BOs have in practice. We focussed on the concepts central to this research: the goals of the BOs, the interaction problems they aim to address, their used strategies; and how they perceive the performance of BOs. Furthermore, the validity is increased by inserting quotes of the interviewees, enhancing the verifiability of the analysis.

Finally, some considerations on undertaking social science research are in place. The main criticism of conducting comparative analyses is that it tends to mean that the researcher pays less attention to the specific context of a case. We have therefore chosen to not only select three organisations which operate in the same context (of the Wadden Sea), but also to limit our scope, and to predominantly focus on the goals and strategies of the BOs, without trying to evaluate their performances. In doing so, we have stayed close to the empirical data, and it gives us room to explore this data in more detail.

3.3.2 Case selection

The three organisations and their specific projects that we research are selected based on their activities and their close relations with the Wadden Sea area. First, the Wadden Academy, which was established with the sole intention of enhancing the interactions between science and policy in the Wadden Sea area, and the WaLTER project (Wadden Sea Long Term Ecosystem Research, an integrated monitoring plan for the main environmental and managerial issues that are relevant to the Wadden Sea area). Secondly, IMSA Amsterdam, a think-tank/consultancy firm which is renowned in the Wadden Sea area for its 'Win-win and the Wad' project, a project in which IMSA fulfilled an intermediary role in the cockle and gas exploitation controversies. And finally the Netherlands Commission for Environmental Assessment, which is commissioned with the evaluation of the 'Monitoring program natural gas extraction underneath the Wadden Sea'. Hereby, it too places itself between science and policy. In the following section we will provide further information on these organisations in general, and specifically on their goals, the science-policy interaction problems they address, their strategies, and how they perceive the performance of the organisations.

3.3.3 Data collection

The empirical research was conducted using two data collecting techniques: an in-depth document analysis of documents provided by the organisations themselves (through their websites) and online articles, and semi-structured interviews. In total we conducted 13 in-depth interviewees, with an

array of stakeholders. In the case of the Wadden Academy, for example, we interviewed board members, and members of the scientific and advisory board. Furthermore, we interviewed a key player in the WaLTER project, and a provincial policymaker responsible for the policy coordination of the Wadden. IMSA was researched in a similar way, with, amongst others, an interview with a senior management member, an interview with an entrepreneur who has had close relations with IMSA in general, but also specifically in the selected project. Finally, in the case of the NCEA we interviewed three individuals from the key organisations (NCEA, NAM and the Ministry of Economic Affairs) on the NCEA in general and on the case of the monitoring program in particular[3]. The selection of the interviewees was made on the basis of their involvement with the BO and through snowball sampling. The interviewees were able to conceptualise their own thoughts on concepts like interaction problems, goals and strategies. During the analyses, we translated these answers into our framework.

3.4 | Results

3.4.1 Introducing the three boundary organisations

The Wadden Academy describes itself as a "compact, facilitating organisation with scientific authority"[4]. It was established in 2008, after the need was expressed in an advisory report to the Dutch national government for more integrated and enhanced knowledge on the ecological and social-economic development of the Wadden Sea ('Room for the Wadden', 2004). Consisting of a General Board (five scientists, each holding their own portfolio) supported by the Bureau, a supervisory board which advises the societal and scientific relevance, and a Scientific Advisory Board (consisting of 12 scientists), who advise, solicited or unsolicited, on the scientific direction of the Academy, the Wadden Academy is predominantly led and guided by scientists. This is reflected in the main actors who participate with the Academy: research institutes in and surrounding the Wadden Sea area. The WaLTER project ('Wadden Sea Long-Term Ecosystem Research'), which serves as an example of how the Wadden Academy works here, is organised and led by scientists from various research institutes. The project 'aims to set up an integrated monitoring plan for the main environmental and managerial issues that are relevant to the Wadden Sea area (…). The monitoring network should provide an effective basis for decision-making, but also stimulate valid data interpretation'[5].

IMSA Amsterdam, hereafter IMSA, is a think tank and consultancy firm, consisting of 15-20 employees. Led by Wouter van Dieren ("member of the Club of Rome and one of the founding fathers of the Dutch environmental movement" (Runhaar and Van Nieuwaal, 2010:243)), the organisation has existed for over 25 years. It carries out projects which include the solving of disputes between stakeholders. Using binding and (institutional) boundary-transcending activities, it aims to create common grounds for all stakeholders. In the Wadden Sea arena, it is renowned for its key role in the cockle fishery and gas exploitation controversies (Floor et al., 2013), which formed the basis for the

3: Further information on the interviewees, and the questionnaire can be found in Appendices I and II

4: http://www.waddenacademie.nl; last visited on 31-05-2015

5: http://www.walterproject.nl; last visited on 02-04-2015

Win-win and the Wad project. The actors involved in the Win-win and the Wad project ranged from corporate businesses, local, regional and national government, scientists and research organisations, to NGOs. The main initiating organisation, which hired IMSA was the NAM, the oil- and gas organisation which wanted to exploit gas, underneath the Wadden Sea. At the time, the NAM was at the centre of a large dispute between an array of stakeholders, each with different interests, values, and understandings of existing scientific knowledge.

The Netherlands Commission for Environmental Assessment, hereafter NCEA, is a governmental organisation, responsible for the preparation of "mandatory and voluntary advisory reports for the competent authority (national, provincial and local) on the scope and quality of environmental assessments"[6]. It consists of a chair, nine deputy chairs and about 300 (external) experts (from universities, public and private sector). They are supported by a secretariat, consisting of a board and workgroup secretaries, with a Dutch and an international division. In the case of a project, a workgroup or Audit commission is formed out of one workgroup secretary and a group of external experts. Their advice (on e.g. an EIA, or a monitoring program) can be requested by a variety of organisations. In the particular project we describe here, the monitoring program natural gas extraction underneath the Wadden Sea, the initiator is the NAM. For this project, the NCEA has established an Audit commission, advising the Minister of Economic Affairs on the quality of the monitoring program developed by the NAM, the organisation responsible for the gas exploiting activities underneath the Wadden Sea.

As a final note, it needs to be stated that these organisations do not operate in a vacuum. Because they operate in similar areas (physically, scientifically, and politically) there are interactions between them as well. An example of such an interaction is the current development of a Wadden barometer, a new monitoring system for the Dutch Wadden area, by IMSA and the Wadden Academy, on behalf of the latter. And although this type of interaction falls outside the scope of this research, it is important to be aware of these interactions which take place between these BOs.

3.4.2 Goals

On their website, the Wadden Academy states that their goal is to "identify gaps in our knowledge of the Wadden Sea Region, to programme research and to disseminate the outcome, in the research areas of geoscience, ecology, society and cultural history, social and spatial economics, and climate and water". This is also what has been mentioned by the interviewees as the goals of the Academy, with the addition that, according to a member of the general board, the Academy needs to reach more collaboration between the different research institutes, in order to create a better structure for the invested money to yield its returns. In comparison to the literature overview on goals in paragraph 3.2.2, we argue that the Wadden Academy focusses on process, rather than impact.

The NCEA independently advises on the content and quality of EIAs. The goal of the NCEA is to

6: http://www.commissiemer.nl; last visited on 30-05-2015

provide advice to the competent authority on the scope and quality of the impact assessments and monitoring programs they are presented with. In the specific project we discuss in this paper, the NCEA provides the Ministry of Economic Affairs with advice on the quality of the monitoring program, developed by the NAM. They focus on the credibility of the used knowledge and the future outcomes of the program, but also to what extent the program answers the questions that the competent authorities want to see answered. Similar to the Wadden Academy, the NCEA appears to focus in this sense on process.

IMSA Amsterdam focusses on impact, by aiming at solving disputes between stakeholders on (scientific) knowledge, and at creating common grounds on which all stakeholders can agree, in order to to "eliminate pseudo-analyses and their influence on the general public" (high-management member IMSA). In the case of the 'Win-win and the Wad'-project, IMSA believed that as long as the claim that 'the Wadden Sea was an area of unspoiled nature and that it should have as little human intervention as possible' was repeated, policy kept being adjusted to it, which was not always in favour of the ecological status of the Wadden Sea (see also Runhaar and Van Nieuwaal, 2010), especially since the knowledge which supported this claim was strategically produced and used. The aim of IMSA with their project was to develop a new management model for the Wadden Sea nature, with the inclusion of economic activities upon which policy decisions could be based.

3.4.3 Science-policy interaction problems

From the literature overview, we have seen that there appears to be a dominant discourse towards science-policy interaction problems that relate to what Van Enst et al. (2014) refer to as the "operational misfit between demand for and supply of knowledge". When examining the three BOs in the Wadden Sea, we see that especially the Wadden Academy recognizes and aims to address these issues: "There are large gaps of information and a lack of an overall scientific research program"; "Knowledge is limited accessible"; "The articulation of questions by policy-makers is difficult; Which knowledge/information is needed?" These issues can be understood as problems concerning the operational misfit between demand for and supply of knowledge.

IMSA, on the other hand, focusses on, and argues that the difficulties regarding the management of the Wadden Sea area, can be linked to strategic use and production of knowledge. Although many reports are produced, "they are autonomous, their development is self-evident, but do they give the answers to the questions asked?". Furthermore, various interviewees mention the idea that for each argument a researcher can be found who can support the idea with scientific knowledge. An interviewee related to the NCEA acknowledges this problem as well. He argues that "many topics in the Wadden Sea are overstrained; there are always a dozen people who are willing to argue otherwise, and to blow up the weak sides of a research/data set". This, in combination with miscommunication, can result in misuse and misinterpretation of knowledge.

Issues concerning the strategic use ("Stakeholders use science as a power-tool"; "Policymakers have the tendency to postpone the decision-making process, due to a lack of knowledge.") and selective

presentation of knowledge ("An arena is created where scientists battle among each other") were also mentioned. A specific example of the strategic use of knowledge was given by the senior management member of IMSA, who argued that stakeholders use knowledge to develop pseudo-analyses (analyses of knowledge which are beneficial to their own incentives), in order to create Wadden Sea-related symbols. These symbols (for example the idea of the Wadden Sea as 'unspoiled nature') appeal to the general public, influencing their perceptions. IMSA argues that the general public was presented with a picture of the Wadden Sea as an area which should have as few human interventions as possible, while in fact, they argue, interventions in the Wadden Sea have taken place for decades, leaving it far from 'unspoiled'.

3.4.4 Strategies

One of the main strategies the Wadden Academy uses is the development of boundary objects, e.g. (scientific) reports in which they (the Academy in close collaboration with other research institutes involved in Wadden Sea research) attempt to synthesise different data sources, and translate them into a less scientific language. Also, the Academy initiates the organisation and development of a science-policy matrix (a matrix in which policy relevance and knowledge availability have been integrated, in order to develop a trilateral research agenda[7], which also serves policymakers), which is constructed in close collaboration with both policymakers and scientists. At the start of this initiative, however, it is unclear for the Academy what its effect will be, whether or not the science-policy interaction problems will be reduced.

IMSA uses boundary objects to bridge the boundaries between stakeholders as well. In the case of 'Win-win and the Wad', a Cascade-model was developed in collaboration with a range of scientists from both scientific research institutes and the NAM. The model showed what the environmental impact of different interventions were (including gas exploitation and cockle fishery activities), in relation to each other. One of the interviewees stated that with this model in particular, an increase in the legitimacy of the used knowledge was pursued. He argues that 'the commitment to the analysis is crucial, before finding a solution. What IMSA did was reach consensus on the analysis', which gave the different stakeholders a common ground to start from.

Proactively interacting with both knowledge developers and users, is an often used strategy for all three organisations. The Wadden Academy organises monthly lectures and scientific conferences. By inviting both researchers and policymakers from the trilateral Wadden area to participate, the Academy aims to facilitate the interactions between these two groups, to enhance the dissemination of knowledge between stakeholders, but also the identification of knowledge gaps. Another example of this proactive interaction is the chairman of the Academy is part of the RCW – Directing College Wadden – in which national, regional, local policymakers, NGOs and scientists meet, in order to align interests. However, all interviewees, including the board members of the Academy, argued that

7: At the 2010 trilateral Wadden Sea conference, the Netherlands, Denmark, and Germany agreed that a trilateral interdisciplinary research agenda had to be developed, in order to act upon the growing effects the rapid global changes have on the geomorphology and biodiversity of the Wadden Sea ecosystem (http://www.waddensea-secretariat.org)

there still is too little interaction between the Academy and policymakers. According to one interviewee "Policymakers do not turn to the Wadden Academy if they are in need of information", rather they approach a research institute directly. Furthermore, at the scientific conferences, the audience is predominantly scientific, as are the presentations and debate. And, as another interviewee stated, because the Academy (until 2014) was part of the Royal Netherlands Academy of Arts and Sciences (KNAW), this gave them an 'ivory tower image, and thus little connection to/with the region'.

During the 'Win-win and the Wad' project, IMSA organised several formal and, more importantly, informal meetings between (opposing) stakeholders, in order to create consensus on the existing knowledge. As a result of the first informal meeting, IMSA sent a letter to all the Dutch political parties, advising them to (amongst others): "allow gas exploitation; use part of the revenues to create a Wadden fund for solving the main environmental problems; commission research on the ecological impacts of shell fisheries and prepare decision-making for the continuation of this activity; and install a Commission to elaborate and advise on these issues". The advice to install a Commission, is considered to be 'politically strategic', according to one of the interviewees. The letter was supported by 20 stakeholders, including the Wadden Society and the NAM (Van der Linde, 2008), which, up until that moment, were diametrically opposed. This advice meant a breakthrough in these contested issues.

The NCEA continues to be (thought of as) completely independent in its advice. Recognized by all interviewees, the NCEA aims to achieve this through strategically selecting its experts (who are not allowed to be directly involved in the project), but also by adding paragraphs in its reports which (at first hand) might not be of importance to either the initiator, or to the competent authority. An example of such a paragraph can be found in one of the reports by the Audit commission in the project of the monitoring program by the NAM. The Audit commission makes reference to the cumulative effects of activities in the Wadden Sea, arguing that these effects should be taken along in the reports by the NAM. Although, as one of the interviewees explained, this was not part of the assignment given to the NCEA, this person argues that it is aware of the fact that its reports are being reviewed by more stakeholders than the initiator and the competent authority. By including this concept of cumulative effects, it aims to forestall possible negative reactions to its advice. Wanting to be transparent, it therefore also publishes all its reports, letters of advice and documents on which the advices are given online.

Finally, a strategy we found which is not explicitly mentioned in the literature discussion in section 3.2, is the strategic use of the media. All three organisations have used media outputs to enhance the interactions between science and policy. The Wadden Academy publishes opinion articles in regional newspapers on a broad range of topics, and weekly online publications concerning Wadden Sea related topics. In doing so, it translates scientific results into more accessible outputs. However, this way of using the media is primarily meant to present scientific research on the Wadden Sea to a broader audience, and not with the intention to influence the interactions between science and policy, or the public debate.

The NCEA strategically used its legal obligation to publish all its official outputs. The Audit commission faced difficulties due to the fact that the data, based on which the monitoring reports were written, were collected by a variety of research institutes located in and surrounding the Wadden Sea area. According to an interviewee, more than often, these sets of data were part of larger research schemes which did not have a prime focus on researching the impact of gas exploiting activities. This resulted in a situation in which the NAM collected a range of data sets, which were not specifically meant to connect to, or support and complement each other. In this case, this discrepancy between the sets of data was identified by the Audit commission. It concluded, based on the first proposal of the monitoring program handed to it, that the level of credibility and salience of the program, and therefore the future results, were lacking (credibility because of the lack of complementing data sets; salience, because the answers that would be given based on the monitoring program did not fit the questions asked by the competent authority). According to an interviewee, it appeared to be difficult for the various parties to solve these issues. When, at the beginning of 2014 the commission was asked to review the latest version, and it still concluded the quality of the program was still lacking, it wrote an official, and intentionally publicly accessible, review and letter to the minister of Economic Affairs, advising on the status of the monitoring program. As an interviewee states it: "They have been gently pushed for five years, providing them with multiple advices, all very much focused on the content of the document, but we could not continue that way. That is why we send out the letter".

In the case of the 'Win-win and the Wad'-project, IMSA also used the media strategically, but with other intensions. It was not only Wouter van Dieren, as president of the organisation, who appeared in radio interviews and on television. He also arranged for other stakeholders to present themselves and their organisations to the media. It was said by multiple interviewees that these media appearances were not always appreciated by the involved stakeholders, especially at the beginning of the project when the relationships were still highly complex and value laden. But causing this commotion by means of the media was purely intentional: to stir up the public and political debate. An example was the interview the chair of a large NGO gave to a Dutch newspaper. The aim of this interview was to create more legitimacy for the project and the produced knowledge among the general public and to influence the public debate, but more importantly, to influence the political debate. Because the 'unspoiled nature' of the Wadden Sea was turned into a symbol (see 3.4.3), the political arena acted on emotion, rather than on scientific knowledge, this interviewee stated. With this newspaper article, IMSA addressed this issue by means of one of the opposing organisations, eventually causing a shift in the political debate. This understanding of politics, public opinion, seeing windows of opportunities, and the extensive network IMSA contains, have, according to all interviewees, been crucial to the success of the project. Or, as the interviewee from IMSA said: "We provide a combination of knowledge, stakeholders and media (which we have chosen selectively), which all move into the same direction.

3.4.5 Perceived performance

It is acknowledged by the interviewees, but also by the KNAW (Royal Netherlands Academy of Arts and Sciences) in its evaluation report on the Wadden Academy (2013) that the reports, publications and conferences the Wadden Academy produces and organises appear to focus particularly on what

Cash et al. (2003) would understand as an increase in the level of credibility and salience of the produced knowledge: "The Wadden Academy succeeded in generating and publishing multidisciplinary scientific knowledge on the Wadden system, filling a gap in the usual disciplinary approach of science. (…) The scientific reports (…) are highly relevant to societal and scientific organisation active in the Wadden Sea area" (KNAW evaluation report, 2013:10-11).

However, when asked how the Academy perceives its success, this appears to be difficult to determine. This is predominantly linked to the short period the Academy has existed: "they are still at the beginning of their activities", as is the case for the WaLTER project. This would imply that the Academy still has to prove its use as a BO within an arena which is often characterized as (institutionally) crowded. Another perception, raised both during the interviews and document research, is that the interaction between the Academy and policymakers is too limited to have a direct influence on the decision-making processes.

Finally, as one of the interviewees states, although the Academy has a large intellectual capacity, it lacks the resources to conduct research itself. This makes it highly dependent on the backing it receives from other institutes (e.g. in terms of access to data, on which it bases its reports). If one tries to mediate between two worlds, it would make sense that the organisation in the middle would not be as dependent on one of the two worlds as the Wadden Academy appears to be, up until now.

In case of IMSA, the interference by IMSA into the (public and political) debate on gas exploitation, and the management of the Wadden Sea in general is perceived as significant. All interviewees agreed that there has been an increase in the legitimacy of the knowledge production process, even though, especially at the start of the project, the level of independency, credibility and legitimacy of IMSA was doubted (especially by the opponents of the gas exploitation activities). Because the project was financed by the NAM, IMSA had to strategically create a knowledge development process, in which all stakeholders felt represented. Following the reports developed by IMSA, the Dutch government installed the Meijer Commission, charged with the task of exploring possible policies for gas exploitation, shell-fishing activities and the conservation of the Wadden Sea nature. In the final report of the Commission (Room for the Wadden), which ultimately resulted in (amongst others) the approval of gas exploiting activities, the Cascade-model was used to increase the credibility of their recommendations. The strategies used by IMSA therefore appear to have created the room for manoeuvre and negotiation which was necessary to take a next step in the debate.

3.5 | Conclusions and discussion

Although growing, the body of literature with empirical cases of BOs is less extensive than the theoretical body of literature. In the articles which do describe BOs in practice, there is a clear dominance in understanding BOs as being scientific and/or governmental organisations/agencies (e.g. Pesch et al., 2012; Gulbrandsen, 2011; Huitema and Turnhout, 2009; Schneider, 2009; Miller, 2001). This view on BOs however, leaves little room for other organisations, which might not have a purely scientific and/

or governmental background, but do place themselves at the boundary between science and policy, with the aim to mediate between the two. This research, however, shows that a-typical organisations (such as a consultancy firm) can very well be understood as strategic BOs whose aim it is to enhance the interactions between science and policy.

Based on the results from our research, we can conclude that the three organisations we examined differ to a large extent. This differentiation can, first of all, be found in the background of the organisations: e.g. the Wadden Academy is a governmental institution, funded by the Waddenfund and three Provinces, and depends on other research institutes for their data. IMSA has a commercial incentive, being a think-tank and consultancy firm. And finally, the NCEA is, like the Wadden Academy, a governmental institution, but independent and with a legal status, as opposed to the other two.

Secondly, this research shows that this difference in organisational structure also has its influence on the goals of the organisations, and the science-policy interaction problems they attempt to address. Where the Wadden Academy, which is led by scientists, aims to address problems which are related to the operational misfit between demand for and supply of knowledge, IMSA aims to reduce the strategic misuse of knowledge, and rather create consensus on the scientific analysis.

This, thirdly, has an influence on the strategies the organisations use. Based on the formulated strategies, we argue that IMSA and the NCEA focus on impact, whereas the Wadden Academy focusses on output. All three organisations are involved in the creation of boundary objects. However, the Wadden Academy seems to create these objects as output, whereas IMSA and the NCEA seem to use the objects in a more strategic way to create impact, a differentiation which did not follow from the literature overview. Furthermore, in the case of IMSA, and 'Win-win and the Wad', the stagnated discussion was pried through formal and informal interaction with and between stakeholders, in order to create consensus on the used knowledge base. The NCEA used their legal status and formal outputs to increase pressure, in order to increase the level of credibility and salience in the produced and used knowledge. Finally all three organisations have shown examples in which they use media outputs in a strategic manner. This is a strategy which we find to be lacking in the literature.

Fourthly, what the indicators of success were and to what extent the activities of the organisations influenced the interactions between science and policy appear often difficult to answer. This is in line with our literature overview, which also acknowledges a lack of indicators to identify 'success'. We therefor would recommend further research, in which a clear differentiation has to be made between the indicators of successful output, and indicators of successful impact.

A final observation, which we feel is lacking in the current body of literature, involves enabling factors, which appear to be crucial. The legal status of the NCEA served them in building up pressure towards the involved stakeholders. In the case of IMSA, the public and political debates built up such pressure onto the (institutional) Wadden Sea arena that changes needed to be made. This situation made it possible for IMSA to create a window of opportunity to guide these changes.

In conclusion, we argue that this research provides the debate on BOs with a more nuanced picture: BOs are not by definition research organisations, but have different backgrounds, goals and strategies. Resulting from this, the type of science-policy interaction problem, or dispute, should guide the quest for the required type of BO: when there are problems related with the operational misfit between demand for and supply of knowledge, other types of BOs can be of help than in the case of issues related to the misuse or –production of knowledge. This is in line with the used strategies. Although in the three presented cases strategies that involve proactive interaction with stakeholders are used (which corresponds with the conclusions drawn from the literature overview), especially in the case of more disputed situations other strategies (like the strategic use of formal media outputs) were appropriate. Furthermore, this article shows that certain enabling factors (such as political mandate, public and/or political pressure) appear to be of influence on the processes as well. Without these enabling factors the strategies might not serve the aims of the BO.

We would therefore recommend further research on the influence of these enabling factors on the goals and strategies of BOs and their performance. Furthermore, attention should be brought to initiatives of BOs which interact among each other. A recent example of such interaction can be found between the Wadden Academy and IMSA. They started the initiative to create a, so-called, Wadden barometer: a model which aims to increase the salience, credibility and legitimacy of used and produced knowledge. We argue that it would be of value to the debate to examine how such collaborations influence the interactions between science and policy, and in which situations these collaborations are fruitful.

Chapter 4

WORKING AT THE BOUNDARY: AN EMPIRICAL STUDY INTO THE GOALS AND STRATEGIES OF KNOWLEDGE BROKERS IN THE FIELD OF ENVIRONMENTAL GOVERNANCE IN THE NETHERLANDS

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Abstract

There is a broad range of literature on individuals who mediate at the boundaries between science and policy. However, there seems to be little empirical evidence on the goals and strategies of knowledge brokers, even though they appear to be becoming increasingly important in the field of environmental science and policy. This paper aims to improve the understanding of why and how knowledge brokers operate through an analysis of 27 in-depth interviews. It demonstrates that they see themselves as (strategically) sensitive to all stakes and stakeholders involved, possess a large network, and act without interests. They appear to act strategically in two different settings: on stage, where the collaboration of all stakeholders is needed, and backstage, where the knowledge broker steers the process on his/her own. Furthermore, our research suggests that the (perceived) credibility and legitimacy of the knowledge broker is more important to the process than the degree of credibility and legitimacy of the knowledge used in the decision-making process, and that it would be advisable to deploy knowledge brokers proactively, instead of reactively, which could lead to 'incident politics'.

4.1 | Introduction

In the field of sustainable development, the use of scientific knowledge is considered essential for understanding complex environmental problems such as climate change and biodiversity loss, identifying effective measures to address these problems, and informing environmental policy-making (Van Enst et al., 2016; Holmes and Clark, 2008; McNie, 2007; Turnhout et al., 2007; Cortner, 2000). However, as Van Kerkhoff and Lebel (2006) argue, the use of scientific knowledge is neither sufficient nor self-evident. The use of science in decision-making about environmental problems appears to be complicated, especially in situations with high levels of conflict among stakeholders, and where there are controversies surrounding environmental issues (Van Enst et al., 2014; Hegger et al., 2012; Driessen et al., 2010). In such situations, scientific knowledge can be strategically used, or selectively presented, either by scientists or by policymakers (Saarela and Söderman, 2015; Runhaar and Van Nieuwaal, 2010). These difficulties have been well recognised in the scientific literature on (among others) environmental governance. Science–policy interfaces (SPIs) are often discussed in relation to these interaction problems as being possible 'solutions' (Holmes and Clark, 2008; Van den Hove, 2007). In this context, SPIs are to be understood as processes, organisations, or individuals that "encompass relations between scientists and other actors in the policy process, and which allow for exchanges, co-evolution, and [the] joint construction of knowledge with the aim of enriching decision-making" (Van den Hove, 2007:807). Another term often used for these strategic practices is that of 'boundary work' (Owens et al., 2006; Guston, 2001; Gieryn, 1983). This paper will discuss individuals who engage in boundary work (Turnhout et al., 2013; Kinnie et al., 2012; Meyer, 2010; Pielke, 2007), and the ways in which they aim to overcome problems in science–policy interactions. The literature predominantly conceptualises these individuals, who focus on processes to improve the use and production of scientific knowledge in policy and decision-making, as 'knowledge brokers' (e.g. Schlierf and Meyer, 2013; Turnhout et al., 2013; Meyer, 2010; Hoppe, 2009, 2010; Michaels, 2009; Bielak et al., 2008). However, even though the scholarly literature on boundary work and these individual mediators discusses goals and strategies (e.g. Hoppe 2009, 2010; Cash et al., 2003; Landry et al., 2001), little empirical research appears to have been done on how these knowledge brokers address issues and processes concerning the interactions between science and policy in practice. Understanding which type of science–policy interaction problems knowledge brokers address, by means of what goals and strategies, and understanding their competences and capabilities, could yield more insight into how and when knowledge brokers should or could be deployed in a policy-making process.

This paper therefore presents exploratory research into knowledge brokers, the science–policy interaction problems they address, and their goals and strategies specifically within the Dutch environmental governance arena. This is a realm in which issues such as conflicts between economic development and nature conservation, for example, predominantly occur in a regional or national context (e.g. Floor et al., 2013; Seijger et al., 2013; Cuppen et al., 2010). We address the research question: *how do knowledge brokers perceive the interactions between science and policy, and how do they define their role in terms of goals and strategies, to improve the production and use of science in policy and decision-making?* For this research, we understand 'knowledge brokers' to be a theoretical concept, which will be researched empirically in terms of institutional diversity, goals, and strategies, in order to achieve further theoretical depth.

To answer the research question, first, the general concept of 'boundary work' will briefly be clarified, followed by the main theoretical characteristics of knowledge brokers. The third section will explain the methodology used during the empirical research. The fourth section will present the empirical findings, including a typology of knowledge brokers. Finally, in the last section, we will present our reflections, conclusions, and points for discussion.

4.2 Boundary work and knowledge brokers: a brief literature review

4.2.1 Boundary work

The concept of boundary work finds its origin in the work by Gieryn (10983), who discusses the active management of the socially constructed boundary between science and policy as the utility of boundary work. The need for boundary work rises from tensions that arise "at the interface between communities with different views of what constitutes reliable or useful knowledge" (Clark et al., 2016:4615). Clark et al. (2016) argue that in the case of an impermeable boundary, no communication can take place across it. On the other hand, if a boundary is too porous, science might get mixed with politics, which would decrease the value of research-based knowledge. In more general terms, Van Enst et al. (2014) argue that there are three types of meta-problems related to interactions between science and policy: (i) the strategic use of knowledge; (ii) the strategic production of knowledge; and (iii) the operational misfit between the demand for, and supply of, knowledge. Boundary work, in those cases, is required to construct and manage the interactions among various stakeholders, or communities, with the aim to lead to more productive and informed policy-making (Rosenkopf and Nerkar, 2001). The scholarly literature on boundary work is expanding, addressing the concept from different perspectives (e.g. Van Meerkerk, 2014; Crona and Parker, 2012; Fleming and Waguespack, 2007; Hoppe, 2005; Landry et al., 2001; Rosenkopf and Nerkar, 2001; Aldrich and Herker, 1977). In general, however, three functions can characterise boundary work: (i) communication—active, iterative and inclusive; (ii) translation—facilitating mutual understanding between experts and decision-makers, eliminating the hindrance of jargon, language, experiences, and presumptions; and (iii) mediation—enhancing the legitimacy of the process by increasing transparency, bringing all perspectives to the table, providing rules of conduct, and establishing criteria for decision-making (Cash et al., 2003). By means of these functions, boundary work, carried out by knowledge brokers for example, should lead to creation of credible, legitimate, and salient knowledge: knowledge that is scientifically adequate, accurate, and trustworthy; reflects and respects the divergent beliefs and values of stakeholders; is seen as free from bias; and is considered to be relevant to decision-makers and the problem at stake (Buizer and Cash, 2013; Hegger et al., 2012; Cash et al., 2003;).

4.2.2 Knowledge brokers as boundary workers

In regards to conducting boundary work, the reviewed scholarly literature refers to different typologies of boundary workers, ranging from boundary-spanning individuals who are often part of an organisation on one side of the boundary (Van Meerkerk, 2014; Williams, 2013), to people who aim

to connect science and policy (and scientists and policy makers) by either acting as "intermediaries between researchers who produce knowledge, and policy makers who are prospective consumers of that knowledge" (Michaels, 2009:996), or by attempting to overcome the boundaries between science and policy by facilitating the creation, sharing, and use of knowledge. The latter type of boundary workers, to which the literature refers to as 'knowledge brokers', will be central in this paper.

Despite slight differences in the characteristics of knowledge brokers presented by various authors (e.g. Meyer, 2010; Moss et al., 2009; Pielke, 2007) what these individuals appear to have in common is a degree of neutrality, impartiality, authority, and the ability to build bridges between science and policy, due to their own cross-sector experiences. Considering their institutional backgrounds, the reviewed literature tends to describe knowledge brokers as academics (e.g. Schlierf and Meyer, 2013; Michaels, 2009; Pielke, 2007), although there are also references to policy makers (Hoppe, 2009) and to private sector individuals (Meyer, 2010; Runhaar and Van Nieuwaal, 2010) acting as knowledge brokers. In terms of their goals and strategies, knowledge brokers are expected to "expand the scope of choice available to decision-makers" (Pielke, 2007:17), facilitate interactions, and supply, translate, and link knowledge to and between different contexts (Meyer and Kearnes, 2013; Turnhout et al., 2013; Schlierf and Meyer, 2013; Moss et al., 2009). Additionally, Cash et al. (2003) argue that knowledge brokers should enable the production and use of knowledge that is (perceived to be) credible, legitimate, and salient. Eventually, this should lead to enriched decision-making processes. These goals are to be reached by mean of strategies, which are conceptualised following Mintzberg as a "consciously intended course of action, a set of guidelines to deal with a situation (…) [with] two essential characteristics: they are made in advance of the actions to which they apply, and they are developed consciously and purposefully" (1987:11). However, on the subject of strategies, the scholarly literature on knowledge brokers appears to be less concrete. Moss et al., for example, describe the 'hidden role' of knowledge brokers, by distinguishing three dimensions: (1) the opening up of relationships, or mediating, between production, consumption, and regulation; (2) working between different scales, or levels, of action, e.g., challenging existing hierarchical forms of governance to bring local agendas into the policy realm; and (3) working between technologies and social contexts, e.g., presenting technologies in such a manner (translated) that it speaks to all parties involved (2009:24–25). However, these dimensions still shed no light on how knowledge brokers go about these actions.

4.2.3 Conclusions

Based on the previous discussion, we draw the following conclusions. Firstly, the use of knowledge brokers to manage, and even overcome, the boundary between science and policy appears to be self-evident. However, little in depth analyses are made regarding how strategies such as 'facilitating', 'negotiating', or 'mediating' are operationalised. Secondly, although references to different institutional backgrounds of knowledge brokers can be found, to what extent these different backgrounds influence the goals and strategies of these individuals remains inexplicit. With this study, we aim to further explore these issues.

4.3 | Methods

4.3.1 Interviewee selection

We based our interviewee selection on the following: first, in the field of environmental governance in the Netherlands, the need for knowledge brokers appears to be most pressing in cases in which scientific knowledge is highly disputed, and where there are many conflicting interests. Therefore, cases of this type could lead to the identification of knowledge brokers. Secondly, the interviewee should have a certain amount of cross-sector experience (science and policy) (e.g. Buizer and Cash, 2013; Meyer, 2010). Finally, an equal distribution of institutional backgrounds (science, policy, and consultancy) among the interviewees was sought after. In selecting our interviewees, these considerations served as a guide: they were more applicable to some persons than to others.

Taking the above into account, we first selected the key figures who executed the role of knowledge broker in well-known and well-documented cases in the Netherlands in which there was controversy about the role of scientific knowledge in (national) environmental policy development and decision-making processes[1]. For example, we interviewed a knowledge broker with a background in policy, who held a mediating position in the discussion on the gas extraction and cockle fishery activities in the Wadden Sea, and another who was involved in knowledge production for the transition towards sustainable mussel fishery in the Wadden Sea. Secondly, we selected individuals who held a key position as a knowledge broker, and identified themselves as such, within Dutch ministries and large governmental programmes and organisations that focus on environmental issues. For example, we interviewed a former Chief Scientist of a Dutch Ministry on his daily activities, which included informing senior policy makers and ministers. Another interviewee held the position of knowledge broker within the Dutch Delta Programme, a governmental programme responsible for water management in the Netherlands. Thirdly, we selected private sector consultants, or advisors, who specialised in facilitating processes between science, environmental policy makers, and other stakeholders. Finally, by means of snowball sampling, other interviewees were identified. This method also provided validity and verification, since the people suggested were often already on our list of interviewees. In total, this yielded 27 knowledge brokers with a range of institutional backgrounds: nine interviewees with a scientific background, nine interviewees with a background in policy, and finally nine private sector consultants, or advisors. To mention a few, we interviewed university professors who also had (or had had) very senior positions in the Dutch government and ministries, entrepreneurs, representatives of (large) consultancies, and knowledge brokers who worked either in a governmental organisation or in a research organisation whose remit is to inform a Dutch ministry. Although the cases discussed during the interviews showed resemblances, such as in terms of policy field (environmental policy), level (predominantly national), and complexity (multi-stakeholder, multi-interest), none of the interviewees discussed similar cases. In addition, we wish to stress that we are aware that our list of interviewees is not exhaustive, but we do believe it covers a broad range of knowledge brokers within the Dutch national environmental governance arena.

1: to ensure the anonymity of our interviewees, we are not able to provide too many substantive details on specific cases

4.3.2 Data collection and analysis

Our aim was to understand which type of science–policy interaction problems knowledge brokers address, what goals and strategies they used, and what competences and capabilities they applied. Our data collection was structured accordingly. First, we addressed the competences and characteristics of a knowledge broker. Secondly, we discussed the different empirical goals knowledge brokers have, and thirdly, in relation to these goals, their used strategies. Finally, since the literature suggested that knowledge brokers' institutional backgrounds influenced goals, strategies, competences, and capabilities (see Section 4.2.2), we also addressed the type of science–policy interaction problems the interviewees came across during the empirical research. We added this in order to possibly establish whether a knowledge broker with an institutional background in science might address different science–policy interaction problems than a knowledge broker with a private sector background.

Our data collection consisted of semi-structured interviews. Prior to the interviews, all of the interviewees were sent a topic list consisting of five questions that would be the main themes for the interview. We based both the topic list and the questionnaire (see Appendix III) that guided the interviews on the conceptual framework presented in Section 4.2. As we interviewed the knowledge brokers, but not the stakeholders who were involved in the boundary working processes, the answers the interviewees provided us with are self-perceived. Finally, with the consent of the interviewees, all of the interviews, which were conducted in Dutch, were recorded and transcribed.

Using Nvivo software, the transcribed interviews were coded for qualitative data analysis. The first part of the analysis was based on deductive coding (Hennink et al., 2011). On the basis of the different concepts in the conceptual framework, a list of categories was developed prior to the data analysis. Subsequently, verbatim quotes from the interviews were assigned to these different categories. Per category, this resulted in a list of quotes originating from different interviews. The second part of our analysis was based on inductive coding: using the quotes in each category, we developed sub-clusters in order to systematically categorise the coded transcripts. For example, the interviewees were asked to describe certain competences that they thought knowledge brokers ought to have, which resulted in over 200 quotes for that question. Analysing these quotes, we came across remarks (which we have translated for this paper) such as "I had status", "on both sides I was respected and had authority", "at a certain point you have a voice, and that voice becomes authoritative". These three quotes were clustered into the code 'power, authority', based on the choice of words and their explicit meaning. As another example, the interviewees were also asked which interaction problems between science and policy they encountered during their work. This question resulted in over 100 quotes. Analysing this list yielded quotes such as "everyone works on the problem from their own perspective", "the guidance from policy to science is lacking", and "they [scientists] say that policymakers are not interested in knowledge, but that is not true. However, they do not realise that knowledge (…) can be difficult. They need to provide clarity". These were clustered into the interaction problem 'cultural differences between the world of science, and the world of policy', based on the (sometimes less explicit) references to cultural differences, e.g., different perspectives and backgrounds, or a different understanding of what is needed in the process. We are aware that this methodology might have its

limitations, as researcher bias might influence the interpretations of the verbatim quotes. However, by explicitly demonstrating how we approached the analysis, and supporting the results with verbatim quotes from the interviews (translated from Dutch to English) and including the questionnaire in the Appendices, we aim to be transparent about our methodology and analysis. On a final note, we wish to stress that it is not the aim of this paper to present a quantitative analysis. However, in our analysis, we did also pay attention to the distribution of answers between the knowledge brokers with different institutional backgrounds in order to discover to what extent a person's institutional background might influence their goals and strategies.

4.4 | Results

We analysed the empirical data on four categories discussed above in the literature overview on knowledge brokers. Firstly, the science–policy interaction problems knowledge brokers address are discussed, in order to better understand the situations in which knowledge brokers operate. Secondly, their goals are discussed, followed by the strategies they use. Finally, their self-perceived competences and capabilities are presented. In this section, each of these categories will be explored in two ways. First, in general: after analysing all of the interview data, we created sub-categories, at this stage making no distinction between 'who said what'. Second, we determined whether there were noticeable differences between knowledge brokers with different institutional backgrounds (science-related knowledge brokers, policy-related knowledge brokers, and consultants). The results of the four categories are presented in four figures, displaying the cumulative amount of knowledge brokers who addressed a specific sub-category, but also to what extent this sub-category was discussed by the knowledge brokers with different institutional backgrounds.

4.4.1 Science–policy interaction problems addressed

The interviewees discussed a wide range of issues that (according to them) caused problems regarding the interactions between science and policy, and as a result complicated the use of science in policy and decision-making processes. Based on the interviews, which generated over 100 statements, four types of problems can be defined (for a full explanation of these interactions problems, we refer to Appendix V), as is shown in Figure 4.1.

First, all of the interviewees discussed the misuse of knowledge. This interaction problem was addressed by means of empirical examples in which contra-expertise was used to discredit scientific reports, situations in which knowledge was used to support pre-set policy, and cases where knowledge was ignored. Relating the latter, one interviewee explained, for example: "It depends on the culture of the department, but knowledge from outside is perceived as inconvenient, to put it bluntly. When a university or research institute produced a report in the field of [the department] sometimes a sigh was heard: 'and now we have to do something with it'. It was not experienced as helpful". (PM4)

Secondly, all of the interviewees recognised problems related to cultural differences between science and policy; these problems arose because of differences in terms of discourses, culture, levels of abstraction, and notions of time. Also discussed were problems with the formulation of policy and research questions by policy makers that were due to insufficient active steering from policy towards science, and to policy makers' reluctance to seek clarification by asking questions. To give an example: one interviewee explained that he "asked the scientists questions because the policy makers did not dare to do so. (…) They didn't feel safe enough. They felt like their academic background was too limited to ask the proper questions". (S2)

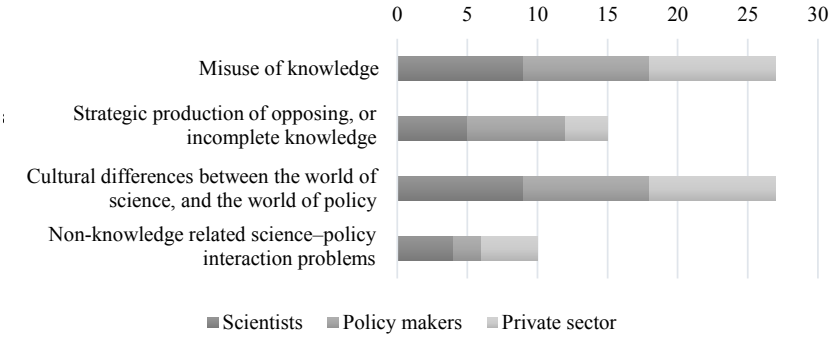

Figure 4.1. Science–policy interaction problems mentioned during interviews, categorised per knowledge broker 'type' and quantified accordingly.

Thirdly, most of the knowledge brokers we interviewed addressed issues concerned with the strategic production of opposing, or incomplete knowledge, such as the production of incomplete knowledge due to a lack of collaboration and co-creation, or situations in which research was conducted out of academic interests rather than driven by policy questions.

Finally, science–policy interaction problems transcending knowledge were mentioned. One of our interviewees explained: "Most of the time you get involved because people are done talking to each other. In Dutch, we say 'trust comes by foot, and leaves on horseback'. In this case, all of the horses ran in different directions. Every conversation between stakeholders ended within minutes, with threats of lawsuits. They were done talking". (C5)

Based on the foregoing, it is especially interesting to see that the problems knowledge brokers address are far from exclusively knowledge-related. Where the scholarly literature on SPIs and knowledge brokers predominantly emphasises the problematic (mis)use and (mis)production of knowledge, this empirical research suggests that besides these problems, knowledge brokers are also confronted with a variety of issues that, at first sight, have no relation to knowledge, but which do have a negative influence on the use of science in policy and decision-making processes. It could, however, be hypothesised that underlying these issues, which appear to focus on the inter-relational aspect of

interactions, is the problematic production and use of knowledge. As the interviewees explained, it is necessary to solve these interaction problems first in order to then be able to focus on the interaction problems related to the production and use of knowledge.

Finally, based on the analysis presented in Figure 4.1, two additional remarks can be made. First, the strategic production of knowledge appears to be a problem predominantly discussed by the interviewees with a policy background; scientists discussed the strategic production of knowledge to a lesser extent. This strategic behaviour is often addressed in the literature on science–policy interactions: for example, Strydom et al. (2010) argued that scientists keep science out of reach of policy makers in order to ensure that they retain their control on the interpretation of science. If policy makers experience this the most, it is hardly surprising that these knowledge brokers emphasise this issue. On the other hand, scientists and consultants discuss problems that are not limited to knowledge more often by than policy makers. The reason could be that the interviewed knowledge brokers from the private sector, for example, tend to be brought into a process to solve whatever interaction issues there might be, whether or not these are to do with the use and production of knowledge.

4.4.2 Goals of knowledge brokers

The interviewees' responses to the questions relating to their goals yielded close to 75 statements. These were inductively combined into three main goals (for a full explanation of these goals, we refer to Appendix V), as presented in Figure 4.2.

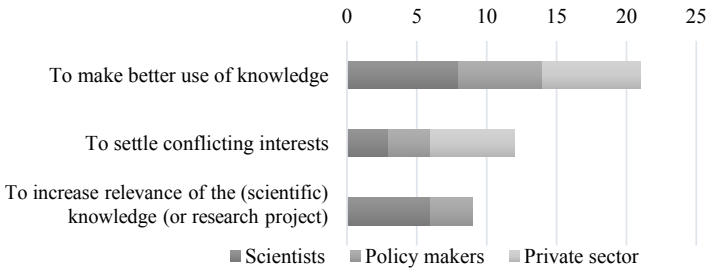

Figure 4.2. Science–policy interaction problems mentioned during interviews, categorised per knowledge broker 'type' and quantified accordingly.

Firstly, the interviewed knowledge brokers claimed that their aim was to allow knowledge to be used better in decision-making processes. This first goal is in line with the literature review on boundary work presented earlier in this paper: facilitating the production, sharing, and use of science in order to enrich decision-making processes is at the core of the theory on boundary work and knowledge brokers (e.g. Runhaar et al., 2016; Meyer, 2010; McNie, 2007; Van den Hove, 2007; Cash et al., 2003). By increasing the credibility, legitimacy, and salience of the knowledge produced, the aim is to provide the stakeholders with all of the opportunities they need to be able to use the knowledge properly. This

was expressed by one of our interviewees as follows: "Before my arrival, people here stood with their backs turned away from policy. It [policy] was unreliable, dangerous, even though we worked as a public service. (…) I came here because I wanted things to be different, because I wanted to increase the relevance of this institute and make all this expertise useful for society (...) create impact" (PM3).

The second goal, which was predominantly mentioned by the interviewees from the private sector, concerns the resolving of conflicts or conflicting interests between stakeholders that would otherwise cause an impasse in the interaction process. It was suggested that disputes occur not only between scientists, policy makers, and other stakeholders, but also within these stakeholder groups, for example, between scientists with different fields of expertise. To illustrate this, one of our interviewees explained a situation in which "the province strongly dictated [the process] from its own perspective on what needed to happen. The other stakeholders felt left out. Thus far it was plain common process management between different stakeholder groups" (C1). This goal has received less attention in the reviewed scholarly literature, especially in relation to a possible link between it and the institutional background of the knowledge broker. The resolution of conflicting interests could be situated in the debate on knowledge utilisation in which the institutional and cultural differences between science and policy are discussed together with how collaboration could solve these issues (e.g. Hegger et al., 2012), for example, since these issues often result from institutional and cultural differences. However, in the theory discussed here, this is not articulated as such.

The third and final goal presented here concerns the involvement of knowledge brokers to increase the relevance of a project or programme. The empirical research suggests that the intervention of the knowledge broker should ultimately enhance the social and scientific relevance of the programme in question. In concrete terms: by becoming involved, the knowledge broker personally increases the relevance of a research programme or organisation. This means that this goal has a different origin than the other two. The first two goals could be considered to be personal goals, or goals that need to be reached by means of the intervention of the knowledge broker. However, this last goal reflects the goal of the initiator of the process. The interviewees who discussed this goal, who were predominantly knowledge brokers with a scientific institutional background, stated that their particular intervention was used strategically: their involvement, contribution, and status as scientists were used to legitimise the social and scientific quality of the particular project, and to enhance its credibility. It could be hypothesised that regarding this last goal, these particular knowledge brokers did not 'work at the boundary'; rather, they themselves were the 'boundary work'. By this, we mean that their involvement already enhanced the interactions between science and policy, rather than referring to the way in which they acted.

4.4.3 Strategies used by knowledge brokers

Over 300 statements referring to the strategies used were inductively combined into nine general strategies (for a full explanation and operationalisation of these strategies, we refer to the Appendix V), which are presented in Figure 4.3.

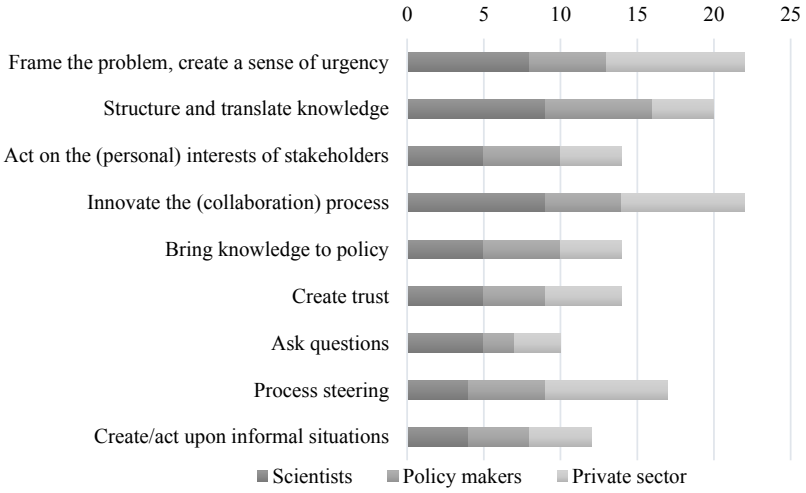

Figure 4.3. Science–policy interaction problems mentioned during interviews, categorised per knowledge broker 'type' and quantified accordingly.

The nine strategies discussed by the interviewed knowledge brokers, and as presented in Figure 4.3, give rise to the following analysis. Knowledge brokers appear to use two types of strategies. The first type concerns strategies that address the more factual side of boundary work: the framing of the problem. For example, this could include forcing stakeholders to approach the problem at hand and propose a solution from an opposing perspective, which could lead to mutual understanding of other standpoints in the debate. This type also includes the structuring and translating of knowledge. For example, one of the interviewees explained that he would create a one-page document that summarised a scientific report, and then distribute it within the Ministry in which he worked. He argued that due to his extensive experience in the field of policy-making, and his knowledge of which dossiers were relevant to his department, he could singlehandedly decide which scientific report would be translated and summarised into this one-page document, and which would not. The knowledge broker thus tried to proactively create awareness, understanding, and acceptance of the available scientific knowledge. Other strategies included bringing knowledge to policy, for example by means of the 'knowledge at the table' principle, and asking questions.

The second type of strategies is concerned with the process side of the boundary work. Ways in which a knowledge broker can influence the interaction process include taking deliberate actions to enhance the interaction process, e.g., choosing the first speaker during a meeting strategically, to set a positive tone. They can also include actively changing roles and wearing different hats to help the process more forward, e.g., shifting strategically between rationales: each stakeholder has their own rationality, and using a policymaker's rationale when addressing a scientist does not work. Knowledge brokers can also strategically steer a process into another direction when a mediation process has reached an impasse. For example, this latter strategy was illustrated by an interviewee who explained that in

some cases, he as a knowledge broker foresaw the process coming to a dead end for various reasons (e.g., lack of credible knowledge, wrong questions asked). However, it was not possible to intervene until all of the stakeholders also understood that the process would stall. Active steering to create this awareness was needed in order to guide the process into another direction.

However, the foregoing immediately raises the question of whether the intervention of a knowledge broker is focussed solely on bringing scientific knowledge to policy (and policy practices), and bringing policy questions to science, or whether process-oriented results are more important. From the distribution of strategies used in relation to the different knowledge brokers, as can be seen in Figure 3, it seems that knowledge brokers from the private sector place more emphasis on the process side of boundary work than scientists and policy makers do when they act as knowledge brokers. Perhaps this is because these private sector knowledge brokers become involved in highly unstructured problems, such as societal problems for which there is no definite solution and where decisions are often based on a range of values and interests of the stakeholders involved. The level of structuredness is (according to Hoppe (2005)) based on the level of reliability of relevant knowledge, and on the level of consensus about relevant norms and values. If neither of these two is applicable to a policy problem, it can be considered to be 'unstructured'. This hypothesis would be in line with the results discussed in the previous sections, since this group of knowledge brokers also identified interaction problems not limited to knowledge as an interaction problem, and claimed that settling conflicts and conflicting interest was at the heart of their work as knowledge brokers.

4.4.4 Essential competences, qualities and capabilities of knowledge brokers

Having discussed the interaction problems on which knowledge brokers focus, as well as their goals and strategies, the final question that remains concerns the knowledge brokers as persons. What competences, qualities, or capabilities do they have that enables them to act as knowledge brokers? The interviewees were therefore asked to define the competences, qualities, and capabilities that they thought a knowledge broker should have. This question generated over 200 statements, which resulted in the 10 categories (for a full explanation of these competences, we refer to Appendix V) that are presented in Figure 4.4.

As can be seen in Figure 4.4, seven competences, qualities, and capabilities can be identified as having been discussed by the majority of the interviewees. In terms of competences, having a personal network, being in the possession of relevant knowledge (both process and factual knowledge), and possessing intellectual capabilities, or, as one of the interviewees stated: "You need to be a systems thinker, capable of finding the coherence of things" (S6), are considered to be important. In terms of personal qualities, being aware of and acting upon the different interests of the participants in the process, and having a personal drive to do this type of work were suggested to be essential. Finally, regarding useful capabilities, over half of the interviewees mentioned the ability to communicate well and to act impartially. The outcome is not surprising, given the goals and strategies of these individuals and the work they do.

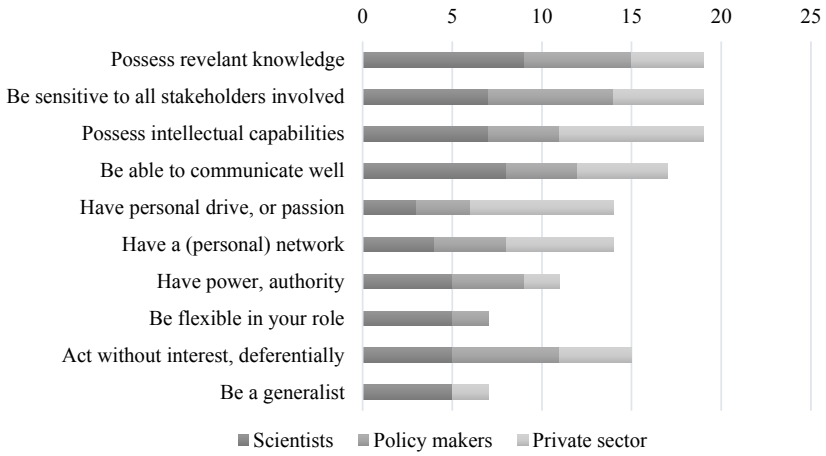

Figure 4.4. Science–policy interaction problems mentioned during interviews, categorised per knowledge broker 'type' and quantified accordingly.

Noteworthy differences between the three categories of knowledge brokers can be seen in their motivation of 'having a drive and commitment'. This was mostly discussed by interviewees from the private sector: terms like 'passion', 'commitment', and 'sincere interest' cropped up during the interviews, but were not elaborated upon. A possible reason for this predominance of private sector interviewees is that the consultants interviewed act as knowledge brokers on a daily basis—it is their job—whereas the scientists interviewed, for instance, often had many other responsibilities. Additionally, as one interviewee argued, in academia you are judged on achievements other than acting as a knowledge broker. The final interesting difference regards the last competence: being a generalist. This was predominantly mentioned by scientist interviewees. The reason for this might be that a scientist knowledge broker often becomes involved due to his/her own field of expertise. However, in the case of contentious knowledge and conflicting interests, multiple fields of science interact. For scientists, this could therefore result in being aware of their 'generalist qualities'.

4.5 | Discussion and recommendations

This research originated from our interest in better understanding how knowledge brokers perceive the interactions between science and policy, and what their goals and strategies are to improve the production and use of science in decision-making processes. Based on the analyses presented in the previous section, we can firstly conclude that this research adds another category to the existing framework on science–policy interaction problems: that of interaction problems not limited to knowledge, which hamper the interactions between science and policy, but are not directly linked to the use or production of knowledge. Secondly, the goals of the interviewed knowledge brokers

are far from exclusively focussed on enhancing the use and production of knowledge. Contrary to what the literature overview presented earlier suggests, the goals discussed by our interviewees also point to the resolving of conflicts between stakeholders. Getting stakeholders to communicate with each other appears to be a dominant goal, especially for the interviewees from the private sector. This brings us to a third conclusion: the institutional background of a knowledge broker has implications for the science–policy interaction problems they address, as well as their goals and the strategies that they use. We have seen that especially knowledge brokers whose background lies in the private sector address interaction problems that are not limited to the issues related to the production and use of knowledge, and often have aimed for the different stakeholders to start communicating with each other. One of our interviewees (director of a small consultancy, specialised in the facilitation of multi-stakeholder processes in the field of environmental governance) argued that his work often comprised the management of people, instead of the brokering of knowledge. On the other hand, the interviewees with a scientific background, more than the other two categories, argued that they were involved in boundary work processes because their presence alone already increased the credibility and legitimacy of the knowledge development process. The observation that knowledge brokers with different institutional backgrounds address different science–policy interaction problems could hypothetically point to an interesting recommendation for practice. The success of enhancing science–policy interactions, with the ultimate aim to enrich decision-making processes might depend on the choice of knowledge broker in relation to the interaction problem at stake. Fourthly, based on the strategies discussed in the previous section, we made a distinction between strategies focussed on the process side of boundary work, and strategies that focussed on the substantive side of boundary work. However, another type of differentiation is also possible. It could be hypothesised that knowledge brokers work in two settings that require different types of strategies: one on stage, which involves different stakeholders, the other one backstage, where the knowledge broker him/herself strategically manoeuvres the process into a certain direction. The framing of the problem, but also actively bringing knowledge to policy and the creation of trust, are strategies that could fall under the first category (on stage): the collaboration of all stakeholders is needed to make these strategies useful and productive. Strategies related to the process side of boundary work, such as the strategic steering of the process and the creating of informal situations, could be described as backstage strategies: the knowledge broker foresees where the process needs to be steered, and tries to do so on his/her own. This perspective on the strategies of knowledge brokers makes the process of boundary work less transparent than the current scholarly literature discussed in this paper would have us believe.

So, what role does scientific knowledge have in all of these processes? Of all the competences and capabilities that emerged in the empirical results, the one that most interviewees mentioned as being the most important was the possession of knowledge on the topic on which they are working. However, based on the foregoing, it appears to be more likely that the (perceived) credibility and legitimacy of the knowledge broker is more important to the process than the degree of credibility and legitimacy of the knowledge used in the decision-making process. When comparing the (hypothetical) role of the honest broker (e.g., Pielke 2007) with the practical reality of the interviewed scientist knowledge brokers, this idea of presenting or focussing on incorporating credible knowledge into the interaction

process to enrich decision-making processes is less dominant than might be expected. This does not mean that the intermediary processes these knowledge brokers are involved in do not focus on knowledge at all. As argued throughout this paper, the interactions between science and policy are often difficult because of the knowledge at issue—whether it is regarding its use or its production. However, this research suggests that a knowledge broker is needed not only when there are conflicts around knowledge. Or, as one of the interviewees puts it: "I would always use an intermediary when [the process] is blocked, and yet there is enough knowledge and insight present to be able to develop alternatives, but due to resistance this has not been done. (…). The world of knowledge does not spread on its own, and the stakeholders involved are not at all interested [in this knowledge], since they want to keep their viewpoint. That is the ideal moment for a knowledge broker".

We would argue that this research provides us with a next step in understanding the concept of knowledge brokers, both in theory and in practice. However, as with any research, this research has some limitations that need to be considered. First of all, we did not analyse in depth how the boundaries between science and policy were shaped, and by whom. Rather, we took this as the starting point of this explorative study. Future research could analyse in more depth how actors shaping the boundary contribute to the need for particular types of knowledge brokers on the boundary. Secondly, we are also aware that our sample of 27 is too small to give a complete and general answer on why and how knowledge brokers work in practice. Lastly, our geographical focus might also cause limitations: the Netherlands is known for its consensus culture, and this culture is likely to influence the strategies used by knowledge brokers within that setting.

We recommend further research into the actual effectiveness of knowledge brokers in enriching decision-making processes. More in-depth empirical research into single knowledge brokers is a suggestion. Focussing on the strategies of knowledge brokers in specific cases will provide more detailed accounts of how individual knowledge brokers work. Secondly, during the interviews, the interviewees discussed various situations in which they acted as knowledge brokers. Most of the interactions between science and policy in the situations discussed were already troubled at the time the knowledge broker intervened in the process. This comes across as 'incident politics': deploying knowledge brokers reactively, when the interaction problems already exist. Instead, we recommend starting a debate on the practice of environmental governance, regarding whether or not knowledge brokers should proactively be given a mediating role in complex decision-making processes from the beginning of the process. This is an important consideration since, as one of the interviewees stated, there does not need to be a science–policy interaction problem for there to be a need for a knowledge broker.

Chapter 5

PROMOTING ENRICHED COASTAL ZONE MANAGEMENT: THE ROLE OF BOUNDARY OBJECTS

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Abstract

In coastal zone management (CZM), scientific knowledge can help enrich and underpin the development of policy options by providing insight into (the management of) ecosystems, the use of ecosystem goods and services and ecological limits to the exploitation of natural resources. Due to the large array of interests and stakeholders involved in CZM, however, the production and use of knowledge which is perceived to be credible, legitimate and salient is often complicated. Scholarly literature suggests employing collaborative and participatory approaches, such as the development and use of boundary objects, to enhance the production and use of knowledge in CZM, with the aim of enriching decision-making processes. This paper will empirically explore two assessment systems as boundary objects in order to address the question 'To what extent and in what way do boundary objects contribute to enriched coastal zone management?'. Our analysis suggests that for a boundary object to contribute to enriched CZM, the need for it to be credible is less important than the need for all involved stakeholders to perceive it and its development process as being legitimate to their interests. Secondly, without a direct 'policy window', the boundary object has little chance of directly enhancing the knowledge of decision-makers.

5.1 | Introduction

Coastal zone management (CZM) faces a number of challenges. The physical and ecological functioning of these zones is under pressure, inter alia due to sea level rise, acidification and overfishing (e.g. Gattuso et al., 2015; Cazenave and Cozannet, 2014). Interactions among ecological and economic interests are complex, not least because the different objectives of the broad array of stakeholders ranging from policy-makers, coastal managers and industry to researchers and civil society organisations etc. can give rise to tensions (e.g. Puente-Rodríguez et al., 2015). This presents challenges for the management of the physical coastal zone as well as the management of knowledge in this process (Giebels et al., 2013). Scientific knowledge can help enrich and underpin CZM by providing insights into and policy options for the management of ecosystems, the use of ecosystem goods and services, and the ecological limits to the exploitation of natural resources (Van Tatenhove et al., 2016:377). However, the large array of interests and stakeholders involved in CZM often complicates the production and use of knowledge. In particular, tensions may occur between science and policy – "the former seeks unbiased, objective descriptions or reality, while the latter must incorporate various factors in its development, including values, ideologies, economics, biases, and emotions" (Rose and Parsons, 2015:71). It is also argued that often, "the supply of scientific knowledge does not meet the requirements of users of knowledge in terms of the speed in which knowledge is delivered, its level of detail, its scale, its relevance or the extent to which uncertainties have been reduced" (Van Tatenhove et al., 2016:377).

In order to optimise the role of science in enriching and underpinning CZM, various authors in CZM literature have proposed to employ collaborative and participatory approaches (e.g. Runhaar et al., 2016; Van Tatenhove et al., 2016; Döring and Ratter, 2015; Seijger et al., 2015; Vugteveen et al., 2015; Tompkins et al. 2008). Enriched decision-making can be understood to be the behaviour of decision-makers when influenced by their enhanced knowledge of the consequences of their decisions (Heink et al., 2015). To make this more tangible, in enriched decision-making, knowledge is used to arrive at a clearer picture of the problem setting, to underpin and implement policy and management measures, to explore policy options, and it is also used in learning processes among policy-makers, scientists and stakeholders (e.g. Van Tatenhove et al., 2016; Van de Riet, 2003). This research will focus on a specific science–policy interface, or approach, for organising participatory knowledge development processes, namely the employment of boundary objects. Boundary objects are "hybrid constructs that integrate elements from scientific and political worlds to facilitate the negotiation and exchange of multiple types of knowledge and action" (White et al., 2010:221), and 'can be used to transfer or communicate complex scientific information into understandable and tailored information which is tacitly connected to the target group' (Van Pelt et al., 2015:42). In the field of CZM, various boundary objects have been used in order to enrich decisions (e.g. Floor et al., 2016). For example, ecological indicators (e.g. Turnhout et al., 2007; Turnhout, 2009) can be used as boundary objects to measure the ecological quality of ecosystems. Another boundary object is the concept of 'significant effect' as a threshold for allowing human activities in protected marine areas (Floor et al., 2016). Döring and Ratter (2015) discuss the concept of 'Heimat' as a boundary object.

Heimat is a German word or concept which encompasses a range of place-based meanings reflecting a spatially and socially experienced construct, and, as a boundary object, is used in science–policy interactions to create self- and outside perceptions of why and how people relate to a certain natural area, mutual understanding and develop common goals (Döring and Ratter, 2015). Becker (2016) refers to (climate) scenarios as boundary objects: these are visualisations of scenarios based on scientific data that should help communicate complex and nuanced information in a mode which people understand (Becker, 2016). These examples give some idea of the variety of boundary objects. More specifically, boundary objects are not so much physical objects per se as the end products or outputs of participatory processes. As can be seen in the given examples, they can be presented in different ways. Irrespective of their forms, boundary objects have the common aim of bringing together stakeholders (scientists, policy-makers and other stakeholders) within the coastal management arena who then collectively develop a knowledge-based boundary object to, for example, assess the ecological state of a coastal zone area. Notwithstanding all of this, even though the literature presents us with examples of boundary objects, the questions of how and to what extent they facilitate enriched decision-making in CZM remains underexposed.

This paper aims to address this 'black box' in the literature on boundary objects in CZM. Our main research question is therefore: *'To what extent and in what way do boundary objects contribute to enriched coastal zone management?'*. In order to address this question, the following sub-questions have been formulated: i) How does the scholarly literature characterise boundary objects in terms of their features and their functions?; ii) How can the potential influence of boundary objects on enriched decision-making processes be determined?; and iii) How, and to what extent do boundary objects contribute in practice to enriched coastal zone management?.

In order to address these questions, we firstly analysed the scholarly literature on boundary objects to establish their features and functions. Next, we empirically explored two boundary objects which both aim to assess the current ecological state of the Dutch Wadden Sea area. This is a coastal zone of great ecological value (it was awarded UNESCO Heritage status in 2010) due to its unique ecosystem, but it is also of great economic value due to its natural resources (e.g. gas and salt) and its harbours and tourism industries. Because of these contrasting interests, the management of the Wadden Sea area can be characterised by the continuous struggles between ecological and economic interests involving a large array of stakeholders, ranging from industries, to government (national, provincial, and local), environmental agencies, and research institutes (e.g. Van Nieuwaal, 2010; Runhaar and Van Nieuwaal, 2010; Floor et al., 2013). The exploration of boundary objects by means of a case study serves the aim of analysing how these objects function in practice and their contribution to enriched CZM (Yin, 2009). By analysing a two-case study, we will attempt to draw conclusions that can be further generalised and hypotheses aimed at further informing the current scholarly literature on boundary objects in CZM. The two boundary objects we will analyse are assessments of the impact of human interference on the ecological state of the Dutch Wadden Sea: the Wadden Sea Barometer[1]

1: In Dutch: 'Waddenbarometer'

(hereafter WSB) and the Waddenhouse Deliberation ranking[2] (hereafter WHD). We consider these assessments to be boundary objects since they have been developed in a participatory process with the aim of developing and communicating knowledge across the boundaries among science, policy and practice, in order to support CZM in the Wadden Sea. Besides the similarities, there are notable differences between these two assessments as well: whereas the WSB had a descriptive approach, the WHD not only assessed but also ranked the ecological and economic impact of human activities on the Wadden Sea. Ranking activities in this way immediately impacts on the interests of involved stakeholders and can potentially give rise to the boundary object itself being contested.

5.2 Boundary objects and their contribution to enriched decision-making: a literature review

This section will address the first two sub-questions by providing a brief literature review on boundary objects (the structure of which is depicted in Figure 5.1), addressing their characteristics and functions, and developing a framework that could be used to empirically analyse how and to what extent boundary objects can contribute to enriched decision-making processes. CZM literature provides few (empirical) examples of boundary objects. To provide a more thorough and in-depth theoretical analysis of the functions of boundary objects and how they contribute to decision-making processes, we begin by addressing how the scholarly literature characterises boundary objects in terms of their characteristics and their functions in the first part of this paper. Here, we not only use CZM literature but also broaden our perspective by including scholarly literature which discusses boundary objects within the field of environmental governance in general. This literature discusses issues closely related to CZM, such as water management (e.g. Van Pelt et al., 2015; White et al., 2010; Lejano and Ingram, 2009), and ecosystem management (e.g. Abson et al., 2014; Cortner, 2000). In the second part of this section, we will look more closely at the contribution of boundary objects to enriched decision-making. As we will show, the literature on boundary objects provides us with limited guidance to analyse these contributions. We will therefore use the framework developed by Cash et al. (2003), who argue, in their article, that in order for scientific knowledge to enrich sustainable decision-making processes, the knowledge needs to be perceived by all involved stakeholders as credible, legitimate and salient. Briefly, these three criteria can be understood as follows: for knowledge to be perceived as scientifically credible, it needs to be scientifically adequate, accurate, trustworthy and of high quality (e.g. Van Enst et al., 2014; Hegger et al., 2012; Buizer and Cash, 2005). Legitimacy is reached when the producers of the information are seen as free from bias and the knowledge produced respects the divergent values and beliefs of the stakeholders (e.g. Hegger et al., 2012; Cash et al., 2003). This would increase the level of trust regarding the information and the likelihood that it will be used by the end-user (Cvitanovic et al., 2015). Finally, salience refers to the level of relevance of the scientific research to decision-makers and the problem at stake (e.g. Cash et al., 2003).

2: In Dutch: 'Waddenhuisberaad'

5.2.1 A boundary object: what are its features and its functions?

Following Star and Griesemer, who are considered to be the founders of the concept, boundary objects can be understood as objects which are "plastic enough to adapt to the local needs and the constraints of the several parties employing them, yet robust enough to maintain a common identity across sites" (1989:393), or, to make it more concrete: "objects that are shared and shareable across different problem-solving contexts. (…) objects that work to establish a shared context that 'sits in the middle'." (Star, 1989:47). For this purpose they possess a certain interpretive flexibility. An object can be interpreted differently by various actors, due to differences in use and interpretation, but "must provide a common focus" (Feldman et al., 2006:95). Star and Griesemer argue that the nature of a boundary object is "reflected by the fact that they are simultaneously concrete and abstract, specific and general, conventionalized and customized" (1989:408). So what, then, is considered to be a boundary object? As mentioned in the previous section, concepts such as 'significant effect' (Floor et al., 2016), 'Heimat' (Döring and Ratter, 2015), or 'sustainability' (Brand and Jax, 2007) are discussed as being boundary objects. In the sphere of classification systems, ecological indicators (e.g. Turnhout, 2009) are discussed as such. Furthermore, in a more concrete sense, ecosystem services (e.g. Abson et al., 2014), simulation games (e.g. Van Pelt et al., 2015), scenarios (e.g. Chaudhury et al., 2013; Becker, 2016), and interactive simulation models (e.g. White et al., 2010) are also examples of boundary objects. This list of examples of boundary objects, however, does not answer the question. Rather, it might make understanding the idea of a boundary object even more difficult. As stated before, they are not physical objects. So could it be that different authors attribute different meanings to the concept of 'boundary object'? A follow-up question could therefore be: what makes these objects 'boundary objects' and what are their common functions? Or, in short: what does a boundary object do?

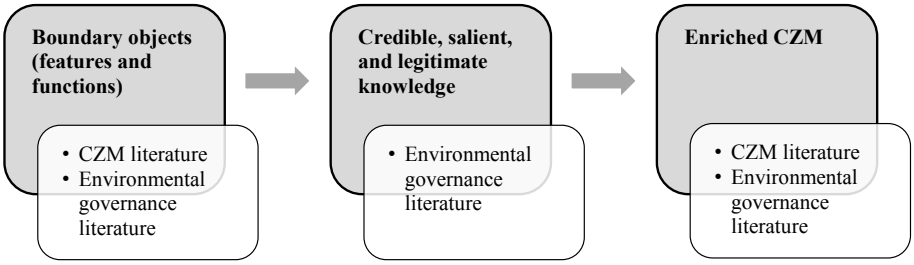

Figure 5.1. Structure of literature review on boundary objects in CZM

Based on the scholarly literature concerning boundary objects that we reviewed, at least three functions can be identified. First of all, Van Pelt et al. argue that boundary objects (in their case simulation games) "can be used to transfer or communicate complex scientific information into understandable and tailored information which is tacitly connected to the target group" (2015:42). In other words, boundary objects (such as, for example assessments and rankings) aim to gather, combine and clarify scientific knowledge, making the information more understandable and useful for decision-making

processes (e.g. Van Pelt et al., 2015; Clark et al., 2011; White et al., 2010). However, in order for a boundary object to fulfil this function, the development and use of a boundary object needs to facilitate and structure the interactions and communication among stakeholders (e.g. Abson et al., 2014, White et al., 2010), which is the second function. The act of collectively going through the process of developing the boundary object provides a concrete means for individuals to specify and learn about their differences and dependencies across a given boundary (Carlile, 2002). This development of a boundary object facilitates the negotiation and exchange of multiple types of knowledge (e.g. Abson et al., 2014; White et al., 2010; Brand and Jax, 2007). After the boundary object is developed, its room for flexible interpretation provides a common ground (without the need for consensus (Star, 2010)), or scope, which can be used as a starting point on which to base further interactions (White et al., 2010). The third function is also in line with this second function: boundary objects serve to establish a shared context that "sits in the middle" (Star, 1989:47) by letting scientists from various disciplines cooperate (in spite of the tremendous differences) in order to create applicable science (Carlile, 2002). The interdisciplinary character of the knowledge on which boundary objects are based allows for this shared context.

Taking these (possible) functions of boundary objects into consideration, to what extent do they contribute to enriched CZM? The reviewed literature provides us with little understanding on this matter: White et al. (2010), for example, describe how water managers evaluate a simulation model (the boundary object), but do not assess to what extent this model might influence their decision-making processes. We therefore propose to search for a framework which could (hypothetically speaking) draw a link between the functions of boundary objects and enriched CZM.

5.2.2 A boundary object: criteria leading to enriched CZM

As argued earlier in this paper, in order to overcome interaction barriers existing between science and policy and by doing so to enhance the use of scientific knowledge within these interaction processes, scholars emphasise that "the likelihood of success is enhanced via the implementation of collaborative and participatory approaches to knowledge exchange and scientific research" (Cvitanovic et al., 2015:29). An often-used framework to analyse this issue is developed by Cash et al. (2003), who argue that decision-makers are more likely to use scientific knowledge in decision-making processes if the knowledge at issue is perceived as credible, legitimate and salient by the stakeholders involved. These criteria, in turn can be related to the three functions of boundary objects discussed in the previous section. For example, the function of gathering, combining, clarifying and communicating complex scientific knowledge should (hypothetically) increase credibility because of the increased level of trustworthiness and accuracy of the combined knowledge, but its salience should also be increased because it will be more understandable and thus more likely to be applied. As for the facilitation and structuring of the interactions between involved stakeholders (a more process-oriented function), this would (hypothetically) lead to an increased level of legitimacy for both the process and the ultimate boundary object, due to the creation of a process which is inclusive and therefore respectful of the different values and beliefs of all involved stakeholders. Finally, the establishment of a shared context and a sharing of applicable knowledge could increase the level of credibility (since

epistemological differences are being bridged), legitimacy (since the word 'shared' incorporates a certain inclusiveness of stakeholders' perspectives) and salience (because of the increased relevance this function aims to attain).

In order to analyse the credibility, legitimacy and salience of boundary objects, these criteria first need to be made operational. In order to do this, we rely on the work by Hegger and Dieperink (2014), who analysed joint knowledge production processes, White et al. (2010), who analysed the (perceived) credibility, legitimacy and salience of simulation models, and Heink et al. (2015), who researched how credibility, legitimacy and salience could serve as criteria for the effectiveness of science-policy interfaces. In line with these authors, we will review these criteria as perceived by participating key actors. The operational criteria should be considered to be sensitising concepts rather than definitive concepts: "[S]ensitising concepts have no fixed operational definition, but provide the researchers a frame on 'where to look'" (Hegger and Dieperink, 2014:34). In line with this, it needs to be stressed that concepts such as credibility, legitimacy and salience can be considered to have a variety of meanings, and as Heink et al. argue in their paper, these meanings can be ambivalent. They state that "most knowledge and most decisions are credible, relevant or legitimate […]. For example, local knowledge is highly credible for stakeholders but often does not meet standards of scientific credibility." (2015:686). Although we could agree on this given example, we would argue that it is not a case of either/or. Since participatory processes are at the basis of the development of boundary objects, it would seem that in order for a boundary object to be credible, the knowledge on which it is based should not only meet scientific standards, as Heink et al. put it, but should also include other 'types' of knowledge.

Combining the literature mentioned resulted in Table 5.1, making credibility, legitimacy and salience operational, which we will use in analysing our two case studies.

Criteria	Making it operational
Credibility	The technical evidence is scientifically valid [α β δ]
	Epistemological differences are bridged [γ]
	Different forms of knowledge are included [γ]
Legitimacy	The boundary object is perceived as unbiased [α β]
	The role of the stakeholders involved is clear during the development process of the boundary object [γ]
	The boundary object includes divergent actor values and perspectives [α β]
	Stakeholders agree that the right questions have been asked concerning the right problem [γ]
	There needs to be active and inclusive communication among stakeholders [γ]
Salience	The boundary object is perceived to be relevant to decision-makers [α β γ δ]
	The language used decreases the complexity of the scientific knowledge, making it more accessible and understandable [γ]

Table 5.1. Indicators of, and conditions for, the credibility, legitimacy and salience of a boundary object; α: Cash et al. (2003); β: White et al. (2010); γ: Hegger and Dieperink (2014); δ: Heink et al. (2015)

5.3 | Methodology

In order to explore boundary objects in practice, we used the method of case study research. A case study allows for studying a phenomenon in its real-life context (Yin, 2003). This method therefore allows us to explore the extent to which boundary objects contribute to enriched CZM and complementary aims contribute to the theory-building on boundary objects. In this research, we have chosen to examine two cases which provide us with insights into the (variations between the) development and use of boundary objects: the Wadden Sea Barometer and the Waddenhouse Deliberation ranking. The two selected cases can be understood to be boundary objects, since they are both constructs from different types of knowledge (scientific and expert on the one hand, and multi-disciplinary on the other) which include political elements as well, since their development was demanded by policy needs and their questions were therefore leading in the development of this 'construct'. Furthermore, they are developed in a participatory process with the aim of developing and communicating knowledge across the boundaries among science, policy and practice. Following the definitions by White et al. (2010) and Van Pelt et al. (2015), this makes these two assessments boundary objects. Because the two boundary objects were developed recently, we were able to access accurate data. Finally, this research can be considered to be exploratory by virtue of its position within the current body of literature: other authors often do not address the question of the extent to which boundary objects contribute to enriched decision-making. However, researching two cases does not entitle us to claim to have developed standardised conclusions, which is why this research must be seen as exploratory. Firstly, we conducted extensive desk research into the two boundary objects that are the subject of this paper. The documents we consulted initially were predominantly in the public domain. Later, we obtained documents that were more difficult to locate from the organising actors of the two objects. This desk research was done to give us a thorough idea of the content of the two boundary objects and of the processes which led to the final assessments. Secondly, during the Waddenhouse Deliberation, held in February 2016, unstructured observation was conducted. Unstructured observation has the aim to "record is as much detail as possible the behaviour of participants with the aim of developing a narrative account of that behaviour" (Bryman, 2004:167). Thirdly, we conducted semi-structured interviews with key individuals in the two cases (project leaders and developers of the two objects and a CZM policy-maker). These interviews were used to gain an understanding of the processes which led to the final boundary objects themselves, and were therefore held with the people who were closely related to the task of developing the assessments. Finally, in addition to these interviews, we gathered information by means of two online questionnaires (one for each case study). These questionnaires, which consisted of a set of statements and which can be found in the supplementary material, were used to explore how credible, legitimate and salient the assessments were perceived to be by the stakeholders involved (scientists, policy-makers, representatives of environmental organisations, and representatives of Wadden Sea industry sectors). The statements in the questionnaire directly correspond with making the three criteria of credibility, legitimacy and salience operational. The statements were rated on a 6-point scale (ranging from strongly agree to strongly disagree in five steps; 'no opinion/do not know' was the sixth option. In both cases, we selected the respondents to

the questionnaires based on the final assessment report[3]. The Wadden Sea Barometer report indicated 21 people (including scientists, experts, coastal zone managers, policy-makers, representatives of environmental organisations, representatives of industry) who were involved in the development of the Barometer. In the case of the Waddenhouse Deliberation ranking, the final report mentions the names of 48 people who contributed to the development of the ranking (range similar to the WSB). Nine of these people were mentioned in relation to both boundary objects. It needs to be noted that by using the stakeholders identified in the two reports, we might fail to include other potential stakeholders who are influenced by CZM decisions. Table 5.2 shows the response rate in both cases.

	Case Wadden Sea Barometer	Waddenhouse Deliberation ranking
# of interviews	2	3
# of questionnaire respondents	9 (out of 21)	23 (out of 48)

Table 5.2. Number of interviews per case and the response rate to the online questionnaire per case

In the following analyses, references will be made to our data. We differentiate between interviewees, and respondents. The latter were given the opportunity to add comments to the questionnaire. Where these comments are quoted, they have been given the reference 'Resp.#X'. Where we refer to one of our interviews, the designation is 'Interviewee #X'.

5.4 The contribution of boundary objects in enriched coastal zone management: two cases from the Dutch Wadden Sea

5.4.1 An introduction to the Wadden Sea Barometer and the Waddenhouse Deliberation ranking

Before elaborating on the two cases that are central to this paper, a brief introduction to the underlying history of the reasoning applied to the issues of the Dutch Wadden Sea should be given. The use of boundary objects such as assessment systems (e.g. Ten Brink et al., 1991; Cash et al., 2003; Runhaar and Van Nieuwaal, 2010) is not new to coastal zone areas such as the Wadden Sea region and therefore, the Wadden Sea Barometer and the Waddenhouse Deliberation ranking do not stand on their own. The area has historically been subject to contested stakes; economic and ecological interests have been vying with each other for decades. The Wadden Sea (see Figure 5.2 for a map of the international Wadden Sea region) is of great ecological value, having unique qualities for which it was awarded Unesco World Heritage status in 2009. It is a partially intertidal wetland area bounded by a series of islands and the coast of the Netherlands, Germany and Denmark. It is rich in shellfish, which makes it an important area for migratory birds. Its tidal channels, mud flats and salt marshes give it a highly dynamic ecosystem, which hosts a broad range of species (e.g. Turnhout et al., 2008; Van der Molen et al., 2016). On the other hand, especially in the case of the Dutch Wadden Sea area,

3: The Wadden Sea Barometer: https://www.waddenacademie.nl/nl/nieuws/nieuwsbericht/article/waddenbarome/; The Waddenhouse Deliberation: https://rijkewaddenzee.nl/nieuws/waddenhuisberaad/

fishery activities, gas and salt mining activities, harbours and tourism are of great economic importance to both the local area and the Dutch government.

Figure 5.2. The international Wadden Sea area, stretching from the Netherlands to Denmark (derived from www.waddensea-worldheritage.org)

An important question for which the CZM in this region requires knowledge is the extent of the influence of human activities on the ecological state of the coastal zone area in relation to its natural restorative capacity. In recent history, various assessment systems have been developed to create an in-depth understanding of this question. Examples of such systems in the Dutch Wadden Sea area are the so-called Sea Amoeba model and the Cascade model. The first of these, developed in 1991, aimed to develop and assess quantitative and verifiable ecological objects on which management decisions could be made regarding the 'maintenance and the attainment of a water quality level to preserve the ecological values in relation to desired use of the water system' (Ten Brink et al., 1991:265) The latter, developed in 2004, was a ranking model which identified and ranked the environmental impact and risks to the Dutch Wadden Sea region of various (human) interventions such as gas exploitation and cockle fishery activities, based on existing scientific knowledge (Runhaar and Van Nieuwaal, 2010). In the process of creating this latter model (which included a broad range of stakeholders), an increased level of legitimacy of the knowledge used was sought (Van Enst et al., 2016). The model that emerged was the result of a consensus on the analysis of the available knowledge. This provided common grounds upon which further discussions regarding the management of the Dutch Wadden Sea area could be based[4].

In April 2013 a meeting was organised among scientists, policy-makers and other actors with an interest and/or stake in the Wadden Sea region. This meeting was held approximately 10 years after a similar gathering, which had in fact turned out to be the first step towards the development of the Cascade

4: For further insights into how the Cascade model resulted in policy decisions, see for example Runhaar and Van Nieuwaal, 2010

model and the radical changes in CZM in the Wadden Sea region which followed (see for example Runhaar and Van Nieuwaal, 2010, Floor et al., 2013). IMSA Amsterdam, a think tank and consultancy organisation which had also initiated the gathering in 2003, wanted to evaluate whether the measures taken in the decade from 2003 to 2013 had worked, what new developments had come to the surface in the interim, and whether new interventions were now needed to enhance the Wadden Sea system (Verslag bijeenkomst Skylge+10). As explained by interviewees 1, 2 and 3, voices were raised expressing a need to develop an assessment model, similar to the Cascade model, to examine the current state of the region. The expressed needs were: on the one hand, to compare the current state of the Wadden Sea to that of ten years previously; on the other hand, to obtain reliable new data to serve as guidance for ongoing monitoring the area. It was felt that developing a similar boundary object would reveal the improvements, but also potential (future) risks to the region. The fundamental impetus for both the Wadden Barometer and the Waddenhouse Deliberation can be found in these needs.

5.4.2 Wadden Sea Barometer

The Wadden Sea Barometer (hereafter WSB) can be defined as a monitoring tool for assessing the Wadden Sea region from the perspective of sustainable development. Its development, guided by Telos (a research institute connected to Tilburg University in the Netherlands), was a response to the need to monitor the area and to establish whether the management of the Wadden Sea region was 'on track'. The report of the WSB assesses the ecological, economic and socio-cultural state of the Wadden Sea area, based on a set of indicators. Furthermore, it displays to what extent the area is developing (positively or negatively).

Telos states in the report on the barometer that the process of developing the barometer was guided by a number of basic principles. Foremost among these was the need for commitment and engagement of stakeholders: it was the aim of the process to create ownership of the barometer among the stakeholders. Furthermore, it was agreed that the data and indicators which were to guide the development of the barometer should be based predominantly on indicators and data already in use in the monitoring activities in the Wadden Sea region. In other words, the barometer should primarily be based on existing (scientific) data and indicators. A final basic principle would be the transparency and trustworthiness of the process and therefore of the barometer: each indicator should be defined meticulously and should include evidence of the credibility of the data used. Table 5.3 has been developed, linked to the functions of the barometer:

Basic principles (developed by Telos)	Related functions of a boundary object
Commitment and engagement of stakeholders is needed	The object is the structuring and facilitation of interactions among stakeholders
Data and indicators used to develop the WSB are to be based on existing data and indicators being used in monitoring activities	Scientific knowledge is to be gathered and combined to create a shared context and applicable knowledge base
The process must be transparent and trustworthy	The object is the structuring and facilitation of interactions among stakeholders

Table 5.3. Telos' basic principles related to the functions of a boundary object

The development of the barometer (presented in Figure 5.3) started with conversations and interviews with a broad array of stakeholders, including scientists, (local) policy-makers, experts, environmental organisations and the private sector. These meetings had two purposes: on the one hand, the project leaders wanted to create support for the barometer; on the other hand, the meetings were intended to gather insights, knowledge and information intended to serve as input for the development of the indicators for the barometer. In relation to these activities, interviewee #2 noted that although people were cooperative and in support of the development of such a boundary object, there was also some suspicion: because the WSB was 'not invented here', the capability of the barometer to address the inner struggles and tensions among stakeholders, namely the industries and other interests in the region, was questioned.

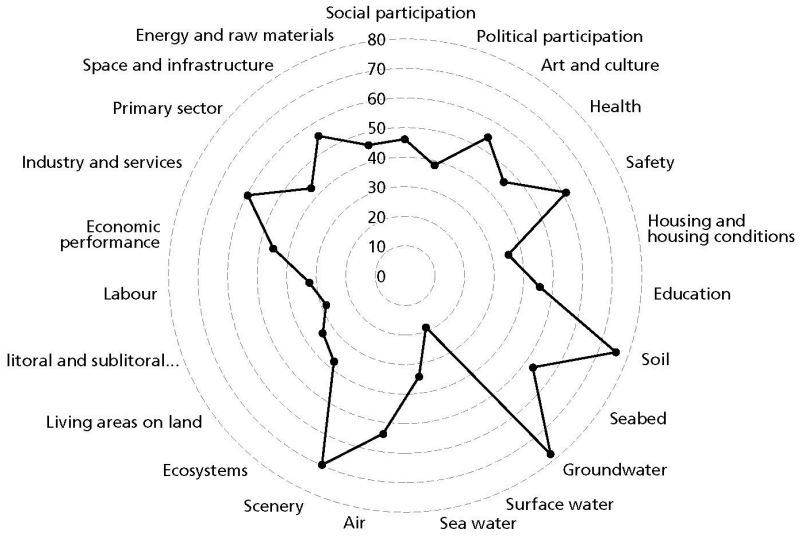

Figure 5.3. Spider diagram[5], presented in the conclusions of the Wadden Sea Barometer report

In conclusion, and in relation to the previously discussed functions of boundary objects, the aim of the WSB was to structure scientific knowledge and make it more usable for decision-makers. Furthermore, by using insights from various scientists and data from different scientific disciplines in the development of the barometer, its aim was to create a shared context and, as interviewee #1 put it, to create support for the credibility of the boundary object. On a critical note, however, although interviewees #1 and #2 explained that interviews were held with stakeholders in the development of the barometer, the WSB did not seem to have as one of its aims to facilitate and structure interactions and communications among stakeholders as part of the process. Although attempts to do so were made later on in the process, the interactions and communications were predominantly among individual

5: Figure translated from Dutch to English. The original figure can be found at: https://www.waddenacademie.nl/nl/nieuws/nieuwsbericht/article/waddenbarome/;

	Conditions	Statements questionnaire
Credibility	Scientific validity of the technical evidence	*The Wadden Sea Barometer is based on the most accurate and recent scientific knowledge.*
		The scientific credibility of the ecological analyses is high.
		The scientific credibility of the economic analyses is high.
		The scientific credibility of the social-cultural analyses is high.
	Epistemological differences bridged	*The Wadden Sea Barometer incorporates, besides scientific knowledge, non-scientific knowledge*
	Inclusion of different forms of knowledge	*There is a balance between scientific and expert knowledge on one side, and practical knowledge on the other side*
	Active and inclusive communication	*Throughout the process, there has been sufficient communication between all stakeholders and the organisation.*
Legitimacy	Boundary object is perceived as unbiased	*The final report is unbiased.*
	Boundary object includes divergent actor values and perspectives	*You can agree with the allocated scores and the final Wadden Sea Barometer.*
		All actors with an interest were able to be part of the process, which lead to the development of the Barometer
		All actors with an interest were able to be part of the process, at the appropriate time.
	Role of involved stakeholders is clear during the process	*Throughout the process, it was clear to you what your role as participant was, and what was expected of you*
	Stakeholders agree that the right question have been asked concerning the right problem	*The Wadden Sea Barometer and its corresponding report do right by the existing policy questions.*
Salience	Boundary object is perceived to be relevant to decision makers	*The Wadden Sea Barometer is relevant to policy makers*
	Decrease of complexity by adapting the used language	*The Wadden Sea Barometer is understandable to a broad audience.*

Table 5.4. Overview of statements and responses regarding the perceived credibility, legitimacy and salience of the Wadden Sea Barometer ++: strongly agree; +: agree; +/-: neutral; -: disagree; --: strongly disagree

stakeholders and Telos, rather than among stakeholders guided by Telos. This not only influences the contribution to an increase in interactions, but also influences the perception of 'shared context'. Shared, in this sense, does not only mean that the boundary object is capable of being interpreted in many ways, but also that its development process has been shared, creating ownership. In the case of the WSB, such ownership was also lacking, as will be further explained in the following section. So, after identifying these functions of the WSB, what does the questionnaire tell us about the perceived credibility, legitimacy and salience of the barometer?

++	+	+/-	-	--	No opinion
	2	3			4
	1	4			4
	2	3			4
	2	1	1		5
	2	1	2		4
	2	2	1		4
	1		1		7
2	3	1			3
	3	1			5
		4			5
					9
	3	1			5
1	3		1		4
1	2	2	1		3
		3	2	1	3

Credibility, legitimacy and salience of the Wadden Sea Barometer

Table 5.4 presents the results of the questionnaire on the WSB[6]. The response suggests that overall, either the respondents were neutral (i.e. neither positive nor negative) to positive about the credibility, legitimacy and salience of the barometer, or they had no opinion. Before drawing conclusions on this (latter) observation, let us have a closer look at the results. Although on some subjects the opinions vary, for example on the inclusion of non-scientific knowledge in the barometer or whether the barometer is understandable to a broad audience, the overall outcome suggests that the respondents who felt capable of assessing the barometer based on the statements, feel that the barometer is relatively credible, legitimate and salient, which is in line with the functions the barometer aimed to have. On the matter of legitimacy, however, some issues are noteworthy. Especially in relation to the criteria that the 'boundary object includes divergent actor values and perspectives' and whether 'all actors with an interest were able

6: Of the 21 people we contacted to fill in the questionnaire, 9 responded. Of these 9, a total of 3 people explained that they did not know how to rate the statements or did not have an opinion on the matter. Since these responses cannot be quantified as a non-response, they have been added to Table 2 as 'no opinion/do not know' to all statements.

to be part of the process, at the appropriate time', the responses show that the respondents predominantly have no opinion on this matter or lack the insights to answer these statements. This brings us to the observation that for almost all statements nearly half, or more than half of the respondents answered 'no opinion/do not know'. From the identified stakeholders who declined to fill in the questionnaire, we received responses that they did not feel entitled to answer to the statements. Their main argument was that they did not recall having taken (any) part in the development of this barometer. This then leads us to ask to what extent the WSB in fact is developed in a participatory manner if only a hand full of people feel entitled to assess the WSB on its credibility, legitimacy and salience. Furthermore, it can be questioned to what extent one can create ownership of a barometer, if the individuals you aim to engage with during the development of the barometer do not feel entitled share their perception of the credibility, legitimacy and salience of the barometer. As will be explained in the next paragraph, these issues influenced the contribution of the WSB to enriched decision-making.

Contribution of the Wadden Sea Barometer to enriched CZM

According to interviewees #1 and #2, who developed this Barometer, the WSB made no contribution to enriching the Wadden Sea CZM, even though the barometer could be considered to be credible, salient and to some extent legitimate. How can this be explained? Interviewee #1 explained that there was little interest and attention following publication of the barometer. This lack of attention, and as a result little use of the barometer, can be attributed to the lack of ownership the barometer had among stakeholders in the Wadden Sea region. This lack of ownership can be ascribed to two factors. First of all, there was the problem of 'not invented here' (Waddenplein, IMSA, 2014). Even though, in the development of the barometer, people with strong ties and networks in the region were consulted, it was not developed in and by the Wadden Sea region. Secondly, there had been only limited interactions with and among the stakeholders in the region, and this led to little engagement and therefore little ownership. Interviewee #2 explained that a so called 'consensus meeting' was proposed in which 'people with great track-records in Wadden Sea affairs and ecology, or on account of their personal activities or networks could meet to validate, defend and disseminate the choices made among affiliated stakeholders' (interviewee #2). Unfortunately, such a meeting never took place. Furthermore, as interviewee #1 explained, by the time the prototype of the WSB was published, a change in the political landscape of the Wadden Sea had taken place. Whereas, at the start of the development of the WSB, the Waddenfund[7] was one of the main drivers and one of the intended users (they wanted to assess the necessity and feasibility of funding requests, based on the barometer), by the time the prototype of the barometer was published, the administrative structure of the Waddenfund had changed, making the need for the barometer less relevant or, in other words, less salient. 'This changed landscape was also the reason for not conducting the final step in the development of the barometer: the external validation' (interviewee #1), in which the barometer would be presented to a broad array of relevant stakeholders.

7: The Waddenfund is a fund which invests in initiatives and projects which sustainably enhance the ecological and economic development of the Wadden Sea region (http://www.waddenfonds.nl)

5.4.3 Waddenhouse Deliberation ranking

Despite the WSB, the need for an assessment of the impact of human activities on the Wadden Sea region remained. In addition, the Dutch Ministry of Infrastructure and the Environment wished to develop a new 10-year vision on the Wadden Sea policies[8]. To accommodate this development, input was requested. The Wadden Academy and PRW[9] acted on this request by initiating and funding the development of the Waddenhouse Deliberation ranking (hereafter WHD). The deliberation was organised in the context of the 'policy exploration regarding the future role and ambition of the national government and the region for the Wadden Sea area, for the purpose of possible adjustments of the Structural Vision for the Wadden Sea' (WHD Report, 2016:4).

The development of this boundary object was similar to that of the Cascade model. As interviewee #2 (who was also involved in the development of the WSB) and interviewee #3 both explained, it was expected that by using a similar methodology as was used in 2004 (i.e. scoring a broad range of human activities in the Wadden Sea, such as harbour activities, tourism, gas and salt extraction, fishery activities, military activities), based on a set of (pre-determined) indicators, the final product would yield similar credibility, legitimacy and salience as it did over a decade before.

The aim in developing this boundary object was to bridge the gap between science and policy in two stages. Firstly, by organising the deliberation, the existing scientific knowledge was to be mobilised to address the existing demand from policy-makers for knowledge. The ranking was developed based on the scores given by a broad range of scientists and experts who were representatives of two domains: the ecological and the socio-economic. They were 'selected on the basis of their expertise in both domains and their independence' (WHD Report, 2016), although in what manner this independence was determined and which potential participants were left out because of these 'selection criteria' is not described. In the second step, other stakeholders (e.g. representatives of the various (impacted) economic sectors from the region, policy-makers and environmental organisations) were also involved, either by invitation by initiators of the WHD, or on their own request, with the aim to discuss and reflect on the results of the deliberation. Between the WHD (February 2016) and the official presentation of the ranking (July 2016), preliminary reports were sent to the participants in the deliberation for review, and reflection sessions were held with the aforementioned stakeholders in order to present and discuss the results.

With regard to the functions of boundary objects we have discussed above, the WHD seems (to some extent) to aim at addressing all three. By creating a ranking, it aimed to create more understanding and usability of the (scientific) insights into the use of the Wadden Sea for decision-makers. The chosen process included a range of scientists from various fields and aimed to establish a shared context. On a critical note, however, the two groups of scientists and experts (natural and social sci-

8: In Dutch, this document is called 'Structuurvisie Wadden'

9: Programma naar een Rijke Waddenzee, a governmental program which focuses on the restoration of nature and on the transition to sustainable, economic use of the Wadden Sea (http://www.rijkewaddenzee.nl)

ences) only had limited interaction with each other. The combining of the different disciplinary fields was done by the people organising the deliberation. With regard to the facilitation and structuring of interactions and communications, the report seems to suggest that this happened but, as was the case with the WSB, these interactions and communications were predominantly between the organisers of the deliberation and stakeholders, rather than among the stakeholders themselves.

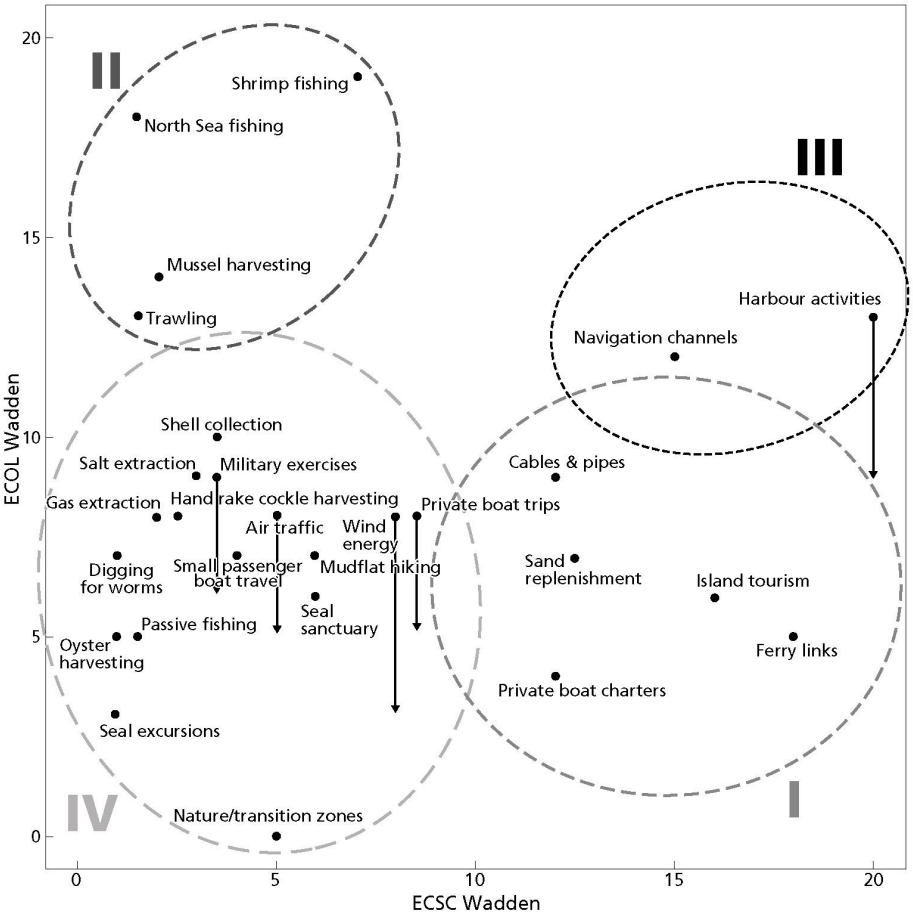

Figure 5.4. Final panel scores of the Waddenhouse Deliberation[10], indicating the influence of human activities (explain in the ecological domain (vertical) and the socio-economic domain (horizontal)) on the state of the Dutch Wadden Sea area

10: Figure translated from Dutch to English. The original figure can be found at: https://rijkewaddenzee.nl/nieuws/wadden-huisberaad/

Credibility, legitimacy and salience of the Waddenhouse Deliberation ranking

Table 5.5 presents the combined answers of our 23 respondents[11]. It can be concluded that although the answers are substantially spread across the possible answers, generally speaking the respondents predominantly perceive the WHD ranking as having limited credibility, legitimacy and salience. This also emerged in their comments. On the issue of scientific validity, one respondent said 'The lobby from the ecological movement was strong and dominant, and influenced the results. In that sense, it was not scientific but political' (Resp.#8). Someone else noted that 'in science, conclusions are not based on a majority but on facts and scientific discussions (…). The number of people who support a certain interpretation should not matter' (Resp.#10). In relation to the process, one of the participants of the WHD stated that 'there was too much pressure to finish in one day, and this hindered an effective learning process' (Resp.#19).

The discontent about the ranking is already evident from these three statements (all made by participants of the WHD). On a closer look, however, the stakeholder group seems to have a more negative perception of the ranking than the participants in the WHD do. An example of this can be seen in the evaluation of the level of salience where the percentage of negative respondents is much higher in the group of stakeholders than in the group of participants of the WHD. A similar picture can be drawn in relation to the level of credibility: 4 out of 7 statements were responded to more negatively by the group of stakeholders. How can we explain this? Do the presupposed criteria include indicators which can explain this outcome?

From the literature review presented in section 5.2, we have seen that one of the most important cornerstones for the development of a boundary object is its participatory process. Two statements related to this indicator were scored: i) all actors with an interest were able to be part of the process; and ii) all actors with an interest were able to be part of the process at the appropriate time. This second statement is an elaboration of the first one: we wanted to test whether the timing of possible participation had an influence on the perception of legitimacy of the process. The responses are clear: the stakeholders give a highly negative evaluation: 5 out of 8 responded negatively to the statement about being involved at the appropriate time. Based on this, it could therefore be hypothesised that because these stakeholders were involved in the development of the ranking too late, they had too little influence on the process. This is reflected, for example, in the assessment of the level of credibility. Both groups of respondents agree on the statement that the ranking incorporates scientific and non-scientific knowledge. However, out of eight respondents in the stakeholders group, five (strongly) disagreed with the statement 'There is a balance between scientific and expert knowledge, on the one hand, and practical knowledge, on the other hand'. The hypothesis could also explain the difference in attitude towards the statement that "the final ranking is relevant to policy-makers": 7 out of 15 participants responded positively to this statement (and only 3/15 negatively), whereas 4 out of 8 or the other stakeholders responded negatively to this statement. Because the group of

11: 23 of the 48 people contacted responded to the questionnaire. 15 of these 23 where participants in the Waddenhouse Deliberation; the remaining 8 respondents were other stakeholders (policy-makers, environmental organisations, private sector companies)

	Conditions	Statements questionnaire
Credibility	Scientific validity of the technical evidence	*The ranking is based on the most accurate and recent scientific knowledge.*
		The scientific credibility of the ecological analyses is high.
		The scientific credibility of the socio-economic analyses is high.
	Epistemological differences bridged	*The ranking incorporates, besides scientific knowledge, non-scientific knowledge*
	Inclusion of different forms of knowledge	*There is a balance between scientific and expert knowledge on one side, and practical knowledge on the other side*
	Active and inclusive communication	*Throughout the process, there has been sufficient communication between the participants of the WHB and the organisation.*
		Throughout the process, there has been sufficient communication between all stakeholders and the organisation.
Legitimacy	Boundary object is perceived as unbiased	*The final report is unbiased.*
	Boundary object includes divergent actor values and perspectives	*You can agree with the allocated scores and the final ranking*
		All actors with an interest were able to be part of the process.
		All actors with an interest were able to be part of the process, at the appropriate time.
	Role of involved stakeholders is clear during the process	*Throughout the process, it was clear to you what your role as participant was, and what was expected of you*
	Stakeholders agree that the right question have been asked concerning the right problem	*The final ranking and its corresponding report do right by the existing policy questions.*
Salience	Boundary object is perceived to be relevant to decision makers	*The final ranking is relevant to policy makers*
	Decrease of complexity by adapting the used language	*The final ranking and report are understandable to a broad audience.*

Table 5.5. Overview of statements and responses regarding the perceived credibility, legitimacy and salience of the Waddenhouse Deliberation ranking ++: strongly agree; +: agree; +/-: neutral; -: disagree; --: strongly disagree; No op.: no opinion/do not know

stakeholders was involved at a later stage than the group of participants in the WHD, by the time they came onto the scene, the definition of the problem underlying the development of the ranking had already taken place.

Contribution of the Waddenhouse Deliberation ranking to enriched CZM

In the previous section, we have shown that the outcome of the questionnaire among participants and stakeholders of the WHD suggests that the final ranking is perceived to be neither credible or legitimate, nor salient. According to Cash et al. (2003), this would limit the chances for the boundary

Participants WHD						Other stakeholders					
++	+	+/-	-	--	No op.	++	+	+/-	-	--	No op.
	4	4	3	4			2	1	2	3	
	2	5	2	4	2		1	3		3	1
	2	2	2	6	3		1	2	2	2	1
1	8	5	1				4	1	1	2	
	3	6	3	3				2	1	4	1
	6	2	4	1	2		1	1	2	2	2
	2	2	2	3	6		1	2	1	2	2
1	2	6	1	4		1	1	1	2	2	1
	4	2	8			1	2	1	3	1	
1	2	2	2	2	6		3	1	1	3	
	4	1	2	2	5		1	1	4	1	1
	9	2	1	2	1	1	2		1	2	2
1	3	1	7	1	1		4		1	3	
2	5	2	3		3	1	2	1		4	
1	5	1	3	4	1		2	1	2	3	

object to enrich decision-making processes. Furthermore, when the final ranking was presented, it caused very negative reactions, especially from the industries that were placed high in the ranking as having a negative influence on the ecological state of the Wadden Sea. Interviewee #4 explained that the disaffection this ranking had generated negatively influenced its usability to enrich decision-making processes. Our interviewee argued that even if a report is scientifically credible, when it causes so much disaffection, it is not possible to blindly make use of its analyses. This does not mean, however, that the WHD is entirely unusable. The turmoil was predominantly focused on two industries: harbours and fishery activities. The rest of the ranking, which was less contested, was used together with other reports on the Wadden Sea as input for the development of the Wadden Sea policies. However, due to the sensitivity of the WHD, our interviewee was not able to give specific examples on this matter.

5.4.4 Comparative analysis

In both cases, the organising parties aimed to create an assessment of the Wadden Sea region in which the perspective of a broad array of stakeholders was embodied. They aimed to develop this assessment based on scientific knowledge, but also attempted to negotiate with and involve stakeholders with other (expert) knowledge into the processes. Still, in both cases, the respondents to the questionnaire but also the interviewees were clear: neither of the two assessments was perceived to fulfil the criterion of being fully credible, legitimate and salient. Further comparison between these two cases presents some interesting issues.

First of all, with regard to the three functions of boundary objects discussed in the literature review section above, the empirical research suggests that both assessments aimed to meet the first and third functions (combining, clarifying and communicating knowledge; and establishing a shared context and applicable knowledge), but only addressed the second function (facilitating and structuring interactions) to a limited extent. Considering the (lack of) contribution of these two cases to enriched CZM in the Wadden Sea, we suggest that these three function are not a case of either/or, but that in order for an assessment to be a boundary object, it needs to fulfil at least the first function. Connecting these functions to the framework introduced by Cash et al. (2003) regarding the need for credible, legitimate and salient knowledge to enrich decision-making processes, we argue that without inclusive interaction and communication, the legitimacy of the boundary object is open to scepticism.

Secondly, the two cases demonstrate that even when an assessment is evaluated as being relatively credible and salient, it does not follow that it will automatically enrich decision-making processes in CZM, as was the case with the WSB. On the other hand, in the case of the WHD where only a minority of our respondents valued the ranking as credible, legitimate and salient, it was nonetheless argued that the ranking (in combination with other reports) did enrich decision-making processes on the CZM of the Wadden Sea. It could therefore be hypothesised that alongside the level of credibility, legitimacy and salience of the boundary object, other external factors also contribute to whether or not a boundary object enriches policy-making processes. Van Enst et al. (2016), in their article on boundary organisations, speak of 'enabling factors', such as public and political debates which might pressure (in this case) policy decisions regarding CZM. The existence of a policy window at that time because a new Wadden Sea policy was soon to be developed by the Ministry of Infrastructure and the Environment, for which (scientific) input on the ecological state of the Wadden Sea was needed, might also have contributed to the fact that the WHD ranking did ultimately enrich the policy-making process. A second hypothesis might be that even though the respondents in this research on the whole evaluated the level of credibility, legitimacy and salience of the WHD ranking as negative, parts of the assessment might have been contested less than others and therefore more suitable for enriching the policy-making process.

Finally, the case of the WHD shows that there were differences (albeit limited) in how the participants in the deliberation evaluated the ranking and how the other stakeholders who had no part of the deliberation did. This could, hypothetically, suggest that there is an internal perception of the cred-

ibility, legitimacy and salience of a boundary object (as perceived by those people who were closely involved in the development process), and an external perception of these same three criteria (as perceived by the stakeholders who were not closely involved in the development of the boundary object but who are influenced by its outcome). This differentiation, however, could have been addressed had the development process been more inclusive, in which case the boundary object would have addressed its second function of facilitating and structuring interactions.

5.5 | Conclusions and discussion

To draw up the final conclusions, this paper was aimed at conducting exploratory research into boundary objects and the extent to which they can contribute to enriching coastal zone management. As stated at the outset of this paper, in enriched decision-making, knowledge is used to arrive at a clearer picture of the problem setting, to underpin and implement policy and management measures, to explore policy options, and it is also used in learning processes among policy-makers, scientists and stakeholders (e.g. Van Tatenhove et al., 2016; Van de Riet, 2003). Based on our empirical findings, we suggest that for boundary objects to enrich CZM decision-making processes, it is of crucial importance that the boundary object and its development process are perceived as legitimate by all stakeholders. Without this level of legitimacy, a boundary object can be credible and salient, but will find itself faced with difficulties when it comes to enriching decision-making processes. Secondly, this research suggests that there needs to be a policy window for the boundary object to directly enhance the knowledge of decision-makers.

At this point, we wish to raise three hypotheses which could be used to structure further research into this subject.

1. This research suggests that for a boundary object to function as a means to facilitate and structure the interactions and communication among stakeholders, an inclusive process is of great importance, also for the acceptance of the knowledge generated by means of a boundary object, and thus the perceived credibility of this knowledge. This is especially so when the boundary object places values on the assessment, turning it into a ranking (as was the situation with the WHD ranking). The comment of one of the respondents in this matter speaks volumes: "This report (…) is based on opinions and preferences of various involved parties, without inviting the people who actually make a living in the Wadden Sea". The first hypothesis is therefore that if stakeholders believe that they have been involved in the process too late and have therefore had little to no influence on the evolution of the final ranking (from defining the problem to providing practical experience and expert knowledge and on to ranking the different indicators), they will tend to evaluate the boundary object finally arrived at not only as lacking legitimacy, but also as lacking credibility.

2. In order for the ranking system to be accepted for enriching policy-making processes and thus to have salience, this research suggests that not only those stakeholders involved but also others

influenced need to have ownership of the boundary object. Our second hypothesis is that if ownership is not created, either because the object is 'not invented here', or because there has been a lack of active and constant involvement of stakeholders, the boundary object loses its salience.

3. For the boundary object to have an influence on decision-making processes, this exploratory research suggests that a policy window is of great importance. Our empirical research shows that in the case of the WSB, this window was 'closed' due to changes in the policy landscape in the interim, which resulted in a sharp reduction in the relevance of the ranking system. In the case of the WHD ranking, because there was a policy window, a new set of guidelines concerning the governance of the Wadden Sea needed to be established. As a result, even though the ranking lacked credibility and legitimacy due to procedural choices and even though the respondents did not perceive the final ranking as salient, in the end the boundary object did (to some extent) enrich the policy-making process. Our third hypothesis is therefore that no matter the quality of the boundary object (as regards the three criteria), without a policy window, it will not contribute to enriched CZM.

In summary: we started this paper by introducing it as exploratory research into two boundary objects within the field of CZM. In order to analyse the extent to which a boundary object could contribute to enriched decision-making, we introduced the framework by Cash et al. (2003), and argued that having insight into the perception of involved stakeholders of the credibility, legitimacy and salience of a boundary object might provide us with further understanding of its contribution to enriched CZM policy. However, since the application of this framework within the specific domain of CZM is relatively unexplored (with the exception of e.g. White et al., 2010), we would urge further research to establish the value of this framework. With regard to the Wadden Sea, we have additionally shown in this paper that various boundary objects have been developed to contribute to the CZM of the area (e.g. Floor et al., 2016). We argue that boundary objects seem to be a promising approach to bridging science and policy with the aim of arriving at both sound and well-accepted policy decisions concerning controversial issues for the CZM of the area. This paper should be understood as a step towards further understanding how this aim can be reached.

Chapter 6

Conclusions and reflections on science–policy interfaces for the Wadden Sea

6.1 | Introduction

Informing public policy processes concerned with environmental and sustainability issues (for example, in coastal zone management) with scientific knowledge is of great importance. It can provide insights into current and future environmental conditions, into the often complex interactions in socio-ecological systems and provide ex ante or ex post assessments of environmental policies (e.g. Van Tatenhove et al., 2016; Runhaar and Van Nieuwaal, 2010; Jasanoff, 1990). The analysis by Turnhout et al. (2008), for example, shows how science has contributed to the development of ecological policy targets for the Wadden Sea. However, as many scholars in the field of environmental governance argue, the relationship between environmental science and policy is often contested (e.g. Van Enst et al., 2014; Hanssen et al., 2009; Holmes and Clark, 2008; Pielke, 2004). This same scholarly literature suggests using so-called science–policy interfaces to address these science–policy interaction difficulties and enhance the use of knowledge in decision-making processes. Following Van den Hove, in this dissertation science–policy interfaces are conceptualised as entities (such as organisations or individuals) which develop and implement (social interaction) processes, aiming to enhance the interactions between science and policy, and ultimately enrich decision-making processes. This dissertation has analysed problems in science–policy interactions and how, via science–policy interfaces, these interactions can be enhanced, with the ultimate aim of contributing to enriched decision-making processes. An enriched decision-making process, which is thought to be the output of science–policy interfaces, is understood to be a process in which knowledge is used to gain a clearer picture of the problem setting, underpin and implement policy and management measures, explore policy options, inform policy evaluations, and be used in learning processes between policy-makers, scientists and stakeholders (e.g. Van Tatenhove et al., 2016; Van de Riet, 2003). In this dissertation three interfaces have been analysed: boundary organisations, knowledge brokers and boundary objects (e.g. Seijger et al., 2016; Van Meerkerk, 2014; Boezeman et al., 2013; Hegger et al., 2012; Pesch et al., 2012; Edelenbos et al., 2011), all of which are interfaces that are placed (or place themselves) at the boundary between science and policy with the aim of enhancing the interactions and enriching decision-making processes by the use of scientific knowledge. Furthermore, in this dissertation I side with the often-employed framework of Cash et al. (2003), who argue that to be used in environmental decision making and to enrich it, science must meet three criteria: it needs to be perceived as credible (scientifically valid) and salient (relevant to decision makers), and to have been produced in a way that is seen as legitimate by all stakeholders involved.

The objective of this dissertation was to increase our understanding of the interaction problems science and policy face, and the extent to which science – policy interfaces could contribute to eliminating these problems and enriching decision-making. In doing so, it aims to contribute to the scientific debate on how science–policy interfaces contribute to the use of knowledge in policy and decision-making processes. All the empirical case studies discussed in the previous chapters were set within the Dutch environmental governance landscape, with a specific focus on the Dutch Wadden Sea. In Chapter 1 I argued that this region is particularly interesting for the debate on interactions between science and policy, for a number of reasons. First, the often conflicting economic and ecolog-

ical interests of this area have given rise to a constant search for a balance between economic activities and the protection of the ecological state of the Wadden Sea, so that this region can be governed sustainably (e.g. Floor et al., 2016). Secondly, even though the production of scientific knowledge on the Wadden Sea is extensive, the credibility, legitimacy and salience of this knowledge is often questioned (for the reason discussed above), making it contested (e.g. Van Nieuwaal, 2011; Runhaar and Van Nieuwaal, 2010; see for example Textbox 1 in Chapter 1of this dissertation). Finally, the institutional landscape of the Dutch Wadden Sea, which is comprised of stakeholders ranging from industries and government to environmental agencies and research institutes, is highly complex (e.g. Seijger, 2014; Van Nieuwaal, 2011). This, in turn, leads to a diffuse division of responsibilities between different levels of governance. Combined, the complexity and sensitivity of this region results in the interactions between science and policy being faced with a range of difficulties. The use of science–policy interfaces in this region to overcome or deal with these difficulties therefore seems unavoidable.

This final chapter summarises and reflects upon the main findings presented in this dissertation. It is structured as follows: section 6.2 presents the conclusions and reflections on the formulated sub-questions, after which a synthesis of the overall research, guided by the main research question underlying this dissertation is given. Section 6.3 reflects on the research approach and case selection. Section 6.4 provides recommendations for further research on science–policy interfaces. Section 6.5 presents my final thoughts regarding this dissertation in relation to the (Dutch) Wadden Sea region.

6.2 | Conclusions and reflections

The research presented in this dissertation aimed to answer four sub-questions, which in turn provide insights for answering my main research question:

MRQ: *How do science–policy interfaces such as boundary organisations, knowledge brokers and boundary objects contribute to enhancing the interactions between science and policy with the aim of enriching decision-making processes?*

From this main research question, the following sub-questions were derived:

SRQ1: What science–policy interaction problems are recognised in the scholarly literature, and how can they be categorised and characterised?

SRQ2: In which cases and/or circumstances are science–policy interfaces used to enrich decision-making processes?

SRQ3: By means of what strategies do science–policy interfaces aim to enrich decision making, and to what extent do they succeed in that respect?

SRQ4: What lessons can be drawn from the analysis and evaluation of individual science–policy interfaces in terms of general recommendations for the science and policy communities, and the opportunities and limitations of combining science–policy interfaces?

SRQ1. *What science–policy interaction problems are recognised in the scholarly literature and how can they be categorised and characterised?*

Scholars in the field of environmental governance have paid much attention to the problematic interactions between science and policy (e.g. Saarela and Söderman, 2015; Pietri et al., 2011; Runhaar and Van Nieuwaal, 2010; Strydom et al., 2010; Michaels, 2009; Tribbia and Moser, 2008; Pielke, 2007; Van Buuren and Edelenbos, 2004). This literature illustrates a multitude of problems, such as knowledge being contested (e.g. Michaels, 2009), scientists who join competing knowledge coalitions (e.g. Van Buuren and Edelenbos, 2004), and the issue that policymakers and scientists employ different timeframes and levels of abstraction (e.g. Strydom et al., 2010). However, no categorisation of these interaction problems appears to have been developed. In this dissertation, I argue that such an overview is needed in order to determine and understand in which situation and to what extent a particular science–policy interface contributes to solving these problems. To address this knowledge gap, with this dissertation I aim to contribute to the body of literature which discusses science–policy interactions and SPIs in relation to sustainability issues, by developing a framework which introduces four 'meta-problems': 1) the strategic use of knowledge by policy; 2) the strategic production of knowledge by science; 3) the operational misfit between demand for and supply of knowledge; and 4) interaction problems that are not directly related to knowledge but that complicate the use of knowledge by policy-makers and stakeholders.

The first three 'meta-problems' were defined and presented in Chapter 2, based on (theoretical) interaction problems discussed in the reviewed scholarly literature that range from knowledge being used selectively (e.g. Owens et al., 2006) and deliberately ignored by policy-makers (e.g. Wardekker et al., 2008), through scientists selectively presenting knowledge (e.g. Pielke, 2007) and joining competing 'knowledge coalitions' (e.g. Van Buuren and Edelenbos, 2004), to the world of science and policy employing different timeframes and levels of abstraction (e.g. Strydom et al., 2010; Pohl, 2008). Furthermore, I differentiated between 'strategic' and 'operational' interaction problems. The former are to do with scientists and policy-makers deliberately influencing relations or interactions between science and policy in order to promote their particular interests. The latter are more practical and 'neutral' interaction problems, which address the production and use of knowledge but are more related to institutional and cultural differences between science and policy. It is expected that in these latter cases no manipulative behaviour of involved actors is involved. Following Cash et al. (2003), I argue that fundamental to these types of interaction problems is a lack of credibility, legitimacy and/or salience of the knowledge produced and used. For example, if a study does not answer the questions asked by policy, or if the research is presented long after it was needed (or too early), it runs the risk of not being relevant to the decision-making process and therefore lacking salience. If in the knowledge production process stakeholders are neglected, the process risks creating so-called 'superfluous knowledge' which completely lacks legitimacy and/or salience (e.g. Van de Riet, 2003). The opposite can also happen: too much focus on the support of stakeholders in the knowledge production process might lead to 'negotiated nonsense' as Van de Riet describes it (2003:3-4). This knowledge will lack credibility. And if a research report is contested by a particular group of stake-

holders, it could lack legitimacy and perceived credibility. In line with Cash et al. (2003) and Van den Hove (2007) I therefore argue that by addressing the previously discussed interaction problems, room is created to develop knowledge that is scientifically credible, legitimate to all actors involved, and salient to policy, as preconditions to enrich decision-making processes. It needs to be noted that trade-offs between these preconditions are likely to occur in practice (e.g. Sarkki et al., 2014). For example, a trade-off between legitimacy and salience can occur when the language used is so vague that all stakeholders can reach consensus about the knowledge produced, but in turn this might result in a loss of salience (because the knowledge no longer addresses the policy questions) and credibility (because the knowledge loses its validity) (e.g. Girod, 2009). Cash et al. (2003) therefore argue that boundary work at the interface between science and policy needs to balance the credibility, salience and legitimacy of the knowledge produced (Girod, 2009).

The literature on which this framework is partly based (derived from different bodies of literature, e.g. environmental governance; organisational science; science and technology studies) appears to focus predominantly on interaction problems related to the production and use of knowledge (the strategic use of knowledge; the strategic production of knowledge; and the operational misfit between demand for, and supply of knowledge), and how science–policy interfaces aim to solve these issues (e.g. Pielke, 2007; Van den Hove, 2007). The empirical research presented in this dissertation offers the more nuanced idea, in which the interaction problems between science and policy in practice are not always directly concerned with the production and use of scientific knowledge. The empirical research into knowledge brokers (Chapter 4) and boundary objects (Chapter 5) identified a fourth 'meta-problem' to add to the interaction problems presented in Chapter 2. It concerns interaction problems that are not directly related to knowledge but that complicate the use of knowledge by policy-makers and stakeholders. Examples of this meta-problem given by knowledge brokers (see Chapter 4) include issues related to the complete absence of communication between stakeholders, and policymakers shielding themselves from any science–policy interactions. The existence of this fourth interaction problem suggests that science–policy interfaces should focus not only on scientific knowledge (and its production and use), but also on a more holistic approach to the interactions, also addressing the interactions not directly related to knowledge. After all, if (for example) there is complete absence of communication, this must be rectified. It is possible this fourth meta-problem is connected to the other three. For example, cultural differences (for example, in the way language is used, or different institutional incentives), can strain relationships between stakeholders. The relationships will remain strained, even if the stakeholders later find themselves in another setting in which there is no direct reference to the production or use of scientific knowledge. This issue can also be understood as an additional challenge to achieving sustainability (as discussed in Chapter 1). However, since this issue was not addressed and researched in this dissertation and has not been addressed in the literature, further research on it is recommended.

Finally, the following two additional insights deserve mention. The first is that the empirical cases presented in this dissertation suggest that at the boundary between science and policy in the Wadden Sea arena a combination of these interaction problems can often be found, adding to the complexity

of this field. In Chapter 3, for example, the boundary organisation IMSA claimed that at the boundary between science and policy there is often a mixture of difficulties regarding the strategic use and strategic production of knowledge. Furthermore, given that problems related to the operational misfit were discussed by all knowledge brokers interviewed (Chapter 4), it seems likely that this issue always (or almost always) plays a role in the interactions between science and policy, next to other interaction problems dealing with the strategic use and production of science. So, the more complicated a topic becomes, which increases the possibility of problematic interactions between science and policy, the more necessary it becomes to employ an SPI.

The second insight is that in the acceptance and use of knowledge in decision making, there appears to be an influential role for stakeholders which have no direct influenced on the (participatory) knowledge development processes (for example the general public (see Chapter 3 on the influence of the public debate on decision-making processes), and the environmental organisations and private sector industries (see Chapter 5 on the case of the Waddenhouse Deliberation ranking). From an empirical point of view, this might not come as a surprise, since in an area such as the Wadden Sea interactions are hardly ever 'only' between science and policy: when discussing coastal zone management, for example, other parties or stakeholders are also influenced. And as the case of the Waddenhouse Deliberation ranking showed, being unaware of this third group of actors or including them too late in the process might hamper the closing of the gap between science and policy, and the enriching of decision- making processes with science. So, in line with (amongst others) Swart and Van Andel (2008), the focus should not predominantly be on science–policy, but perhaps more on science–policy–society interactions. Having more inclusive approach to these interactions might both in theory and in practice benefit the understanding of how these interactions work. I would argue that SPIs have an important task in this, by broadly exploring the field of direct and indirect stakeholders, instead of adopting a narrow perspective.

SRQ2. *In which cases and/or circumstances are science–policy interfaces used to enrich decision-making processes?*

From the literature (e.g. the work of Boezeman et al., 2013; Pesch et al., 2012; and Huitema and Turnhout, 2009 on boundary organisations, Seijger et al., 2016; Van Meerkerk, 2014; Meyer, 2010; and Moss et al., 2009 on knowledge brokers; and Hegger et al., 2012; Edelenbos et al., 2011; Karl et al., 2007 on participatory knowledge development processes) it seems that the way to address the interaction problems discussed above is to organise science–policy interfaces. Chapter 2 demonstrated how I linked the defined 'meta-problems' to science–policy interfaces. That overview yields two conclusions: first, the three different interfaces identified in Chapter 2 (individual science–policy mediators; processes of participatory knowledge production; and boundary organisations) should, in theory, be able to address all types of interaction problems. Secondly, given the paucity of references, there appears to be very little (empirical) insight into the practical application of SPIs in addressing these science–policy interaction problems. This issue was therefore addressed in all three empirical analyses presented in Chapters 3, 4 and 5.

Boundary organisations

According to the literature reviewed in Chapter 3, boundary organisations – which are predominantly considered to be scientific and/or governmental organisations or agencies (e.g. Pesch et al., 2012; Huitema and Turnhout, 2009) – often address science–policy interaction problems related to the *operational* misfit between the demand for and supply of knowledge (e.g. Hanger et al., 2012; Owens et al., 2006; Guston, 2001) and (but to a lesser extent) the strategic use of knowledge (e.g. Lidskog, 2014; Tribbia and Moser, 2008; McNie, 2007). For the empirical analysis in Chapter 3, three boundary organisations (all active in the Wadden Sea area) were analysed. Each of these organisations had a different institutional background (in science, policy and the private sector), which enabled me to not only analyse boundary organisations as a distinct SPI, but also possible variations within this type of interface. Contrary to the literature review presented in Chapter 3, from the research findings presented in that chapter it seems that boundary organisations active in the Wadden Sea area do not need to have an institutional background exclusively in science or policy. Rather, I would argue that a boundary organisation which is less embedded in the institutional landscape of the area and is not part of the science or policy arena can act less politically sensitively. Building on this, the empirical evidence suggests that the researched boundary organisation with a scientific institutional background predominantly operates in situations where there are problems related to the operational misfit. The researched boundary organisation with a background in policy advice and especially those with a private sector background, appears to act when there are multiple interaction problems, such as the strategic misuse and production of knowledge. To conclude, I would hypothesise that in the case of structured policy problems (when there is certainty about the relevant knowledge and consensus on norms and values (see Figure 2.2 in Chapter 2)) boundary organisations with a scientific institutional background can be used to enrich decision-making processes. However, when the policy problems become more unstructured (due to various science–policy interaction problems and scientific knowledge being scrutinised), a boundary organisation from outside the scientific and policy arenas may have to be used to enhance the interactions between science and policy.

Knowledge brokers

The literature review presented in Chapter 4 demonstrates that knowledge brokers are primarily being discussed within the context of interaction problems related to the strategic production and strategic use of knowledge (e.g. Van Meerkerk and Edelenbos, 2014; Schlierf and Meyer, 2013; Williams, 2013). This implies that these science–policy interfaces focus on these types of strategic problems rather than on operational problems. The empirical research presented in Chapter 4, however, demonstrated that the knowledge brokers I interviewed focus not only on these two interaction problems (with a dominant perspective on the misuse of knowledge), but also on operational misfits: all respondents addressed issues related to this meta-problem. Specifically, problems related to the formulation of policy and research questions were addressed during the interviews, as well as differences in discourses, culture and notions of time. Additionally, the empirical research suggests that knowledge brokers encounter interaction problems which are not solely knowledge-related, such as a complete absence of communication, or policy-makers who intentionally shield themselves from science–policy interactions. Knowledge brokers from the private sector in particular appear to act on these

non-knowledge-related interaction issues. The need for caution must be stressed here, however, since hypothetically it could also be argued that beneath these interaction difficulties, issues related to knowledge lie, or vice versa. However, the empirical data did show that the knowledge brokers who encounter these issues aim to solve these non-knowledge-related issues first before they focus on the production and use of knowledge in order to eventually enrich decision-making processes. Given the range of science–policy interaction problems addressed by the knowledge brokers interviewed, and the broad array of strategies aiming at improving both the strategic behaviour of stakeholders and operational problems, I would suggest that the interventions of knowledge brokers as a science–policy interface to enrich decision-making processes is especially recommendable in the case of unstructured policy problems.

Boundary objects

The literature on boundary objects – "hybrid constructs that integrate elements from scientific and political worlds to facilitate the negotiation and exchange of multiple types of knowledge and action" (White et al., 2010: 221), that "can be used to transfer or communicate complex scientific information into understandable and tailored information which is tacitly connected to the target group" (Van Pelt et al., 2015: 42) – discusses their production and use as a means to address both strategic and operational interaction problems. For example, by identifying boundary objects as a platform to exchange knowledge and mutually construct or co-create knowledge (e.g. White et al., 2010), thereby providing a common focus while at the same time allowing for multiple interpretations (e.g. Star and Star, 2010; Feldman et al., 2006; Griesemer, 1989), room is created to include stakeholders other than scientists in the process of producing knowledge. Furthermore, it is assumed that these objects also address operational misfits between the supply of and demand for knowledge, because, for example, they are thought to bridge differences in goals and language (e.g. Abson et al., 2014; Carlile, 2002). The Wadden Sea Barometer and the Waddenhouse Deliberation ranking case studies address similar issues: for example, both cases aimed to reach a consensus on the interpretation of the knowledge used when developing the two assessment systems. When related to the framework presented in Chapter 2, it could be argued that the Wadden Sea Barometer was developed primarily with the aim of dealing with the operational misfit of demand for and supply of knowledge, by creating a 'barometer' which was accessible and understandable to a broad array of stakeholders, and which incorporated the (at that time) current policy and monitoring questions. With regard to the Waddenhouse Deliberation ranking, the interaction problems it addressed also dealt with the strategic use and production of knowledge, since its development, for example, attempted to untangle and prevent issue advocacy. The fourth interaction problem (non-knowledge-related interaction problems), only appeared to surface in the case of the Waddenhouse Deliberation ranking, where different stakeholder groups seemingly were not interested in interacting with the project leaders of the boundary object, or other stakeholder groups. However, as the sample was small, further empirical research should be done on this topic.

In view of the above, I would argue that based on this explorative research it could be hypothesised that boundary objects can be used to enrich decision making in policy problems ranging from structured to unstructured ones. However, given the aim of boundary objects, and the idea that

stakeholders can work together without the need for consensus (e.g. Star, 2010), it is more likely that boundary objects would be developed and used to address unstructured policy problems, since in policy problems of this type there often is a lack of consensus on norms and values and scientific uncertainty.

To conclude, the research presented in this dissertation suggests that science–policy interfaces are predominantly useful in the case of unstructured policy problems, where there are problems with the strategic production and/or use of scientific knowledge, and where there is a lack of consensus on norms and values (which follow from the operational misfit between the demand for and supply of knowledge). And although I think it is likely that these interfaces can (and will) also be used in more structured problems to enrich decision-making processes, given the range of strategies focussed on strategic behaviour of stakeholders and the strategies to enhance the operational issues, such interfaces predominantly appear to focus on situations in which there are multiple science–policy interaction problems negatively influencing the use of knowledge in decision-making processes.

SRQ3. *By means of what strategies do science–policy interfaces aim to enrich decision making, and to what extent do they succeed in that respect?*

Embedded in this research question lies the expectation or presumption that the main goal of science–policy interfaces is to enrich decision-making processes. The research presented in this dissertation, however, shows a more nuanced picture. So, before addressing the strategies of science–policy interfaces, I briefly want to address the notion of 'goals'. The literature on science–policy interfaces in general argues that the main goal of these interfaces is to inform or enrich decision-making processes (e.g. Van Tatenhove et al., 2016; Heink et al., 2015; Van den Hove, 2007; Van de Riet, 2003). It also contends that in order to influence these processes, the knowledge produced and used should be perceived to be credible, legitimate and salient (Cash et al., 2003). Upon closer examination, however, the literature on boundary organisations and on knowledge brokers makes a distinction: on one side, process-related goals are discussed, such as enhancing the interaction process and the process of knowledge production (e.g. Van Meerkerk and Edelenbos, 2014; Kirchhoff et al., 2013; Schlierf and Meyer, 2013; Turnhout et al., 2013; Pesch et al., 2012). On the other side, the emphasis is on establishing knowledge-related goals, for example, by identifying and articulating gaps of knowledge, and gathering and co-creating knowledge (e.g. Meyer and Kearnes, 2013; McNie, 2007; Pielke, 2007; Cash et al., 2003).

Based on my empirical research into boundary organisations and knowledge brokers, a similar differentiation could be observed. For example, Chapter 4 demonstrates that the main goal of the knowledge brokers interviewed was to allow knowledge to be used better in informing and enriching decision-making processes by increasing its credibility, legitimacy and salience. However, a substantial number of the interviewees with an institutional background in the private sector claimed their aim was to resolve conflicting interests between various stakeholders, which can be considered as focusing on the process. The interviewees with a more scientific background claimed they aimed

at increasing the level of salience of knowledge; enhancing the relevance of knowledge is thought to contribute to the influence of knowledge on decision-making processes (e.g. Cash et al., 2003).

The above conclusions corroborate the conclusion reached after the literature review: the goals of science–policy interfaces can, in the first place, be *process-oriented* and/or *knowledge-oriented*. Additionally, achieving these goals would hypothetically lead to credible, legitimate and salient knowledge, after which it would be the final goal to enrich decision-making processes. Based on this, Figure 1.1 presented in Chapter 1 can be further developed into the following framework (Figure 6.1):

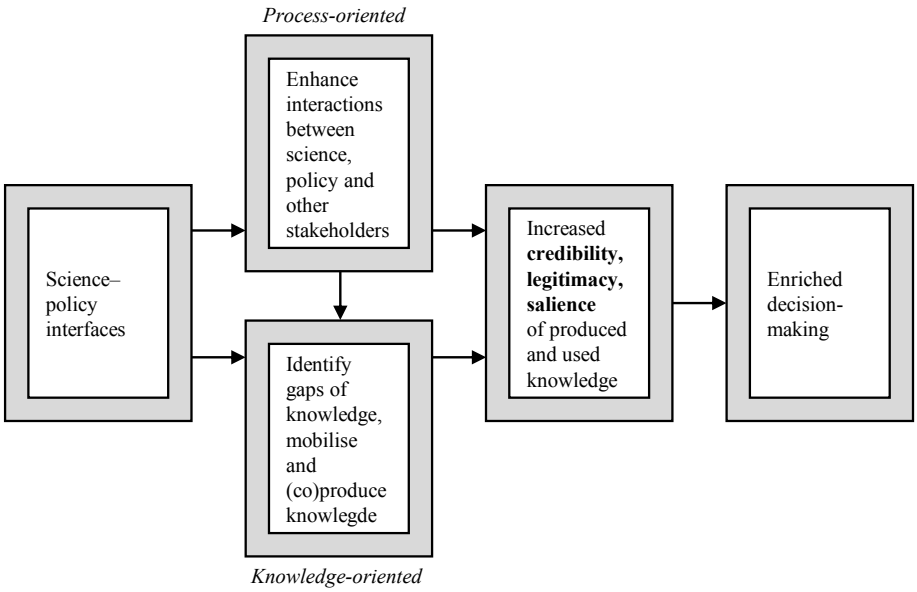

Figure 6.1. Flow chart of the goals of science–policy interfaces in achieving enriched decision-making

This framework leads us to the question of strategies: by means of what strategies do science–policy interfaces aim to reach these process, and knowledge-oriented goals, and ultimately enrich decision making, and to what extent do they succeed in that respect?

As regards the particular strategies science–policy interfaces might use to enrich decision-making processes, the literature tends to use generic labels, such as 'mediation' (e.g. Huitema and Turnhout, 2009; Moss et al., 2009; Niederberger, 2005), and 'translation' (e.g. Gulbrandsen, 2011; Tribbia and Moser, 2008; Moss et al., 2009), and 'the use of boundary objects' (e.g. Lidskog, 2014; Cutts et al., 2011; McNie, 2007; Cash et al., 2003; Guston, 2001). This should not be seen as a criticism, but merely as an observation. I argue, however, that more in-depth understanding of these strategies and their operationalisations would help to improve understanding of *how* science–policy interfaces enrich decision-making processes. Furthermore, these insights could improve understanding of the importance

and influence of knowledge which is perceived to be credible, legitimate and salient in decision-making processes (in theory), and of the ability this understanding to direct such processes (in practice).

I draw three main conclusions. First of all, the strategies of boundary organisations, knowledge brokers and boundary objects as discussed in Chapters 3, 4 and 5 can be categorised into three types of strategies: (1) process-oriented strategies; (2) knowledge-developing- oriented strategies; and (3) decision-making enriching strategies. These types of strategies can be directly linked to the framework presented in Figure 6.1. An example of process-oriented strategies is the organisation of (in)formal meetings between stakeholders, discussed by (representatives of) boundary organisations (in Chapter 3, both IMSA and the NCEA advocated the use of this strategy). Furthermore, various knowledge brokers mentioned creating a sense of urgency: for example, by forcing stakeholders to approach the problem and proposing a solution from an opposing perspective in order to create mutual understanding of other positions in a debate (see Chapter 4 and Appendix V). Perhaps these types of strategies do not directly influence the credibility and salience of knowledge. However, they do aim to influence the legitimacy of the interaction process. Regarding the knowledge development strategies, the development and use of boundary objects was discussed by all three researched boundary organisations. Although each of them used boundary objects differently (the Wadden Academy develops these types of objects as knowledge-developing-oriented strategy, whereas IMSA strategically developed these objects to be used as a decision-making enriching strategy, as is explained in Chapter 3), in all three examples this strategy was aimed at increasing the credibility and salience of the knowledge produced. Furthermore, enriching strategies, such as 'Knowledge at the Table', where scientists join policy-makers in decision-making processes (discussed by knowledge brokers in Chapter 4), and using media outputs strategically (discussed in Chapter 3 on boundary organisations), appear to aim at increasing the legitimacy and salience of knowledge. Finally, an additional differentiation can be made based on the empirical findings presented in this dissertation: science–policy interfaces appear to employ *on stage* and *backstage* strategies (as introduced in Chapter 4 by the knowledge brokers interviewed). This differentiation is especially applicable to the first type of strategy (process-oriented strategies): *on stage* strategies, such as the collective framing of a problem, contribute to the legitimacy of the process. *Backstage* strategies, such as the strategic steering of the process (for further explanation, see Appendix V), are not per se directed at increasing credibility, legitimacy or salience, but, as explained in Chapter 4, can be very necessary to create process in the interaction process.

The second conclusion is that the explorative research on boundary objects as presented in Chapter 5 suggests that boundary objects are not only science–policy interfaces but can in fact also be a strategy used not only to enrich decision-making processes by creating an object which is salient and credible, but also to enhance the interaction process (since the development of boundary objects is fundamentally based on co-creation processes and the creating of consensus). Although I urge for further in-depth empirical research into boundary objects, the explorative research conducted on the Wadden Sea Barometer and the Waddenhouse Deliberation ranking suggests that they aimed to enhance the credibility and salience of the knowledge used, but that the legitimacy of the development process is of critical importance for the actual enriching of decision-making processes.

Finally, the foregoing suggests that science–policy interfaces do not focus solely on increasing the credibility, legitimacy and salience of the knowledge developed and used, but that their arsenal of strategies contains other strategies as well. The need for these non-knowledge-related strategies is demonstrated in Chapter 5: without creating a structural dialogue between the (opposing) stakeholders, without creating ownership of the developed boundary object, the *process* will lack legitimacy, which in turn will influence the legitimacy of the boundary object. In order for the process to be perceived as legitimate, it thus needs to be inclusive of the different stakeholders involved. Science–policy interfaces should aim to broadly map the possible stakeholders and reach out to invite them to participate. Strategic choices can be made here, about who participates when and with whom (see for example Chapter 4, where knowledge brokers give examples of choices made in this matter). But it should be the aim of any science–policy interface to create an inclusive process. This insight has direct consequences for situations where, due to opposing interests, relations are highly disrupted. Even if the knowledge is considered credible and relevant to policy-makers (as was for example argued in the case of the Wadden Sea Barometer discussed in Chapter 5), if the interaction processes between science, policy and other stakeholders involved is not perceived to be legitimate, it is likely that the boundary object (and thus knowledge) produced will have little effect in enriching decision-making processes because of the lack of support from the stakeholders involved. Based on this conclusion, it could therefore be suggested that achieving the process goals aimed at creating legitimacy (discussed at the start of this section and shown in Figure 6.1) by means of their complementary strategies is a prerequisite for achieving the impact goals and the 'ultimate' goal of enriched decision making.

SRQ4. *What lessons can be drawn from the analysis and evaluation of individual science–policy interfaces in terms of general recommendations for the science and policy communities, and the opportunities and limitations of combining science–policy interfaces?*

Based on the different empirical case studies presented in this dissertation, I would like to make two recommendations. First of all, science–policy interactions, and therefore also science–policy interfaces, are not all about science. When trying to 'close the gap', or 'work at the boundary', the primary focus of any science–policy interface is on scientific knowledge and (increasing) its credibility. But should it be? Surely, science–policy interfaces should be aware of external factors (as discussed in Chapters 2, 3, 4 and 5) and act upon them, increasing legitimacy and salience? The literature on science–policy interfaces often speaks of a gap between science and policy (e.g. Sarkki et al., 2014; Klauer et al., 2013; Wesselink et al., 2013; Turnhout et al., 2008; Guston, 2001; Bradshaw and Borchers, 2000), a gap which needs to be bridged, or mediated. As discussed in more detail in Chapter 1, this gap is often ascribed to the multifaceted character of sustainability issues: multiple (scientific) disciplines and a broad array of actors. Furthermore, the shift that has taken place from government to governance has made the playing field on which decisions are being made more complex, due to the broad spectrum of stakeholders (and thus interests) involved and the multi-level character of the field. The need for science has also changed, from a more linear perspective in which the credibility of science was of importance ('speaking truth to power') to an open knowledge-development process in which scientists, policy-makers and other stakeholders are all involved, ideally resulting in knowledge that is not only credible, but also legitimate and

salient. As discussed earlier, these challenges give rise to operational issues, difficulties on the process side of the interactions. Decision-making processes are therefore guided not only by scientific knowledge. As addressed in Chapter 2, and confirmed in Chapters 3, 4 and 5, other contextual factors such as social, economic and political dynamics also influence these processes. Using knowledge selectively, or using counter expertise but also presenting knowledge selectively or joining competing knowledge coalitions and starting 'report wars' all also influence the public debate. I would argue that this might cause the 'gap' between science and policy to widen even further. Relationships between stakeholders can be considered to be precarious, especially in regions such as the Wadden Sea, and the influence of the public debate on the area is not to be underestimated. As I argued in Chapter 5, there is often mistrust between scientists and experts, industry, and environmental organisations. The existing gaps between these stakeholders can almost be described as being institutionalised, since in almost every case of an unstructured policy problem, these stakeholders are on opposite sides.

Secondly, timing is all. Currently, science–policy interfaces seem to be being used to enhance the interactions between science and policy when the gap is already wider than 'just' different languages and timeframes. Based on the conclusions drawn in Chapter 4, in which it was discussed how 'incident politics' (knowledge brokers only becoming part of an interaction process between science and policy when the situation is already troubled) complicated the knowledge broker's task of enhancing the science–policy interfaces, and on the conclusions of Chapter 5, that the timely involvement of a broad array of stakeholders in the development process of a boundary object is critical for that boundary object's acceptance and legitimacy, I argue that science–policy interfaces should be used not reactively but proactively.

To answer the second part of this sub-question, what the opportunities and limitations of combining science–policy interfaces are, this research shows the following: in the empirical cases presented in this dissertation, the use or implementation of different interfaces often overlaps. In case of the Waddenhouse Deliberation ranking, for example, the main subject of research was the boundary object. The process which ended in the development of this boundary object, however, was organised by a knowledge broker (who was also involved in the empirical research into knowledge brokers), together with two employees of one of the research boundary organisations (IMSA Amsterdam), and at the request of the Wadden Academy (yet another researched boundary organisation). This level of entanglement of science–policy interfaces implies a perspective of mutual gains: this is especially the case in the situation of unstructured policy problems, as where there is not only a lack of credibility but also of legitimacy and salience the use of multiple interfaces might strengthen the interaction process, and in line with these processes, the enriching of decision-making processes. Other examples of this entanglement can be found in the literature: for example, the article by Runhaar and Van Nieuwaal (2010) on science–policy interfaces and the controversies on cockle fisheries and gas mining in the Wadden Sea describes the interference of boundary organisations, knowledge brokers and the use of boundary objects. On a more critical note, questions can be asked concerning the necessity of combining science–policy interfaces: does it increase the chances of enriching decision-making processes, or can combinations of interfaces also fuel new difficulties? It could be hypothesised that when

addressing science–policy interaction problems in an area such as the Dutch Wadden Sea, knowledge of and experience with the mutual relationships between stakeholders is of great importance. However, as a substantial number of interviewed knowledge brokers explained, in order to function as a knowledge broker, you have to act without personal interest. In such a situation, the combination between interfaces which, combined, bring a lack of personal interest but also experience with the region to the table could produce synergy. A counter argument could be that if too many interfaces are involved, the goals may be watered down and the use of strategies might be complicated.

However, neither the extent to which interfaces empower each other, nor the possible trade-offs of combining interfaces are addressed as such in the scholarly literature reviewed. The research presented in this dissertation could therefore be taken as a starting point for the further exploration of these relations.

Main research question

The previous section discussed the four sub-questions which guided the (empirical) research into science–policy interfaces presented in this dissertation. What we are left with is the overall conclusion of this research, and its implications for the scientific debate on science–policy interfaces, and for practice.

The main research question of this research:

How do science–policy interfaces, such as boundary organisations, knowledge brokers and boundary objects contribute to enhancing the interactions between science and policy with the aim of enriching decision-making processes?

In the case of a multitude of pressing environmental issues, disciplines involved, stakeholders, conflicting interests, 'truths' and scientific insights leading to various interaction problems set in a multi-actor and multi-interest setting, science–policy interfaces can only contribute to enriching decision-making processes when the interaction and knowledge development processes they aim to enhance are perceived to be legitimate. If in knowledge development processes the dominant aim is to create scientific knowledge which is as 'credible' as possible, the usability of knowledge, which greatly depends on legitimacy and salience, is put under pressure. By engaging science–policy interfaces such as boundary organisations or knowledge brokers proactively instead of reactively in these complex and contested situations in order to establish and guide such legitimate interaction processes, room for manoeuvre is created for the negotiation on and development of credible and salient knowledge, which in turn could lead to enriched decision-making processes.

Throughout the research presented in this dissertation, the initial, theoretical goal of researching science–policy interfaces was to understand how they enrich decision making. The interfaces were to impact directly or indirectly on decision-making processes. However, especially in the case of addressing unsustainable practices and situations, which often cause unstructured policy problems, and where the scientific knowledge is contested (and thus lacks credibility) and lacks shared norms and values (and thus legitimacy), interfaces should not focus solely on the production and use of

knowledge. In line with the changing demands of and for science (which require more room to be given to policy questions) the influence of lay and expert knowledge, and the interests of stakeholders, science–policy interfaces should instead first aim to restore the relations between the different stakeholders involved. In an area such as the Dutch Wadden Sea, where the interests of the various actors are so diverse (and visible, due to the shift from government to governance) and their ideas on how to manage and govern the area can be so opposed (e.g. Floor et al., 2016; Hofstede and Stock, 2016), the first step or goal of the science–policy interface explored, whether boundary organisations or knowledge brokers, is to enhance these relationships and (re)create mutual understanding and trust. The empirical research (Chapter 4) shows that especially in the case of knowledge brokers, many of the strategies used aim at enhancing this interaction process without placing knowledge at the centre. The cases described in this dissertation suggest that only after the relationships between the stakeholders are considered to be constructive (by which I mean that a mutual sense of urgency, and trust between stakeholders, and between stakeholders and the knowledge broker have been created, as argued in Chapter 4) can further actions can be taken with regard to the knowledge base. The empirically researched case studies presented in this dissertation (Chapters 3, 4 and 5) suggests that science–policy interfaces predominantly focus on unstructured policy problems. Since in these types of policy problem the interaction issues between science and policy often do not stand alone, interfaces use a range of strategies to enhance these interactions. For example, is there a case of strategic production and use of knowledge? If so, it is likely that there is a lack of credibility and legitimacy. In such cases, strategies such as the development of boundary objects can be used. In Chapter 5, boundary objects are introduced as a science–policy interface, since their aim is to bring stakeholders together and ultimately enrich decision-making processes. However, throughout the empirical research and as shown in Chapters 3 and 4, the actual development of boundary objects also serves as a strategy of boundary organisations and knowledge brokers to enhance the relationships between stakeholders, increase the credibility, legitimacy and salience of knowledge, and enrich decision-making processes. In line with the Action Strategies for the Wadden Sea developed by Van der Molen et al. (2015) in case unstructured policy problems and multiple interaction problems arise, knowledge boundaries can be bridged by means of boundary objects, because such objects are based on a mutual agenda, on a knowledge framework which is perceived to be credible, and on policy options and standards.

Taking the theoretical and empirical analyses presented in this dissertation together with the concluding remarks in this chapter into consideration, in Textbox 6.1 I propose recommendations to policy which can proactively guide situations in which there are unstructured or moderately structured policy problems and problems of science–policy interaction.

As an illustration to these recommendations, so-called 'Wadden Sea icons' (discussed in Chapter 3) are often at the centre of these unstructured policy problems and debates, and are surrounded by different 'truths'. Firstly, the research presented in this dissertation suggests proactive use should be made of a knowledge broker and/or boundary organisation, ideally (as discussed when addressing SRQ4) one considered to be independent, credible and legitimate by all stakeholders involved (e.g. Seijger et al., 2016; Gaillard et al., 2014), but also with experience of the region and its sticking points. In that sense, a

Textbox 6.1 Recommendations for policy

- √ Proactively employ a knowledge broker and/or boundary organisation, especially when moderately structured and unstructured policy problems are foreseen;
- √ Enhance the relationships between stakeholders and scientists and (re)create mutual understanding and trust;
- √ Create a continuous feedback loop between the science–policy interface(s) and the policy-makers;
- √ Involve not only scientists, but also other stakeholders with experience and knowledge (if necessary, from outside the stakeholder field);
- √ Science–policy interfaces should be aware of and act upon contextual factors and possible windows of opportunity

combination of interfaces could be preferred. The science–policy interface should strategically lead the interaction between stakeholders in such a way that it is considered by all to be legitimate. An important part of this process is the creation of a sense of urgency among all stakeholders. This does not imply that there needs to be consensus on the issue (e.g. Star, 2010), but if all stakeholders perceive a significant problem and agree on the need for a solution (e.g. Feldman et al., 2006), then that can be considered to be the starting point for the process of further interaction. Secondly, throughout the process, a continuous feedback loop needs to be created between the boundary organisation or knowledge broker, and the policy-makers. Questions and needs can change, and without salience it is unlikely that the knowledge produced will be able to enrich decision-making processes. Knowledge should be gathered or (co-)created. The scientists involved should start this process and be guided by clear policy questions relating to the knowledge required, and should operate transparently to ensure not only credibility but also legitimacy. Thirdly, during this process of development, other stakeholders with knowledge (expert or otherwise) should be involved, to provide input and discuss outcomes, thereby increasing the legitimacy of the process and the credibility of the knowledge developed. As discussed in Chapter 4, if there is too much contested knowledge and/or there are controversial issues, the knowledge broker or boundary organisation could decide to bring in an independent actor (e.g. scientist(s), or research institute) to provide an analysis. A possible trade-off of this strategy is that because the strategy is not home-grown ('not invented here': see Chapter 5 on the Wadden Sea Barometer), the legitimacy could be decreased. And finally, in order for the knowledge developed to have the potential to enrich decision-making processes, the science–policy interface should be aware of contextual factors such as social and political dynamics and windows of opportunity (e.g. Wesselink et al., 2013) (discussed in Chapters 3, 4 and 5) and act on them, for example by putting pressure on the process to generate results within the timeframe of the policy-makers (see for example Chapter 5). Or by using media outputs strategically (discussed in Chapter 3): a boundary organisation or knowledge broker (or other stakeholders in the process) could influence these dynamics (positively *and* negatively) and act upon them by presenting the (for example) boundary object at the right moment.

6.3 | Reflection on the research approach and selected cases

The research presented in this dissertation drew on various bodies of literature (e.g. environmental governance; organisational science; science and technology studies). In addition, several analytical frameworks were applied to develop a better understanding of science–policy interfaces. I argue that combining different perspectives as input for the different analytical frameworks has been of added value and resulted in more in-depth insights for the literature on environmental governance and contributes to the literature in other theoretical fields. Furthermore, the application of these frameworks in exploring empirical case studies has contributed to the further understanding of the use and contribution of science–policy interfaces in decision-making processes. In using this approach, a researcher might oversimplify theories, or 'cut corners' in order to make them fit. However, in the chapters of this dissertation, I have aimed to clarify and justify the choices I made, making them less ambiguous.

A second reflection concerns the concept of 'enriched decision-making'. For numerous reasons, presented throughout this dissertation, decision-making processes are far from straightforward, especially in the case of unstructured problems. This makes the aim of interfaces to enrich these processes even more necessary, but also equally more complex. The researched scholarly literature on science–policy interfaces argues that the use of these interfaces (i.e. boundary organisations, knowledge brokers, or boundary objects) ultimately leads to enriched decision-making. However, as argued throughout this dissertation, a clear understanding of the goals and strategies of these interfaces is needed first. In this dissertation, therefore, I conducted a process analysis in which I used three indicators of useful science as evaluation criteria to create further understanding on how science–policy interfaces work, rather than a substantial and detailed analysis of enriched decision-making. To evaluate how and to what extent the knowledge at issue actually enriches decision-making processes requires a different type of analysis, and depends on other factors. The fact that 'enriched decision-making' as such is not addressed in this dissertation could be understood as a limitation. I would strongly recommend further research into this matter as it contributes even further to the understanding of science–policy interfaces.

Regarding the research approaches, in all three case studies I used the combination of document analysis with in-depth (semi-structured) interviews, adding to the internal validity (Bryman, 2004); insights into formally discussed goals and strategies could be tested and complemented by on-the-ground insights of the different stakeholders involved in these interfaces. For each study, more than one case was explored (two boundary objects, three boundary organisations and 27 knowledge brokers). By doing so, common and differentiating characteristics and factors could be established, adding to the theoretical and practical understanding of the different interfaces (Bryman, 2004). With regard to the limitations of this approach, it firstly needs to be noted that because of the small number of cases, especially in the studies into boundary organisations (3 organisations) and boundary objects (2 objects), these case studies must be seen as explorative. For more generalised insights I would recommend further research (as will be discussed in the following section). However, considering

the lack of (comparative) analyses of these science–policy interfaces in the current scholarly literature, these two explorative case studies could be seen as a first important step in opening this 'black box'. Secondly, in all three case studies, we interviewed people who were directly involved in or were part of the science–policy interface: this might limit the insights into how science–policy interfaces work from a bystander's perspective. This was especially the situation in the case study of knowledge brokers. However, given the research questions underlying this case study, the choices made can be justified. It would be interesting, however, to also conduct a more ethnographic, anthropological study of knowledge brokers in which bystanders and other stakeholders are included.

The selected cases provided insights for further theoretical development on the use and contribution of science–policy interfaces in environmental governance, since all the interfaces explored operate within the field of environmental governance. The three case studies (boundary organisations, knowledge brokers and boundary objects) were selected in the expectation that they would show a range of different goals and strategies in their aim of enriching decision-making processes, and would address different science–policy interaction problems. Furthermore, the explored boundary organisations and boundary objects and the knowledge brokers interviewed were selected in the expectation that differences might be seen not only between different *types* of science–policy interfaces (for example in the strategies used) but also *within* a specific science–policy interface, adding to the in-depth analysis of the different interfaces. When approaching a study in this way, the researcher must be aware of (personal) biases which might steer analysis and conclusions. However, in all three case studies I conducted I aimed to be transparent about the analyses made by providing detailed explanations and examples of the methods used, showing that the analyses and conclusions were guided by the data, and not the other way around.

Finally, in terms of the geographical choices made, the selections included interfaces within the Dutch environmental governance realm, with a dominant focus on the Dutch Wadden Sea region. One might question to what extent the Dutch setting influences the way in which science–policy interactions and interfaces are structured, given institutionalised multi-stakeholder processes in strategic environmental decision-making, or what Glasbergen (2002) refers to as the green polder model. In response, I argue that these processes do not preclude the existence of opposing stakes between ecological and economic interests, and furthermore, these opposing interests discussed in relation to the Dutch Wadden Sea are not limited to this geographical area. As a result of the changing climate (and the actions needed to address climate change) and the ever growing (global) economy, the opposing stakes of these two are visible in many more regions than 'just' the Dutch Wadden Sea. The Wadden Sea should therefore be understood as an overarching case of research into science–policy interfaces. Nonetheless I argue that further research into science–policy interfaces in other geographical areas is recommended, as will be explained in the following section of this concluding chapter.

6.4 | Recommendations for further research

The findings presented in this dissertation have provided new insights for the conceptual and practical understanding of science–policy interfaces. They have, however, also led to new questions and topics for further research.

Chapter 2 ends with a possible research agenda into science–policy interfaces. Throughout this dissertation, in answering the research questions formulated in Chapter 1, I addressed this research agenda and its questions, but the scope of this dissertation prevented this research from answering all questions. Therefore, a first recommendation, from an empirical perspective, concerns a further exploration of the extent to which science–policy interfaces are mutually reinforcing, and how they achieve this. In all three empirical chapters and specifically in Chapter 5 on boundary objects I have observed that in practice there is overlap between interfaces, especially between the work of boundary organisations and knowledge brokers, for example in the development and use of boundary objects. And although in the scholarly literature on science–policy interfaces certain authors address this practice to some extent (e.g. Runhaar and Van Nieuwaal (2010), who discuss the role of IMSA as an organisation and Wouter van Dieren as a knowledge broker in the case of gas mining and cockle fisheries in the Dutch Wadden Sea), limited emphasis is placed on the possible reinforcing capabilities of interfaces. In Chapter 5 and this concluding chapter this issue is addressed and insights have been developed. I would argue that more research is necessary to gain more generalised insights into when and how to combine interfaces, and to what extent these combinations lead to enriched decision-making processes. Focus could, however, also be placed on possible trade-offs: to what extent do combinations of science–policy interface hamper the interactions between science and policy, and therefore limit the enriching of decision-making processes? These insights would contribute to the scholarly literature a more in-depth understanding of science–policy interfaces (in practice), and they would contribute to practice by developing further guiding principles on when to use which (combination of) interface(s).

A second empirical recommendation is related to the setting in which science–policy interfaces are researched. As stated previously, this dissertation has a dominant geographical focus on the Dutch Wadden Sea area. However, the Wadden Sea is not limited to the Netherlands, but also includes German and Danish territorial waters (as can be seen in Picture 1.1 in Chapter 1). The management of this coastal zone is therefore also an international issue. The governance arrangements in these countries might differ, hypothetically causing science–policy interfaces to address interaction difficulties in a different manner. Further empirical research is therefore recommended into the strengthening of the international science–policy interactions and the contribution science–policy interfaces could deliver. These insights would contribute to the scholarly literature on science–policy interfaces and to environmental governance in general by establishing how interfaces can contribute to the use of science in international coastal zone management.

Finally, from a theoretical perspective, I recommend further research into the application of the framework developed by Cash et al. (2003) (considering the need for knowledge to be perceived as

credible, legitimate and salient in order to be used in sustainable development) on the contribution of science–policy interfaces to enriched decision making. Although research on credibility, legitimacy and salience and on science–policy interfaces has been presented by various scholars (e.g. Heink et al., 2015; Sarkki et al., 2014; White et al., 2010), the next step – determining the extent to which knowledge enriches decision-making processes – is less explored. This dissertation, specifically Chapter 5 discussing boundary objects, has contributed to this theoretical framework. This, however, also created room for further research into the understanding of how the criteria credibility, legitimacy and salience contribute to the processes of enriching decision-making. Possible directions for future research on this topic might be whether there are trade-offs between these criteria, and how these trade-offs influence (or are influenced by) the strategies of science–policy interfaces.

6.5 Science–policy interfaces for the Wadden Sea: final observations

This PhD dissertation has yielded various conclusions on the utility and necessity of science–policy interfaces. I would, however, like to take the opportunity to share some final observations regarding this research in theoretical and practical sense, and regarding the Wadden Sea area as case study.

Driven by my personal motivations and academic background in anthropology and planning, it was my aim in this dissertation not only to contribute to the practice and science of enhancing science–policy interactions by means of science–policy interfaces, but also to give a glimpse of what kind of people work at this boundary between science and policy, and what challenges they face. The research questions addressed in this dissertation are derived from theory, due to a lack of empirical evidence on when, why and how interfaces such as boundary organisation, knowledge brokers and boundary objects work in practice and to what extent these interfaces contribute to enriched decision making. The empirical research presented here therefore contributes to both the theoretical and practical debates on how the science domain and the policy domain interact, how this interaction can be guided, and the role scientific knowledge embodies in these interactions and decision-making processes. However, in my opinion, the greatest implication of this dissertation lies in understanding that in order for scientific knowledge to enrich decision-making processes, the scientists and policy-makers should reach out to each other (even though the institutions 'science' and 'policy' might be opposed) – a process in which people from boundary organisations, or knowledge brokers should play a vital role.

Related to this previous observation, another question can be asked: to what extent should science–policy interfaces even be necessary? This question can be explained in two ways: first, should science–policy interfaces not simply be seen as a treatment of symptoms? And secondly, how problematic are science–policy interaction problems? Concerning the first; many of the difficulties regarding the interactions between science and policy can be ascribed to institutional differences. So, should we in that case not aim to reduce these institutional differences? And would the promoting

and achieving of sustainable development, which is now hampered due to (amongst others) institutional differences, not also benefit from this reduction? I would argue that some self-reflection and self-critique in this matter would do scientists and policy-makers no harm. However, as long as these institutional differences do exist, there will be science–policy interaction problems, and therefore a need for science–policy interfaces. This leads us to the second explanation of the question on the necessity of science–policy interfaces: are interaction problems a problem? I would argue that these problems could serve a purpose as well: the existence of problems creates room for critical reflections on personal and/or institutional interests, on what matters and on what is at stake. This is in line with what is argued in Chapter 4, where interviewed knowledge brokers admitted to strategically using interaction problems to steer the interaction processes, turning a problem into a solution.

Finally, the Dutch Wadden Sea continues to be a fascinating region for research into the interactions between science and policy and on how scientific knowledge is used and sometimes abused to reach goals. It is also fascinating, however, that in a region subjected in the past two decades to so much scientific research on its governance processes, including science–policy interaction problems and the use of science–policy interfaces to decrease the gap between these two domains, difficulties appear to remain between these and other domains. At the start of my PhD research (early 2011) a proposal was made to extract salt from underneath the Wadden Sea. It seemed an interesting case, since at first glance it had some similarities to the gas extraction case from over a decade previously. Had the different stakeholders in the Wadden Sea arena learned from the gas extraction case, in terms of the knowledge development processes, the need for legitimacy, the use of one or more science–policy interface(s)? Or would this case cause similar issues, and would it be 2004 all over again? Today, mid-2017, we know that the salt extraction activities led to much (heated) debate in the region, although perhaps the public were less involved. Environmental organisations came up with protest slogans such as '*stop fout zout*' (stop wrong salt)[1] and started legal action against the national government. This leaves me wondering: have we not learned from all the controversies in which the Wadden Sea has taken centre stage? Or do we not want to learn? Today, as I draw up my final conclusions and thoughts, a new committee of scientists has been announced, which has been commissioned by the Dutch Ministry of Economic Affairs to research the future of seal sanctuaries in the Netherlands[2]. 90% of the 10,000 seals in Dutch waters live in the Wadden Sea region, making this research very much a Wadden Sea case. The seal is, however, (as one of our interviewees in Chapter 3 framed it) a Wadden Sea icon: appealing to the general public, influencing their perceptions. If the necessity of seal sanctuaries is addressed solely from a scientific perspective, ignoring the criterion of legitimacy, I predict that this could become the next contested issue dividing the Wadden Sea region. I would suggest that the Ministry of Economic Affairs should approach this issue not only from a scientific perspective but should also place emphasis on the legitimacy of the process by including from the outset the stakeholders involved (such as the seal sanctuaries and the tourist industry). This involvement of stakeholders should be organised by an independent knowledge broker: someone

1: https://www.waddenvereniging.nl/onswerk/zoutwinning/achtergrond
2: https://www.rijksoverheid.nl/actueel/nieuws/2017/06/30/onderzoek-toekomst-van-opvang-zeehonden

who is familiar with the debate, the region and its players. In this, the scientific committee should be one of the stakeholders, providing scientific insights and policy options. I would recommend to also take the public discourse into account; after all, seals are a major Wadden Sea tourist attraction. It has been reported in the media that policy advice will be based on the opinion of this scientific committee (or might even be authored by the committee). Not using a science–policy interface on such a (seemingly) sensitive subject is inadvisable in my opinion, as has been argued extensively in this dissertation. After all, in order to enrich decision making, it is not only the credibility of the scientific insights that counts.

Endnotes

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Appendices

Appendix I. Questionnaire semi-structured interviews case study 'Boundary Organisations'

1) What is your role within *boundary organisation X*? Or: what are your relations to *boundary organisation X*?

2) Generally speaking, which science-policy interaction problems do you see occur in the Wadden Sea area?

3) Upon which of these interactions problems does *boundary organisation X* act? Can you give examples?

4) Why is there a need for *boundary organisation X*? What is the necessity for the existence of *boundary organisation X*?

5) What is the goal of *boundary organisation X*?

6) Which strategies does *boundary organisation X* use to solve the interaction problems, or enhance the interactions between science and policy? Could you give examples?

7) In your opinion, when do you feel *boundary organisation X* is successful, and how would you describe 'success'?

8) What would points of improvement be for *boundary organisation X* to better function as a boundary organisation?

9) How would you describe the role *boundary organisation X* in the future Wadden Sea debates?

10) Generally speaking, how do you see the interactions between science and policy in the Wadden Sea area in the future?

Appendix II. Recorded interviews case study 'Boundary Organisations'

Organisation	Function	Date
Wadden Academy	Member Board	09-04-2013
Wadden Academy	Secretary Board	09-04-2013
Wadden Academy	Supervisory Board	10-04-2013
Wadden Academy	Scientific advisory board	25-04-2013
IMSA	Senior management member	21-05-2013
WaLTER	Project leader	22-05-2013
Entrepreneur, Advisory group Wadden Sea Policy ('Commissie Meijer)	Entrepreneur, project leader	23-05-2013
Province of North-Holland	Coordinator Wadden Sea	28-05-2013
Waddenvereniging (NGO)	Former Chair	06-06-2013
Province of Fryslân	Director Policy	11-06-2013
NCEA	Workgroup secretary	09-07-2014
NAM	Senior Ecological Specialist	04-09-2014
Ministry of Economic Affairs	Policy Officer	18-09-2014

Table I. Recorded interviews case study 'Boundary Organisations'

Appendix III. Topic list and interview guide case study 'Knowledge brokers'

Topic list:

1. In which situations did you act as a knowledge broker?
2. Which science-policy interactions problems occurred within these situations, which caused for you to act as a knowledge broker?
3. Which strategies did you apply in order for you to reach your goals, and to improve the interactions between the different stakeholders?
4. When would you describe your work as knowledge broker as successful?
5. What are the essential competences, qualities and capabilities a knowledge broker ought to have?

Interview guide:

1. In which situations did you act as a knowledge broker?
    a. Could you describe a situation, or case, in which you acted as knowledge broker? Could you also explain the content of this situation?
2. Which science-policy interaction problems occurred in this specific situation/case, which caused for you to act as a knowledge broker?
    a. What where the problems between science and policy?
    b. Who, or which organisation took the initiative to involve you into the process? Why?
    c. Who defined the goal of your involvement?
    d. What was the goal of your involvement as knowledge broker?
3. Which strategies did you apply in order for you to reach your goals, and to improve the interactions between the different stakeholders?
    a. Which strategies did you apply, both formal and informal?
    b. What were your strategies to increase the legitimacy of the used knowledge (among all involved stakeholders)?
    c. How did you ensure that the produced and used knowledge was (and stayed) salient to all involved stakeholders?
4. When would you describe your work as knowledge broker as successful?
    a. What would be the indicators for the success of a knowledge broker?
    b. Which contextual factors (such as political dynamics, influence of media and society) could have an empowering and limiting role in your work as knowledge broker?
5. What are the essential competences, qualities and capabilities a knowledge broker ought to have?
6. Could you name three people who you believe to be knowledge brokers as well?

Appendix IV: Recorded interviews case study 'Knowledge brokers'

Interviewee	Sector	Date interview
1) S1	Science	20-2-2014
2) PS1	Private sector	4-3-2014
3) P1	Policy	18-3-2014
4) P2	Policy	11-3-2014
5) PS2	Private sector	13-3-2014
6) S2	Science	19-3-2014
7) S3	Policy	25-3-2014
8) PS3	Private sector	27-3-2014
9) PS4	Private sector	2-4-2014
10) P3	Policy	3-4-2014
11) S4	Science	8-4-2014
12) PS5	Private sector	10-4-2014
13) PS6	Private sector	18-4-2014
14) P4	Policy	6-5-2014
15) P5	Policy	22-5-2014
16) PS7	Private sector	27-5-2014
17) P6	Policy	25-4-2016
18) PS8	Private sector	28-4-2016
19) S5	Science	2-5-2016
20) P7	Policy	4-5-2016
21) S6	Science	3-5-2016
22) S7	Science	12-5-2016
23) S8	Science	17-5-2016
24) PS9	Private sector	20-5-2016
25) P8	Policy	25-5-2016
26) S9	Policy	29-8-2016
27) P9	Policy	23-8-2016

Table II. Recorded interviews case study 'Knowledge brokers' (anonymised)

Appendix V. Tables empirical analysis case study 'Knowledge brokers'

Science-policy interactions problems	Interaction problems explained	Illustrative quotes
Misuse of knowledge	Knowledge is ignored; contra-expertise is used to discredit scientific reports; knowledge is used to support pre-set policy; on the basis of scientific findings, scientists advise policymakers about the decisions they should make.	"It depends on the culture of the department, but knowledge from outside is perceived as inconvenient, to put it bluntly. When a university or research institute produced a report in the field of [the department] sometimes a sigh was heard: 'and now we have to do something with it'. It was not experienced as helpful." PM4
Strategic production of opposing, or incomplete knowledge	Existence of "knowledge coalitions"; academic interests leading in the conduct of research; production of incomplete knowledge due to a lack of collaboration and co-creation.	"The economist made a sophisticated analysis of the economy, but with a shallow solution regarding governance; the lawyer had a sophisticated analysis of the legal system, but in the end a new, or better rule was needed, etc. Everyone is a prisoner of their own field of expertise. They can flourish, but are also constrained." S6
Cultural differences between the world of science, and the world of policy	Problems with the formulation of policy and of (research) questions by policymakers, due to insufficient, active steering from policy towards science, and due to policymakers' reluctance of seek clarification by asking questions; differences in terms of discourses, culture, goals, level of abstraction, notion of time.	"We asked the scientists questions because the policymakers did not dare to do so. (…) They didn't feel safe enough. They felt like their academic background was too limited to ask the proper questions." S2
Science-policy interaction problem not related to knowledge	Complete absence of communication between stakeholders; policymakers act reservedly at the early stage of a policy process, shielding themselves from science-policy interactions.	"Mostly you get involved because people are done talking to each other. In Dutch we say 'trust comes by foot, and leave on horseback'. In this case all the horses ran in different directions. Every conversation between stakeholders ended within minutes, with threats of lawsuits. They were done talking." C5

Table III. Science-policy interaction problems addressed by knowledge brokers explained and illustrated

Goals of knowledge brokers	Goals explained	Illustrative quotes
To resolve conflicting interests	Resolving conflicting situations between stakeholders which would otherwise end up in an impasse in the process. Disputes occur not only between scientists and policymakers, but also between scientists (with different fields of expertise).	"The province dictated strongly from its own perspective what needed to happen. The other stakeholders felt left out. Thus far it was plain common process management between different stakeholder groups." C1
To make better use of knowledge	The problematic interactions between science and policy are often ascribed to the (mis)use of knowledge. By increasing the credibility and legitimacy of the knowledge used, the aim is to provide the stakeholders with all the opportunities they need to be able to use the knowledge properly.	"Before my arrival, people here stood with their backs turned towards policy. It was unreliable, dangerous, even though we worked as a public service. (…) I came here because I wanted things to be different, because I wanted to increase the relevance of this institute and make all this expertise useful for society, (...), create impact. " PM3
To increase relevance of the scientific knowledge (or research project)	The intervention of the knowledge broker should ultimately enhance the social and scientific relevance of this particular program. In concrete terms: by becoming involved, the knowledge broker personally aims to increase the relevance of a research program, or organisation.	"In the entire project there was no one with expertise on the subject of sediment. (…) I was the representative of science." S1

Table IV. Goals of knowledge brokers explained and illustrated

Strategies of knowledge brokers	Strategies explained, and opperationalised	Illustrative quotes
Frame the problem, create a sense of urgency	Help stakeholders collaborate with each other to frame the problem at hand, to create a sense of ownership by: i) forcing stakeholders to approach the problem, and to propose a solution, from an opposing perspective, leading to mutual understanding of other positions in the debate; ii) re-framing the problem with the backing of scientific knowledge and facts.	"On the agenda for a next meeting, I put a theme which was prepared by not one, but two stakeholders; they had to prepare the problem framing together. So, already in the preliminary stage they had to think, 'how can we solve this issue together." C3
Structure and translate knowledge	Structure by collecting and reading research reports, summarising by means of questions, and actively interacting with scientists to understand what is known, and where the information gaps lie. Translating by developing summaries focussed on the audience's interests or objectives.	"I developed a 'learning-table', a table at which expert on a certain subject from various disciplines were seated. And next, I developed an interdisciplinary advisory document based on all these different disciplines, by means of one integrative analysis." S6
Act on the (personal) interests of stakeholders	Know and understand the commitment and agendas of the different stakeholders, as well as the institutional systems to which they belong, as this enables the knowledge broker to respond to stakeholders appropriately (e.g. to know when to provide them with a platform, and when to put them "on hold").	"When you organise a symposium specifically for policymakers, don't host this symposium in a scientific environment. How many policymakers do you think will come? No, you need a completely different setting. Make it an in-house symposium for the policymakers. There they feel at home." S2
Innovate the (collaboration) process	Take deliberate actions to enhance the process (e.g. strategically choose the first speaker during a meeting, to set a positive tone). Actively change roles, wearing different hats to help the process more forwards (e.g. shift strategically between rationales, because every stakeholder has their own rationality: using a policymaker's rationale when addressing a scientist does not work).	"There is no *one* role for a knowledge broker, the knowledge broker needs to constantly switch roles and rationalities." S2
Bring knowledge to policy	Bring the two arenas in direct contact with each other during decision-making processes by i) enforcing KAT (Knowledge At the Table): scientists have a seat at the table when policymaking and decision-making processes take place, thereby bringing their knowledge into these processes much more directly; ii) organising frequent get-togethers for scientists and policymakers, where room is created for the latter to express their needs in terms of scientific research and knowledge.	"I organised a so called 'knowledge room' at the department, (…), discussing the research agenda. (…) Often the scientists immediately started to suggest what they thought would be interesting topic. But it was agreed that the policymakers would be allowed to speak first and explain what they wanted to know, after which the scientists would be allowed to respond." PM1

Create trust	Two levels: i) trust between the stakeholders and the knowledge broker; and ii) trust within the group of stakeholders. The first: being open and receptive to the range of stakeholders, especially at the start of a project, and without a personal agenda. The second: creating mutual understanding of and respect for the cultural and other differences between stakeholder; strategically displaying this respect can generate trust.	"If there is a first meeting and you tell the stakeholders that it will not be on the record, that no minutes will be taken, people will dare to say more." S2
Ask questions	Being critical of the process and towards the stakeholders; repeatedly asking whether the research questions and the goal of the interaction process are still valid, useful and accurate.	"Good knowledge at the wrong time is useless. You should continuously be asking yourself: is the question still useful? Or does the Ministry, or the client, or the social stakeholder need a different answer by now? And if so, play the game: 'you asked for A, but we think you want to know B, is that correct?" PM3
Steer processes	Strategically steer a process into another direction, when the mediation process has reached an impasse. By means of very cautious planning and timing, the knowledge broker can change the course of the process.	"Strategically hit the sensitive spot of [a key stakeholder], by developing a series of scenarios which point out this spot. I know the internal debate, so you know where the difficult point in this debate lies. If you don't do this, but only present a journal with an interesting scientific article, these stakeholders won't be interested." PM1
Create/act upon informal situations	Act upon, or create more informal settings (e.g. by remaining seated at the table after a formal meeting; organising informal visits, outings etc.), as this lessens the pressure on the process, making the stakeholders more receptive to e.g. credible knowledge in discussions, or to create mutual understanding of conceptual frameworks.	"As you're a colleague, you can remain seated after a presentation. (…) During the discussion that follows, you can continue bringing knowledge to the table." PM4

Table V. Strategies of knowledge brokers explained and illustrated

Competences of a knowledge broker	Competences explained	Illustrative quotes
Possess relevant knowledge	Possessing both *process* knowledge (understanding how the policymaking, and administrative processes work), and *substantive* knowledge (understanding and having insight into the matters at hand, in such a way that the knowledge broker can discuss these issues with all stakeholders involved).	"Every week I discussed a scientific report on one sheet of A4 paper. (…) I translated this [report] for the department. (…) I was so aware of what was going on, which discussions had been. I could make a selection because I was familiar with the content and the policy field." PM1
Be sensitive to all interests, and stakeholders involved	Being aware of and acting upon the different interests the participants in the process have.	"To allow environmental issues become part of general company policy you shouldn't focus only on the department that deals with environmental issues. (…) By personally getting to know all the different departments, you get to understand where the linkages are, and how to get them to take these environmental issues on board." S3
Possess intellectual capabilities	Being able to analyse and structure information and discussions. Having a scientific background can provide the validation for these capabilities.	"You need to be a systems thinker, capable of finding the coherence of things." S6
Be a good communicator	Being able to facilitate dialogue between stakeholders, to lead a discussion, be a good listener, be able to tell a story, be a performer.	"They are performers, the can move you. (…) You need to have the ability to tell a story, with all its emotions and values." PM3
Have drive and commitment	Having an intrinsic drive to do the work of a knowledge broker, not deployed from the outside.	"You need to be inspired, be enthusiastic about the subject, have passion, in order to be listened to." C2
Have a (personal) network	Gathering together a coterie of people with in-depth knowledge and power.	"Being asked by senior staff and management to explain things, give presentations. (…) This happens relatively often, because I know a lot of these people, and they trust me." PM4
Have power, authority	Having a certain reputation due to, for example, previous employment and being trusted by certain (or all) stakeholder groups enhances the legitimacy of a knowledge broker.	"I believe that it helps if knowledge brokers have a certain amount of authority, and ...with this authority, and for political reasons, form an interface." C9
Be flexible	Being aware of the role the knowledge broker fulfils during the process (not the scientists, nor the decision-maker), but also of the different roles you play, and obligations you might have during the process.	"Being able to switch between scientific, economic, legal and political rationalities. Being able to talk, think and produce in all four of these areas." C1
Act without a personal interest or agenda	Not having a personal stake, nor presenting a personal agenda during the process.	"You need to be without a personal interest. You need to be willing to walk away without losing, except [for feeling] that it's a shame that a way forward hasn't been found." PM8
Be a generalist	Instead of being an expert in a particular field, being able to acquire a broad understanding of many issues and subjects.	"You need to be able to understand something about everything. Able to think broadly and flexibly." S3

Table VI. Competences of knowledge brokers explained and illustrated

Appendix VI. Online questionnaires case study 'Boundary Objects'

1.	The reason for the development of the Wadden Sea Barometer was clear to you.
2.	The Wadden Sea Barometer is based on the most accurate and recent scientific knowledge.
3.	The Wadden Sea Barometer incorporates, besides scientific knowledge, non-scientific knowledge.
4.	There is a balance between scientific and expert knowledge on one side, and practical knowledge on the other side.
5.	The scientific credibility of the ecological analyses is high.
6.	The scientific credibility of the economic analyses is high.
7.	The scientific credibility of the social-cultural analyses is high.
8.	The Wadden Sea Barometer correctly depicts the influences of human activities onto the ecosystem of the Wadden Sea.
9.	The final report is unbiased.
10.	Throughout the process, it was clear to you what your role as participant was, and what was expected of you.
11.	All actors with an interest were able to be part of the process, which lead to the development of the Barometer.
12.	All actors with an interest were able to be part of the process, at the appropriate time.
13.	You can agree with the allocated scores and the final Wadden Sea Barometer.
14.	The Wadden Sea Barometer and its corresponding report do right by the existing policy questions.
15.	The Wadden Sea Barometer is relevant to policy makers.
16.	The Wadden Sea Barometer is understandable to a broad audience.
17.	Throughout the process, there has been sufficient communication between all stakeholders and the organisation.

Table VII. Statements online questionnaire Wadden Sea Barometer (responses conducted via Surveymonkey.com)

1.	The goal of process to develop the Waddenhouse Deliberation ranking was clear.
2.	The chosen methodology to develop a ranking is appropriate, taking the goals and application of the ranking into consideration.
3.	The purpose of the ranking and complementary report was clear.
4.	The ranking is based on the most accurate and recent scientific knowledge.
5.	The ranking incorporates, besides scientific knowledge, non-scientific knowledge
6.	The scientific credibility of the ecological analyses is high.
7.	The scientific credibility of the socio-economic analyses is high.
8.	The final ranking correctly depicts the influences of human activities onto the ecosystem of the Wadden Sea.
9.	The final report is unbiased.
10.	Throughout the process, it was clear to you what your role as participant was, and what was expected of you
11.	All actors with an interest were able to be part of the process.
12.	All actors with an interest were able to be part of the process, at the appropriate time.
13.	You can agree with the allocated scores and the final ranking
14.	The final ranking and its corresponding report do right by the existing policy questions.
15.	The final ranking is relevant to policy makers
16.	The final ranking and report are understandable to a broad audience.
17.	Throughout the process, there has been sufficient communication between the participants of the WHB and the organisation.
18.	Throughout the process, there has been sufficient communication between all stakeholders and the organisation.

Table VIII. Statements online questionnaire Waddenhouse Deliberation ranking (responses conducted via Surveymonkey.com)

Summary

Introduction

In recent decades, scientific knowledge has been extremely important in informing environmental decision-making processes on e.g. air and water quality, and coastal zone management. However, although in some cases scientific knowledge has clearly played a decisive role in contributing to sustainable policies, in many other cases the relationship between science and policy is often still troubled and contested. This can be attributed to the complex and multi-layered character of the field of environmental governance, and the involvement of a broad array of stakeholders with conflicting stakes and needs. Difficulties in the relationship and interactions between science and policy therefore arise. Issues that are discussed in the scholarly literature include the selective use of knowledge, knowledge being deliberately ignored by policy-makers, the use of counter-expertise, scientists selectively presenting knowledge and joining rival knowledge coalitions, and differences in the demand for and supply of knowledge in terms of language, timeframes, and level of detail. Consequently, opportunities to enrich decision-making processes – i.e. the use of knowledge to gain a clearer picture of the problem setting, underpin and implement policy and management measures, explore policy options, inform policy evaluations, and apply in learning processes between policy-makers, scientists and stakeholders – are not fully exploited.

With regard to possible ways to resolve or reduce these problems and therefore ultimately enrich decision-making processes, various scholars suggest carefully organising and employing science–policy interfaces. Science–policy interfaces can be understood as entities such as boundary organisations (often described as intermediary organisations which place themselves between the scientists and decision-makers), knowledge brokers (individuals who facilitate the creation, sharing and use of knowledge), and boundary objects (such as maps, models, ranking systems and reports) that provide a focus for organising participatory knowledge production processes, which enhance science–policy interactions by means of processes encompassing relations between different actors in the policy process, allowing for exchanges, co-evolution and co-construction of knowledge.

Knowledge gap

The current scholarly debate provides little systematic clarity on the range of different science–policy interaction problems, both in terms of conceptualisation and in terms of empirical evidence. Furthermore, there appears to be a lack of empirical research on how science–policy interfaces solve science–policy interaction problems, and how and to what extent these science–policy interfaces contribute to enriching decision-making processes. The aim of this dissertation is therefore to increase our understanding of the interaction problems science and policy face, and the extent to which science–policy interfaces could contribute to eliminating these problems and enriching decision-making. The main research question this dissertation addresses is therefore:

How do science–policy interfaces, such as boundary organisations, knowledge brokers, and boundary objects contribute to enhancing the interactions between science and policy with the aim of enriching decision-making processes?

The Dutch Wadden Sea

The empirical focus of this research is on the Dutch Wadden Sea. This sea stretches from the Dutch town of Den Helder, to the town of Esbjerg in Denmark, and is an area of specific national and international interest. In 2009, it was designated a UNESCO World Heritage site, because of (amongst others) its unique scenic value and the specific characteristics which make it an exceptional place as a staging post for many migratory birds. However, the area also hosts a number of industrial zones, which make the Wadden Sea of great economic value as well. Industries such as gas extraction, transport, fisheries, salt extraction and recreation are of great importance to the area. The Wadden Sea can therefore serve as an example of a coastal area which is extensively used for a broad range of purposes: from industry to gas extraction and recreation. These activities, however, put pressure on the ecosystem: coastal erosion, and loss of habitat are some examples of this. Governing this area sustainably by finding a balance between the economic activities and use of resources on the one hand and, on the other, the protection of this unique ecological site, is one of the major challenges the Wadden Sea area faces.

The importance of using scientific knowledge in the managing and governing of this area is evident. However, even though the Wadden Sea area is one of the most extensively researched coastal areas in the world, the direct enriching of decision-making processes by means of all this knowledge is less self-evident than might be expected. Based on recent history, various examples of policy problems in which the use of knowledge has been disputed can be found: e.g. gas mining, fishery, salt mining. All these examples share certain similarities: opposing ecological and economic stakes (both within the Wadden Sea area and within the governmental setting), and scientific insights which are used strategically in favour of or against certain positions. Furthermore, the institutional network of the Wadden Sea, which consists of governmental institutes and organisations, environmental agencies, research institutes and industry, is highly complex. As a result, the Wadden Sea is a multi-actor, multi-stake, multi-level and multi-sector institutional playing field.

In this dissertation, the Wadden Sea serves as an illustrative context. Examples of the researched SPIs can be observed in this area. They are either part of the institutional arena of the Wadden Sea and its periphery (boundary organisations), or are involved in processes concerning the Wadden Sea (knowledge brokers), or are assessments of the state of the Wadden Sea (boundary objects).

Problems influencing the science–policy interactions

Chapter 2 combines a range of different science–policy interaction problems into three 'meta problems': i) the strategic use of knowledge by policy; ii) the strategic production of knowledge by science; and iii) the operational misfit between demand for and supply of knowledge. Chapter 4 adds a fourth meta-problem to this list: iv) interaction problems not limited to knowledge.

Scholarly literature suggests that the first three problems are related to a lack of credibility, salience and/or legitimacy of knowledge. Credibility, in this sense, means whether an actor perceives information as meeting standards of scientific plausibility and technical adequacy, and whether sources are trustworthy and/or believable. Salience refers to the relevance of information for the decision-maker and the problem at stake. Legitimacy discusses the extent to which the knowledge produced has been respectful of the divergent values and beliefs of stakeholders, unbiased in its conduct and fair in its treatment of opposing views and interests. Enhancing these three criteria of knowledge should, theoretically, help in overcoming the previously discussed interaction problems. With regard to the fourth interaction problem, the problem is not so much the knowledge, but the legitimacy of the process.

Science–policy interfaces, as explained above, are suggested to enhance science–policy interactions by promoting the production and use of credible, salient and legitimate knowledge. The literature, however, provides little guidance in understanding how science–policy interfaces aim to address these interaction problems, and to what extent they affect the enriching of decision-making processes. Authors who identify problems with the science-policy interactions do not necessarily explain how interfaces can be used to overcome them, and vice versa: on multiple occasions, authors who do discuss the concept of science–policy interfaces appear to not specifically connect interfaces with the problems and interactions they aim to solve. This is problematic, since both the scientific arena and the policy arena would greatly benefit from understanding which science–policy interface could contribute to the resolving of which science-policy interaction problem, and how.

Boundary organisations

In theory, boundary organisations are organisations which mediate the interactions between the political and scientific domain in ways that enhance salience, credibility and legitimacy of the information they produce. Drawing on an extensive literature review on boundary organisations, I argue that although scholarly literature discusses various individual examples of such organisations, little attention has been paid to the specific goals and strategies boundary organisations employ. I suggest that more in-depth analysis on multiple organisations can generate further operationalisation and insights into boundary organisations and the extent to which they enrich decision-making processes. The following research question is therefore central in this empirical research: How can boundary organisations be characterised, in terms of goals, strategies and perceived performance?

Three boundary organisations (and per organisation, a specific Wadden Sea project) active in the Wadden Sea or on its periphery were analysed: the Wadden Academy (an organisation which aims to facilitate and promote more integrated and enhanced knowledge on the ecological and socio-economic development of the Wadden Sea), IMSA Amsterdam (a think-tank/consultancy firm which is renowned in the Wadden Sea area for its project concerning the cockle and gas exploitation controversies) and the Netherlands Commission for Environmental Assessment (NCEA; a governmental organisation responsible for the preparation of "mandatory and voluntary advisory reports for the competent authority (national, provincial and local) on the scope and quality of environmental assessments").

This research suggests that (the researched) boundary organisations can focus either on knowledge itself and its credibility, salience and/or legitimacy, or on how the knowledge can ultimately enrich decision-making. To put this into context, all three organisations used the development of boundary objects as strategies. However, the Wadden Academy created these objects (for example in the form of scientific reports) as a way to mobilise and produce credible, legitimate and salient knowledge. IMSA and the NCEA on the other hand, used their developed boundary objects in a more strategic manner to enrich decision making. The use of the media was also presented in all three boundary organisations as an important strategy for influencing the interactions between science and policy (or scientists and policy makers), and ultimately the use of knowledge in decision-making processes. Furthermore, the empirical study emphasised the influence of 'enabling factors' on the success of the boundary organisation. In the case of IMSA, for example, the public and political debates put so much pressure on the (institutional) Wadden Sea arena that changes needed to be made. This situation made it possible for IMSA to create a window of opportunity for knowledge to be brought forward by a range of (opposing) stakeholders, creating legitimacy and altering the public and, more importantly, the political debate.

Knowledge brokers

Besides boundary organisations, the scholarly literature on SPIs also discusses the interference of knowledge brokers as a possibility for enhancing the interactions between science and policy. Knowledge brokers can be described as individuals who negotiate and enhance the interactions between the worlds of science and policy, to increase the credibility, legitimacy and/or salience of the knowledge used in decision-making processes. According to the scholarly literature, they can be characterised as individuals having the ability to build bridges between various arenas and sectors due to their own cross-sector experiences. Furthermore, they need to possess a certain degree of impartiality and authority in order to enhance the science–policy interactions. However, I argue that there is little empirical evidence on the goals and strategies of knowledge brokers who intervene in troubled science-policy interactions. Further insights into these goals and strategies could yield more understanding of the possible deployment of knowledge brokers to enrich decision-making processes. Chapter 4 therefore presents an explorative empirical study of 27 knowledge brokers and their goals and strategies, in order to answer the question: How do knowledge brokers perceive the interactions between science and policy, and how do they define their role in terms of goals and strategies, to improve the production and use of science in policy- and decision-making?

In answering this question, the research yielded the following insights. First of all, it appears that knowledge brokers use two types of strategies: one on stage, amidst the decision-makers and various stakeholders involved, the other one backstage, where the knowledge broker strategically acts (on their own, one-to-one or in small meetings with decision-makers and/or stakeholders) to manoeuvre the process in a certain direction. Knowledge brokers with a scientific background seem more often to use on stage strategies, such as the (collective) framing of the problem, and the structuring and translating of knowledge. These strategies aim to address the credibility and salience of the knowledge produced and used. The interviewees with a more commercial background seem to place substantial

emphasis on the legitimacy of the actual mediation process, by actively innovating, and even steering it – strategies which appear to have a backstage character, created in more informal settings. Secondly, it is also suggested that the (perceived) credibility and legitimacy of the knowledge broker is more important to the process than the degree of credibility and legitimacy of the knowledge used in the decision-making process. So, it seems that for the work of a knowledge broker, it is far more important to be knowledgeable about the topic, be intellectual, possess a broad, influential network and be sensitive to all interests and to stakeholders (and therefore understand and thus obey the rules of the game). Thirdly, knowledge brokers also encounter interaction problems which are not strictly limited to the production and use of knowledge. Knowledge brokers, particularly in areas where relations between stakeholders can be fragile due to opposing interests and stakes, claim in the first place to create actual interactions between stakeholders (including science and policy) without placing emphasis on knowledge. Only in second place, they use a range of strategies to enhance the credibility, legitimacy and salience of knowledge. And finally, they bring this knowledge (directly) to policy.

Boundary objects

The last SPI this dissertation addresses are so-called boundary objects. Chapter 5 discusses this SPI in relation to coastal zone management. Coastal zone management embodies a context in which the interactions among ecological and economic interests can be complex, not least because the different objectives of the broad array of stakeholders ranging from policy-makers, coastal managers and industry to researchers and civil society organisations etc. can give rise to tensions.

Boundary objects can be considered to be hybrid constructs which integrate and combine elements of the scientific and political worlds, and to facilitate the negotiation and exchange of different types of knowledge and action. They can be used to transfer scientific knowledge into more understandable knowledge and communicate it across the boundaries between science and policy. The scholarly literature on boundary objects provides us with different examples, such as ecological indicators, climate scenarios or concepts such as 'significant effect'. Although these examples show the possible variety of boundary objects, they share the common aim of bringing together stakeholders (scientists, policy-makers and other stakeholders) within the coastal management arena who then collectively develop a knowledge-based boundary object to, for example, assess the ecological state of a coastal zone area. Notwithstanding all of this, even though the literature presents us with examples of boundary objects, the questions of how and to what extent they facilitate enriched decision-making in CZM remains underexposed. To address this issue, Chapter 5 presents an explorative empirical study of two boundary objects, to address the research question: "To what extent and in what way do boundary objects contribute to well-informed coastal zone management?".

To answer this question, two assessment systems considered to be boundary objects were explored: the Wadden Sea Barometer (WSB) and the Waddenhouse Deliberation ranking (WHD). The WSB can be defined as a monitoring tool for assessing the Wadden Sea region from the perspective of sustainable development. The WHD is a ranking system in which a broad range of human activities in the Wadden Sea (for example harbour activities, tourism, gas and salt extraction, fishery activities,

military activities) were scored based on a set of pre-determined indicators. By analysing to what extent the two boundary objects were perceived to be credible, legitimate and salient, the research aimed to explain the extent to which the two objects succeeded in enriching decision-making processes. The explorative research yielded the following conclusions. First of all, the research suggests that without inclusive interaction and communication between the different stakeholders involved, the legitimacy of the boundary objects is open to scepticism. Secondly, the two cases demonstrate that even when an assessment is evaluated as being relatively credible and salient, it does not follow that it will enrich decision-making processes in CZM. It is therefore hypothesised that alongside the credibility, legitimacy and salience of the boundary object, other external factors, such as the existence of a policy window, also contribute to whether or not a boundary object informs policy-making processes. Finally, the case of the WHD shows that there were differences (albeit limited) in how the participants in the deliberation evaluated the ranking and how the other stakeholders who had no part in the deliberation did so. This suggests that there is an internal perception of the credibility, legitimacy and salience of a boundary object (as perceived by the people closely involved in the development process), and an external perception of these same three criteria (as perceived by the stakeholders not closely involved in the development of the boundary object but who are influenced by its outcome).

Conclusions

This dissertation analyses problems in science–policy interactions and how, via science–policy interfaces, these interactions can be enhanced, with the ultimate aim of contributing to enriched decision-making processes. An enriched decision-making process is understood to be a process in which knowledge is used to gain a clearer picture of the problem setting, to underpin and implement policy and management measures, to explore policy options, and to contribute to learning processes between policy-makers, scientists and stakeholders. SPIs can be organisations, individuals or objects, which are placed (or place themselves) at the boundary between science and policy with the aim of enhancing the interactions and enriching decision-making processes by the use of scientific knowledge. And, following the scholarly literature in this subject, in order to be used in environmental decision making and to enrich it, science must meet three criteria: it needs to be perceived as credible (scientifically valid) and salient (relevant to decision makers), and to have been produced in a way that is seen as legitimate by all stakeholders involved.

Chapter 6 presents the final insights yielded by this research. The conclusion of the main research question can be summarised as follows:

How can science–policy interfaces, such as boundary organisations, knowledge brokers, and boundary objects contribute to enhancing the interactions between science and policy with the aim of enriching decision-making processes?

In the case of a multitude of pressing environmental issues, disciplines involved, stakeholders, conflicting interests, 'truths' and scientific insights leading to various interaction problems set in

a multi-actor and multi-interest setting, science–policy interfaces can only contribute to enriching decision-making processes when the interaction and knowledge development processes they aim to enhance are perceived to be legitimate. If in knowledge development processes the dominant aim is to create scientific knowledge which is as 'credible' as possible, the usability of knowledge, which greatly depends on legitimacy and salience, is put under pressure. By engaging science–policy interfaces such as boundary organisations or knowledge brokers proactively instead of reactively in these complex and contested situations in order to establish and guide such legitimate interaction processes, room for manoeuvre is created for the negotiation on and development of credible and salient knowledge, which in turn could lead to enriched decision-making processes.

Samenvatting

Inleiding
In de afgelopen decennia is het gebruik van wetenschappelijke kennis van groot belang geweest bij het voeden van milieubesluitvormingsprocessen inzake bijvoorbeeld lucht- en waterkwaliteit en kustgebiedmanagement. Hoewel in sommige gevallen wetenschappelijke kennis duidelijk een beslissende rol heeft gespeeld in de ontwikkeling van duurzaam beleid, is in veel andere gevallen de relatie tussen kennis en beleid moeizaam en omstreden. Dit kan worden toegeschreven aan het complexe karakter van milieubesluitvorming en de betrokkenheid van een groot scala aan stakeholders, elk met individuele doelen en wensen. Problemen met betrekking tot de relaties en interacties tussen kennis en beleid kunnen hiervan een gevolg zijn. De wetenschappelijke literatuur brengt talloze voorbeelden van dit soort problemen naar voren: het selectief gebruiken en opzettelijk negeren van kennis, het gebruik van contra-expertise, wetenschappers die hun kennis selectief delen en zich bij concurrerende kenniscoalities voegen. Maar ook verschillen in vraag en aanbod van kennis in termen van taal, tijdpaden en detailniveau dragen bij aan het spanningsveld tussen kennis en beleid. Als gevolg hiervan worden mogelijkheden om milieubesluitvormingsprocessen te verrijken, niet ten volle benut – i.e. het gebruik van kennis om een duidelijker beeld te krijgen van het probleem, ter onderbouwing en implementatie van beleids- en managementmaatregelen, voor het onderzoeken van beleidsopties, om beleidsevaluaties te onderbouwen en om het toe te passen in leerprocessen tussen beleidsmakers, wetenschappers en stakeholders.

Verschillende auteurs suggereren het organiseren en toepassen van kennis–beleidinterfaces als een mogelijke oplossing om eerder genoemde problemen te verminderen of te verhelpen, ten behoeve van het verrijken van milieubesluitvormingsprocessen. Onder kennis–beleidinterfaces verstaan we in dit verband entiteiten zoals grensorganisaties (vaak beschreven als intermediaire organisaties die zich tussen wetenschappers en beleidsmakers plaatsen), kennismakelaars (individuen die de ontwikkeling, deling en het gebruik van kennis faciliteren), en grensobjecten (zoals kaarten, modellen, rangordes en rapporten). Ze organiseren processen waarin kennis op een participatieve manier wordt gegenereerd, wat leidt tot verbeterde kennis–beleidinteracties en relaties tussen verschillende actoren in het beleidsproces. Dit schept ruimte voor het uitwisselen en co-creëren van kennis met als doel de verrijking van besluitvormingsprocessen.

Kennislacune
Het huidige wetenschappelijke debat biedt weinig systematische duidelijkheid over de verschillende interactieproblemen op het gebied van kennis en beleid, zowel ten aanzien van de conceptualisering als in termen van empirisch bewijs. Tevens lijkt er een gebrek te zijn aan empirisch onderzoek naar de manier waarop kennis–beleidinterfaces de interactieproblemen oplossen, en de mate waarin deze interfaces bijdragen aan het verrijken van besluitvormingsprocessen. Het doel van deze dissertatie is dan ook om de inzichten in de interactieproblemen die kennis en beleid het hoofd moeten bieden te

vergroten, evenals de mate waarin kennis–beleidinterfaces kunnen bijdragen aan het verhelpen van deze problemen en het verrijken van besluitvormingsprocessen. De hoofdvraag die centraal staat in deze dissertatie is:

Hoe dragen kennis–beleidinterfaces, zoals grensorganisaties, kennismakelaars en grensobjecten, bij aan de verbetering van de interacties tussen kennis en beleid met als doel het verrijken van besluitvormingsprocessen?

De Waddenzee
De empirische focus van dit onderzoek ligt op de Waddenzee, die zich uitstrekt van Den Helder in Nederland tot Esbjerg in Denemarken. In 2009 kreeg de Waddenzee de status van Unesco Werelderfgoed, vanwege (onder andere) haar unieke natuurwaarden en belang als rustplaats voor miljoenen trekvogels. Daarnaast grenzen er veel industriegebieden aan het gebied, wat maakt dat de Waddenzee ook van grote economische waarde is. Industrieën zoals gas- en zoutwinning, transport, visserij en recreatie zijn van groot belang voor het gebied. Al deze activiteiten drukken echter op het ecosysteem, met onder andere kusterosie en habitatverlies tot gevolg. Het duurzaam besturen van dit gebied, door het vinden van een balans tussen de economische activiteiten enerzijds en het beschermen van de ecologische belangen anderzijds, is een van de grootste uitdagingen waar het Waddengebied zich voor gesteld ziet.

Het belang van het gebruik van wetenschappelijk kennis in het besturen van dit gebied is dan ook evident. Ondanks het feit dat de Waddenzee een van de meest onderzochte kustgebieden ter wereld is, is het direct verrijken van besluitvormingsprocessen met al deze kennis in de praktijk echter minder vanzelfsprekend dan verwacht. De recente geschiedenis laat verschillende voorbeelden zien van beleidsproblemen waarin het gebruik van kennis omstreden was. Denk bijvoorbeeld aan de gas- en zoutwinning en de visserij. Deze voorbeelden delen meerdere overeenkomsten: tegengestelde economische en ecologische belangen, en wetenschappelijke inzichten die strategisch werden gebruikt ten voordele of nadele van een bepaalde positie. Daarnaast is het institutionele landschap van de Waddenzee, dat bestaat uit verschillende overheidsorganisaties, milieuorganisaties, onderzoeksinstituten en industrieën, zeer complex. Dit heeft tot gevolg dat de Waddenzee een multi-actor, multi-level, en multi-sectoraal gebied is, waarin uiteenlopende belangen spelen.

De Waddenzee vormt de illustratieve context in deze dissertatie. Verschillende voorbeelden van kennis–beleidinterfaces kunnen in dit gebied gevonden worden: als onderdeel van de institutionele arena van de Waddenzee of haar periferie (grensorganisaties), dan wel als betrokkenen bij beleidsprocessen rondom de Waddenzee (kennismakelaars), of als beoordeling van de staat van de Waddenzee (grensobjecten).

Problemen die de interacties tussen kennis en beleid beïnvloeden
Hoofstuk 2 combineert verschillende kennis–beleid-interactieproblemen tot drie 'metaproblemen': i) het strategisch gebruik van kennis door beleid; ii) het strategisch produceren van kennis door de wetenschap; en iii) de operationele misfit tussen vraag en aanbod van kennis. Hoofdstuk 4 voegt hier

nog een vierde probleem aan toe: iv) interactieproblemen die zich niet beperken tot kennis.
De wetenschappelijke literatuur suggereert dat de eerste drie problemen gerelateerd zijn aan een gebrek aan betrouwbaarheid, relevantie en/of legitimiteit van de kennis. Betrouwbaarheid betekent in dit geval de mate waarin een actor vindt dat de informatie wetenschappelijk plausibel en technisch toereikend is, en de mate waarin de bronnen betrouwbaar en geloofwaardig zijn. Relevantie betreft de toepasbaarheid van de informatie voor de beleidsmaker en de beleidsbeslissingen die genomen moeten worden. Legitimiteit wijst op de mate waarin de informatie recht doet aan de uiteenlopende normen en waarden, en opvattingen en belangen van verschillende stakeholders, en onbevooroordeeld is. Het verbeteren van kennis op basis van deze criteria zou, in theorie, de eerder genoemde interactieproblemen moeten verhelpen.

Kennis–beleidinterfaces zouden, zoals gezegd, de interacties tussen kennis en beleid kunnen verbeteren door het bevorderen van het gebruik van betrouwbare, relevante en legitieme kennis. De literatuur biedt echter weinig duidelijkheid over de manier waarop interfaces deze problemen trachten te adresseren, en de mate waarin ze een effect hebben op het verrijken van besluitvormingsprocessen. Auteurs die interactieproblemen identificeren leggen niet per definitie uit hoe interfaces gebruikt kunnen worden om deze problemen te beslechten, en vice versa. Dit is een probleem, aangezien zowel de wetenschap als de beleidswereld er baat bij zou hebben te begrijpen welke kennis–beleidinterfaces zouden kunnen bijdragen aan het oplossen van interactieproblemen tussen kennis en beleid, en op welke manier ze dat kunnen doen.

Grensorganisaties
Grensorganisaties zijn organisaties die bijdragen aan de interacties tussen het wetenschaps- en beleidsdomein voor een grotere betrouwbaarheid, relevantie en legitimiteit van de ontwikkelde kennis. Op basis van een uitgebreid literatuuronderzoek stel ik in hoofdstuk 3 dat de literatuur weliswaar verschillende, individuele voorbeelden van dit soort organisaties bespreekt, maar dat er weinig aandacht is voor de specifieke doelen en strategieën van grensorganisaties. Ik beargumenteer dat meer diepteonderzoek naar meerdere organisaties kan leiden tot verdere operationalisering en inzichten in grensorganisaties, en de mate waarin ze bijdragen aan het verrijken van besluitvormingsprocessen. De volgende onderzoeksvraag staat dan ook centraal in dit empirisch onderzoek: Hoe kunnen grensorganisaties worden gekarakteriseerd op basis van doelen, strategieën en waargenomen resultaten?

Drie grensorganisaties (en per organisatie een specifiek Waddenzeeproject) actief in de Waddenzee of haar periferie zijn geanalyseerd: de Waddenacademie (een organisatie die zich richt op het faciliteren en bevorderen van geïntegreerde kennis over de ecologische en sociaal-economische ontwikkeling van de Waddenzee), IMSA Amsterdam (een denktank en adviesbureau, bekend in het Waddenzeegebied door zijn project rondom de controverses in de kokkelvisserij en gaswinning), en de Commissie m.e.r. (een onafhankelijke overheidsorganisatie, onder andere verantwoordelijk voor de advisering over de inhoud van verplichte en vrijwillige milieueffectrapporten).

Het onderzoek suggereert dat de (onderzochte) grensorganisaties ofwel op de kennis zelf en de

betrouwbaarheid, relevantie en legitimiteit ervan gericht zijn, ofwel op de manier waarop kennis uiteindelijk besluitvormingsprocessen kan verrijken. Alle drie de organisaties maken, als strategie, gebruik van het ontwikkelen van grensobjecten. De Waddenacademie creëert deze objecten (bijvoorbeeld wetenschappelijke rapporten) als een manier om betrouwbare, relevante en legitieme kennis te mobiliseren. Anderzijds gebruiken IMSA en de Commissie m.e.r. grensobjecten op een strategische manier om besluitvorming te verrijken. Het gebruik van de media werd door alle drie de organisaties aangeduid als een belangrijke strategie om de interacties tussen kennis en beleid, en ultimo het gebruik van kennis in beslissingsprocessen, te beïnvloeden. Daarnaast benadrukt dit onderzoek het belang van zogenaamde sleutelfactoren voor het succes van een grensorganisatie. In het geval van IMSA, bijvoorbeeld, zette het publieke en politieke debat zoveel druk op de (institutionele) Waddenzee dat er wel veranderingen moesten plaatsvinden. Deze situatie maakte het voor IMSA mogelijk om een opening in het debat te creëren door kennis bij tegenstanders voor het voetlicht te brengen. Dit zorgde voor legitimiteit en een verschuiving in het publieke, en nog belangrijker, het politieke debat.

Kennismakelaars

De wetenschappelijke literatuur bespreekt, behalve grensorganisaties, ook de inmenging van kennismakelaars als een mogelijkheid om de interacties tussen kennis en beleid te verbeteren. Kennismakelaars kunnen worden omschreven als individuen die over de interacties tussen kennis en beleid onderhandelen, en deze daarmee verbeteren, teneinde uiteindelijk de betrouwbaarheid, relevantie en legitimiteit van de gebruikte kennis in besluitvormingsprocessen te vergroten. Volgens de wetenschappelijke literatuur kunnen ze gekarakteriseerd worden als individuen die, vanwege hun sector-overstijgende ervaringen, de capaciteit hebben om bruggen tussen verschillende arena's en sectoren te bouwen. Daarnaast dienen ze te beschikken over een zekere mate van onpartijdigheid en autoriteit om de kennis–beleidinteracties te verbeteren. Wederom beargumenteer ik echter dat er weinig empirisch materiaal bestaat over de doelen en strategieën van kennismakelaars. Meer inzicht hierin zou beter begrip moeten kunnen opleveren over de manier waarop het inzetten van kennismakelaars zou kunnen bijdragen aan het verrijken van besluitvormingsprocessen. Hoofdstuk 4 presenteert daarom een exploratief onderzoek naar 27 kennismakelaars, hun doelen en strategieën. De centrale onderzoeksvraag in dit hoofdstuk is: Hoe bezien kennismakelaars de interacties tussen kennis en beleid, en hoe definiëren zij hun eigen rol, in termen van doelen en strategieën, om de productie en het gebruik van kennis in besluitvormingsprocessen te verbeteren?

Het onderzoek leverde de volgende inzichten op. Ten eerste blijkt uit het onderzoek dat kennismakelaars er twee typen strategieën op nahouden: de één 'on stage', te midden van beleidsmakers en andere betrokken stakeholders, en de ander 'backstage', waarbij de kennismakelaar strategisch handelt (zelfstandig, een-op-een, of in kleine – informele – bijeenkomsten met beleidsmakers en/of stakeholders) om het proces een bepaalde kant op te manoeuvreren. Kennismakelaars met een wetenschappelijke achtergrond lijken voornamelijk 'on stage' strategieën te gebruiken, zoals het (gezamenlijk) framen van een probleem en het structureren en vertalen van kennis. Deze strategieën richten zich op de betrouwbaarheid en relevantie van de geproduceerde en gebruikte kennis. De geïnterviewden met een meer commerciële achtergrond lijken meer nadruk te leggen op de legitimiteit van het bemiddelings-

proces, door het proces actief te innoveren en zelfs te sturen – strategieën die meer een 'backstage' karakter hebben en gecreëerd worden in meer informele situaties. Ten tweede wordt in hoofdstuk 4 gesteld dat de betrouwbaarheid en legitimiteit van de kennismakelaar belangrijker is voor het proces dan de betrouwbaarheid en legitimiteit van de gebruikte kennis in de besluitvormingsprocessen. Het lijkt er dus op dat het voor het werk van een kennismakelaar belangrijker is om inhoudelijke kennis te bezitten, over een breed, invloedrijk netwerk te beschikken en gevoelig te zijn voor alle belangen van de stakeholders. Ten derde, kennismakelaars adresseren ook interactieproblemen die niet strikt gelieerd zijn aan de productie en het gebruik van kennis. Vooral in situaties waar de relaties tussen stakeholders fragiel zijn door tegengestelde belangen, stellen kennismakelaars dat ze zich in eerste instantie richten op het creëren van interacties *an sich*, zonder nadruk te leggen op kennis. Pas daarna gebruiken ze strategieën om de betrouwbaarheid, relevantie en legitimiteit van kennis te vergroten, met als laatste stap deze kennis bij beleidsmakers te krijgen.

Grensobjecten

De laatste kennis–beleidinterface die geadresseerd wordt in deze dissertatie zijn zogenaamde grensobjecten. Hoofdstuk 5 bespreekt deze interface in relatie tot kustgebiedmanagement. Kustgebiedmanagement vertegenwoordigt een context waarin de interacties tussen ecologische en economische belangen complex kunnen zijn, niet in de laatste plaats vanwege de verschillende doelstellingen van een grote reeks belanghebbenden, variërend van beleidsmakers, kustmanagers en industrie tot onderzoekers en belangenorganisaties, hetgeen tot spanningen kan leiden.

Grensobjecten kunnen worden gezien als hybride constructies die elementen van de wetenschappelijke en bestuurlijke wereld combineren en integreren, en daardoor de onderhandeling over en uitwisseling van verschillende typen kennis faciliteren. Ze kunnen gebruikt worden om wetenschappelijke kennis te transformeren tot meer begrijpelijke kennis, en dit te communiceren over de grenzen tussen kennis en beleid. De wetenschappelijke literatuur geeft hier verschillende voorbeelden van, zoals ecologische indicatoren, klimaatscenario's of concepten zoals 'significant effect'. Hoewel deze voorbeelden de mogelijke variëteit van grensobjecten weergeven, laten ze ook een gedeeld doel zien: het samenbrengen van belanghebbenden op het terrein van kustgebiedmanagement. Desalniettemin, hoewel de literatuur ons verschillende voorbeelden geeft, blijven de vragen hoe en in welke mate grensobjecten bijdragen aan verrijkte besluitvormingsprocessen in kustgebiedmanagement onderbelicht. Hoofdstuk 5 presenteert dan ook een exploratief onderzoek naar twee grensobjecten, waarbij de volgende hoofdvraag centraal staat: in welke mate en op welke manier dragen grensobjecten bij aan gefundeerd kustgebiedmanagement?

Om deze vraag te beantwoorden, zijn twee beoordelingssystemen onderzocht: de Waddenbarometer en de Waddenhuisberaad-ranking. De Waddenbarometer kan gezien worden als een monitoringsmiddel om het Waddenzeegebied vanuit een duurzaamheidsperspectief te beoordelen. De Waddenhuisberaad-ranking is een rangorde waarin een brede selectie aan menselijke activiteiten in en rondom het Waddenzeegebied (bijvoorbeeld havenactiviteiten, toerisme, gas- en zoutwinning, visserij-activiteiten, militaire activiteiten) een score hebben gekregen op basis van een set indicatoren.

Door het analyseren van de mate waarin deze twee grensobjecten werden gezien als betrouwbaar, relevant en legitiem, probeert dit onderzoek uit te leggen in welke mate de twee objecten hebben bijgedragen aan het verrijken van besluitvormingsprocessen. Het exploratieve onderzoek heeft geleid tot de volgende conclusies. Ten eerste, het onderzoek suggereert dat zonder inclusieve interactie en communicatie tussen de verschillende betrokken stakeholders de legitimiteit van de grensobjecten ontvankelijk is voor scepsis. Ten tweede, de twee cases laten zien dat zelfs wanneer een beoordelingssysteem wordt geëvalueerd als relatief betrouwbaar en relevant, dit niet betekent dat het bijdraagt aan de verrijking van besluitvormingsprocessen in kustgebiedmanagement. Derhalve wordt verondersteld dat naast de betrouwbaarheid, relevantie en legitimiteit van het grensobject, andere externe factoren, zoals beleidskansen, bijdragen aan het wel of niet voeden van besluitvormingsprocessen. Ten slotte, de case van het Waddenhuisberaad laat zien dat er verschillen waren (hoewel klein) in hoe de deelnemers van het beraad de ranking beoordeelden, en hoe stakeholders die geen deel uitmaakten van het beraad de ranking beoordeelden. Dit suggereert dat er een interne perceptie is van de betrouwbaarheid, relevantie en legitimiteit van een grensobject (waargenomen door deelnemers aan het ontwikkelingsproces), en een externe perceptie van deze drie criteria (waargenomen door stakeholders die niet betrokken waren bij de ontwikkeling van het grensobject, maar op wie de uitkomst ervan wel invloed heeft).

Conclusies

Deze dissertatie analyseert problemen op het terrein van kennis–beleidinteractie en de manier waarop middels kennis–beleidinterfaces deze interacties verbeterd kunnen worden, met als uiteindelijke doel bij te dragen aan verrijkte besluitvormingsprocessen. Deze interfaces kunnen organisaties, individuen of objecten zijn, die geplaatst worden (of zichzelf plaatsen) op de grens tussen kennis en beleid, met als doel het verbeteren van de interacties en het verrijken van besluitvormingsprocessen middels het gebruik van wetenschappelijke kennis. Volgens de onderzochte wetenschappelijke literatuur dient deze kennis te voldoen aan drie criteria: de kennis moet worden beschouwd als betrouwbaar, relevant en legitiem.

Hoofdstuk 6 presenteert de concluderende inzichten die dit onderzoek hebben opgeleverd. De centrale hoofdvraag en beantwoording kunnen als volgt worden samengevat:

Hoe dragen kennis–beleidinterfaces, zoals grensorganisaties, kennismakelaars en grensobjecten, bij aan de verbetering van de interacties tussen kennis en beleid met als doel het verrijken van besluitvormingsprocessen?

In het geval van een veelheid aan prangende milieuvraagstukken, betrokken disciplines, belanghebbenden, tegengestelde belangen, 'waarheden' en wetenschappelijke inzichten die leiden tot verschillende interactieproblemen binnen een multi-actor en multi-interest setting, kunnen kennis–beleidinterfaces alleen bijdragen aan het verrijken van besluitvormingsprocessen als de interacties en kennisontwikkelingsprocessen worden beschouwd als legitiem. Als bij kennisontwikkelingsprocessen het hoogste doel is om wetenschappelijke kennis te creëren die zo betrouwbaar mogelijk is, wordt

de bruikbaarheid van deze kennis, die in hoge mate afhangt van relevantie en legitimiteit, onder druk gezet. Door kennis–beleidinterfaces, zoals grensorganisaties en kennismakelaars, proactief in te zetten in dit soort complexe en omstreden situaties, in plaats van reactief, kunnen legitieme interactieprocessen worden gecreëerd. Dit leidt tot ruimte voor onderhandeling over en ontwikkeling van betrouwbare en relevante kennis, hetgeen weer kan leiden tot verrijkte besluitvormingsprocessen.

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Wanda van Enst
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About the author

Wynanda Inez van Enst (Wanda), born 23 December 1984, has a bachelor's degree in Cultural Anthropology and Development Sociology (2006 – 2009) from Leiden University, and a master's degree in Urban Development Planning (2009 – 2010) from the Bartlett Development Planning Unit of University College London (United Kingdom). While studying for her bachelor's degree she was awarded the Speckmann award for the best domestic fieldwork report (her report was entitled 'Social relations and leadership among adolescents in the rural East of the Netherlands'). For her master's degree she conducted fieldwork in Istanbul, Turkey on collaborative interfaces in urban development planning, and wrote her thesis on the opportunities and constraints of urban planning in peri-urban Kumasi, Ghana.

Driven by curiosity on how knowledge is socially constructed, and thereafter used, or misused in strategic planning, in January 2011, Wanda started her PhD research on science–policy interfaces and the Wadden Sea, at the Copernicus Institute of Sustainable Development, Utrecht University. In the following six-and-a-half years, she presented her work at various conferences in the Netherlands and abroad, such as ESG and MARE. Furthermore, she was involved in the development of a set of action perspectives for the Wadden Sea. These perspectives were published under the title 'From frustration to integration: Action strategies for a better fit between knowledge and policy on the Wadden Sea'. Finally, during her PhD, Wanda was extensively involved in the teaching programme of the 'Environmental Governance' group, teaching bachelor and master students in various courses (Policy Analysis; Analysing Practices; Environmental Sociology, Socio-Economic Processes), and supervising bachelor students in the writing of their thesis.

Currently Wanda works at Squarewise, a company which mission it is to speed up the transition to a sustainable society. As a Transitionmaker, Wanda is involved in various projects, in which she advises local and regional governmental organisations on their quest for sustainability.

Wanda and her partner Jelle are the parents of Friso (5) and Olivia (3).

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