Integrating knowledge and policy in an uncertain world: The case of offshore wind farm planning in the Dutch part of the North Sea

Knowledge uptake and intellectual capacity in a dynamic environment

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COLOPHON

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LIST OF ABBREVIATIONS

Table 0.1: List of abbreviations

Abbreviation	Meaning Dutch	Meaning English
OWF	Windpark op zee	Offshore Wind Park
MSP	Ruimtelijke mariene planning	Marine spatial planning
ORE	Duurzame energie op zee	Offshore Renewable Energy
EEZ	Exclusieve Economische Zone	Exclusive Economic Zone
EU	Europese Unie	European Union
OSPAR	Het Verdrag inzake de bescherming van het mariene milieu in het noordoostelijk deel van de Atlantische Oceaan	Oil Spill Prevention, Administration and Response/ The Convention for the Protection of the Marine Environment of the North-East Atlantic
HELCOM	Verdrag van Helsinki inzake de bescherming van het mariene milieu	Helsinki Convention on the Protection of the Marine Environment
MSFD	Kaderrichtlijn mariene strategie	Marine strategy framework directive
SEA	Strategische milieu beoordeling	Strategic environmental assessment
EIA	Milieu effect rapportage	Environmental impact assessment
KNAW	Koninklijke Nederlandse Akademie van wetenschappen	Royal Netherlands Academy of Arts and Sciences
NWO	Nederlandse Organisatie voor Wetenschappelijk Onderzoek	Dutch research council
OFL	Overlegorgaan fysieke leefomgeving	Physical environment consultative council
RVO	Rijksdienst voor ondernemend Nederland	Netherlands Enterprise Agnecy
NZO	Noord Zee Overleg	North Sea Talks
NZA	Noord zee akkoord	North Sea Accord
EBN	Energie Beheer Nederland	Energy management Netherlands
WNF	Wereld Natuur Fonds	World Wide Fund for Nature
NOGEPA	Nederlandse Olie en Gas Exploratie en Productie Associatie	Netherlands Oil and Gas Exploration and Production Association
MONS	De werkgroep Monitoring Onderzoek Natuurversterking en Soortenbescherming	The Monitoring Research Group on Nature Enhancement and Species Protection
WOZEP	Wind Op Zee Ecologisch Programma	Wind At Sea Ecological Program
KEC	Kader ecologie en Cumulatie	Ecology and Cumulation Framework

MWTL	Programma Monitoring Waterstaatkundige Toestand des Lands	Monitoring programme national Water management conditions
MMIP	Meerjarig Missiegedreven Innovation programma	Multi annual mission driven innovation program
SEANSE	Stratrategische milieu effect rapportage Noord Zee energie	Strategic Environmental Assessment North Sea Energy
APELAFICO	Akkoestische ecologie van Pelagische vispopulaties	Acoustic ecology of PELAgic FIsh COmmunities
KNMI	Koninklijk Nederlands Meteorologisch Instituut	Royal Netherlands Meteorological Institute
TKI-WOZ	Topconsortium voor Kennis en Innovatie Wind Op Zee	Top Consortium for Knowledge and Innovation Wind at Sea.
WUR	Wageningen Universiteit en onderzoek	Wageningen University and research
EZK	Ministerie van economische zaken en klimaat	Ministry of economic affairs and climate
I&W	Ministerie van infrastructuur en waterstaat	Ministry of infrastructure and water management
LNV	Ministerie van landbouw, natuur en voedselkwaliteit	Ministry for agriculture, nature and food quality
BZK	Ministerie van binnenlandse zaken en koninkrijksrelaties	Ministry of internal affairs and kingdom relations
BZ	Ministerie van buitenlandse zaken	Ministry of foreign affairs
OCW	Ministerie van onderwijs, cultuur en wetenschap	Ministry of education, culture and science
IWR	Duits instituut voor duurzame energie industrie	German Institute of the renewable energy industry

LIST OF TRANSLATIONS

Table 0.2: List of translations

Dutch	**English**
Wet beheer rijkswaterstaatswerken	the national waterworks management act
Waterwet	water act
Wet windenergie op zee	Offshore wind act
Wet milieubeheer	Environmental management act

ABSTRACT

The Netherlands and many other countries are rapidly expanding the rollout of Offshore Wind Farms on the North Sea to attain sustainable energy targets and ensure energy security. This causes unprecedented interventions and conflicts regarding the use of space in the Dutch part of the North Sea. Marine Spatial planning aims to govern the use of space at sea, keeping in mind the specific context of marine environments, but struggles to govern the rapidly growing Offshore Wind sector. Therefore, the development of knowledge regarding impacts on the North Sea system is rapidly increasing to allow for well-informed marine policy. This results in an extremely dynamic situation considering the rapid development of Wind at Sea as well as related policy and knowledge. Problems arise with the uptake of knowledge into policy. *Knowledge uptake*, or *the acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy*, is limitedly considered in scholarly literature concerning Marine Spatial Planning and Offshore Wind Farm development. This thesis bridges the research gap on knowledge uptake by investigating the current effectiveness of knowledge uptake in processes of Offshore Wind Farm development and policy and decision-making in Marine Spatial Planning.

The thesis employs theories of intellectual capacity to assess the ability of Dutch institutions to *add value to a system by using the potential of skills and knowledge.* These theories include the concepts of: *system understanding,* or the comprehension of systems under study; *knowledge integration* or the sharing of knowledge among disciplines, sectors, and epistemic groups and the bundling of knowledge for integration into policy; and *learning* or the process of creating, retaining, and transferring knowledge, leading to changes in behaviour, skill, and attitude. Learning is divided in *single loop learning,* or the adaptation of action strategies, and *double loop learning,* or the adaptation of policy goals and frameworks. These concepts allow for a broad and in-depth analysis on the presence of knowledge-related capacities and how they contribute to knowledge uptake. To perform this analysis, an in-depth single-case analysis of the Dutch part of the North Sea was performed using a literature review, document analysis, semi-structured interviews, observations, and focus groups.

Findings show an expected presence of attention for system understanding and single loop learning in the policy debate. Considerable knowledge uptake was found, demonstrating the presence of intellectual capacity. However, political interests, difficult circumstances for research at sea, and sectoral approaches were recognized as main barriers to knowledge uptake. Knowledge integration was found to be unexpectedly well developed and increasing due to the novel development of the Dutch North Sea talks. Double loop learning was recognized to be exceedingly time-consuming and largely dependent on supranational goal setting in the EU. The most important finding was that intellectual capacity is best developed when all its aspects are developed in tandem.

Recommendations include: (1) the earlier inclusion of scientists in the decision making process of OWF development, (2) the alignment of expectations between researchers and policy-makers through more detailed knowledge contracts, (3) the development of an overarching institution for the consideration of Offshore Wind Farm and Marine Spatial planning related knowledge, knowledge developers, and knowledge users. Additionally, this study contributes to the academic debate by developing the mentioned definition of knowledge uptake.

Key words: Offshore Wind Energy, Marine Spatial Planning, Knowledge uptake, Knowledge use.

Contents

1. INTRODUCTION, PROBLEMS AND QUESTIONS

1.1. Offshore Wind Farm Development in the Dutch North Sea

Due to increasing international targets for Co2 reduction, as well as a desire to reduce geopolitical dependence on fossil fuels from unstable regions, renewable energy production is rapidly increasing in Europe (RWS, 2022A; Rijksoverheid, 2022, European Commission, 2022; I&W *et al.,* 2021). For the attainment of sustainable energy goals, countries bordering the North Sea increasingly rely on Offshore Wind Farms (OWFs) (European Commission, 2019). The North Sea's suitable wind climate, shallowness, and proximity to industry and port infrastructure make the area ideal for OWF development (Rijksoverheid, 2020; WindEurope, 2021). The Netherlands aims to increase its OWF capacity from 2.5 GW to 21GW by 2030, taking up 1600km² or 3% of the Dutch North Sea area (Rijksoverheid, 2021b; Rijksoverheid, 2022). In the entire North Sea region, OWF capacity is expected to increase from approximately 54GW to 210GW by 2030 (RVO, 2020; WindEurope, 2022). By 2050, the Netherlands considers 72GW (8000 km² or 15.5% of Dutch North Sea territory) as the optimal scenario (Rijksoverheid, 2021b). By 2050, region-wide capacity is predicted at 450GW, but many national governments aspire to develop more (European commission, 2022; Rijksoverheid, 2021a; IWR, 2021; Danish ministry of climate, energy, and utilities, 2018; UK government, 2021; WindEurope, 2021). The need for marine territory results in conflict with other maritime uses like shipping, fisheries, sand extraction, environmental protection, aquaculture, archaeology, and recreation, see fig 1 for the overcrowded planning of the Dutch North Sea (RWS, 2016, 2019, 2022; I&W *et al.,* 2021). These conflicts cause OWF to be a major driver of *Marine Spatial Planning* (MSP). MSP is the main concept for coordinating marine space, offering an alternative to traditional spatial planning approaches by keeping the unique dynamics of marine environments and activities in mind. However, the approach struggles to govern the powerful new offshore wind sector (De Vrees, 2019). As such, this study approaches OWF development through the lens of MSP. Specifically, this study focuses on the uptake of knowledge concerning OWF development in policy and decision-making in MSP.

The case studied in this thesis is OWF planning and MSP in the Netherlands. The Netherlands has a relatively long-standing and well-established OWF policy and decision-making framework compared to other countries. This can for example be seen in its early adoption of MSP in 2004, and the 2018 formation of the North Sea accord. The North Sea accord is the result of the North Sea talks (NZO), a discussion body between stakeholders and the government, consulted by scientific experts who make consensus-based decisions for holistic, integral, and long-term marine spatial planning (OFL, 2018, 2020A). However, according to scholars, integral solutions are not sufficiently realized in practice (Hanlon and Cummins, 2020; Van der Loos *et al.*, 2021; Spijkerboer *et al.,* 2020). As a result, MSP approaches to OWF planning are still predominantly short-term, sectoral, and ad-hoc despite improved efforts. Furthermore, the biophysical system of the North Sea, including the ecology, food web, turbidity, and sediment flows, is insufficiently understood to assess the societal and ecological impacts of extensive OWF placement. This leads to limitations of transparency in policy, complications in the integration of processes and understanding, and exclusion of cumulative, and long-term considerations of OWF planning (Spijkerboer *et al.,* 2020; Gusatu *et al.,* 2020). Scholars and practitioners recognise the lack of knowledge about the North Sea system and the difficulty of applying this knowledge to policy and decision-making as a major reason for these limitations (OFL, 2020A,2021; EZK, 2021; I&W *et al,* 2021; RWS, 2022A; Van Tatenhove, 2011; Keijser *et al.,* 2021). As such, research concerning knowledge and its use in policy can be considered vital for the improvement

of OWF planning and MSP. Based on such research, knowledge-related capacities of institutions can be increased.

1.2. Problems and relevance

The lack of knowledge-related capacity in MSP and OWF placement and development is largely due to the complexity and the novelty of OWF development and MSP (Ansong *et al.,* 2021). This complexity is increased by the many different institutions and organisations involved in knowledge development and uptake (Rijksoverheid, 2020, 2021a, 2021b; Ehler and Douverre, 2009). Many epistemic communities, political influences, and institutional interests affect the uptake of knowledge in decision-making and policy in MSP. Additionally, knowledge development often occurs in a sectoral fashion. The subsequent division of knowledge bases and goals increases the difficulty of developing shared understanding and strategic action. As such, there is not only a lack of knowledge concerning the Nort Sea system, there is also a lack of organisation of the knowledge system, preventing the formation of shared goals. This lack of knowledge and organisation results in uncertainties and challenges MSP (Müller, *et al.*, 2017). Examples of knowledge gaps in content are the unknown effect of large-scale OWF placement on stratification and bird populations, or the unknown effects of large-scale artificial reef formations which can entail both risks and opportunities (Dannheim *et al.,* 2021). On the organisation side an example can be the lack of communication between relevant institutions, and the lack of knowledge use in policy (Keijser *et al.,* 2020; Gusatu *et al.*, 2020). All in all, MSP is meant to govern powerful and rapidly expanding sectors like OWF and attain the national policy goals of a healthy, safe, and productive sea. Scholars and government institutions recognise the lack of knowledge about the North Sea system and the impact of OWFs as a major barrier to the attainment of these goals (OFL, 2020A, 2021; EZK, 2021; I&W *et al,* 2021; RWS, 2022A). Due to the realisation that knowledge about the North Sea system and the impact of OWFs is necessary to inform policy, knowledge development in these topics is advancing rapidly. This fast development of both OWFs and knowledge leads to a dynamic, and diffuse system of knowledge uptake into policy. As such, *knowledge uptake* in MSP, or *the acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy*, is identified by scholars as a main weakness in current MSP (Ehler and Douvere, 2009; Ehler, 2008, 2018; Ansong *et al.,* 2021; Kidd and Ellis, 2012; Vrees, 2021; Spijkerboer *et al.,* 2020; I&W *et al.,* 2022).

In the current OWF development process, the technical development of wind parks, the political will to construct them, and the legal frameworks for their development are progressing rapidly, leaving knowledge capacities behind (NWO, 2020; Rijksoverheid, 2020; Van der Loos *et al.,* 2021). In the current, novel state of development, the long-term effects of ill-informed placement could be costly and harmful for both societal and biophysical systems and could fail to capitalize on opportunities. As such, involving knowledge about the physical, socio-economic, and governance systems is necessary for informed goal-setting in policy and governance. As mentioned, MSP literature and practice indicate that there is a need for improved knowledge and improved capacity for knowledge uptake concerning the placement of OWFs (Ehler and Douvere, 2007; Ehler, 2008, 2018; Ansong *et al.,* 2021; Kid and Ellis, 2012; Vrees, 2021; Spijkerboer *et al.,* 2020; I&W *et al.,* 2022). However, there is limited literature dedicated to the role of knowledge concerning OWF development in MSP; a gap that this study means to address. In spatial planning and development literature, the capacity for knowledge development and uptake is analysed using the concept of *intellectual capacity* which will be employed in this study to put knowledge development and uptake into theoretical perspective (Cars *et al.,* 2017; Popov, 2011; Healey, 1998).

1.3. Research questions and study design

This thesis focuses on the development of knowledge, and knowledge uptake in OWF placement and management for policy and decision-making in MSP The aim of the study is to understand the current status of knowledge uptake and provide recommendations for its improvement. Studying the current uptake of knowledge in Dutch OWF and MSP is pivotal for its improvement, as well as for the identification of opportunities and barriers which different institutions perceive in processes of knowledge uptake. As such, this study aims to further develop the concept of knowledge uptake and its use in MSP and OWF development.

To realize this aim, the main question that this study sets out to answer is: *What opportunities and barriers exist for the development of knowledge uptake in Dutch MSP, and how can the capacity for knowledge uptake concerning the placement and operation of Offshore Wind Farms in Dutch MSP be enhanced.*
In order to answer this question, insight is required into the current system of knowledge uptake in MSP and OWF planning and what is considered as knowledge to begin with. Therefore, the three sub-questions look at the definition and practice of knowledge uptake: *How are knowledge and knowledge uptake currently defined and used in MSP and OWF-related literature?* This first sub-question will be considered in the literature review and discussion. The second sub-question concerns the current organisation of knowledge uptake in Dutch OWF policy: *How are OWF development and knowledge uptake concerning OWF development organised in Dutch MSP policy and decision making?*
The third sub-question aims to explore how knowledge changes frameworks, systems, and goal setting in MSP: *Which types of intellectual capacity are present in Dutch MSP, and OWF related policy processes to what extend and how does this influence knowledge uptake?*

As mentioned, scholars and practitioners indicate a lack of knowledge and its uptake in MSP (I&W *et al.,* 2022, Ansong *et al.,* 2021; Keijser *et al.,* 2021). To adress this, the development of intellectual capacity depends on the simultaneous development of three aspects: *system understanding, knowledge integration,* and *learning* (Janssen *et al.,* 2014; Keijser *et al.,* 2021; Healey, 1998; Cars *et al.,* 2017). These three aspects of intellectual capacity are used to structure the analytical framework in this research, which integrates insights from spatial planning literature, MSP literature, and institutional capacity building literature (Janssen *et al.,* 2014; Keijser *et al.,* 2021; Healey, 1998; Cars *et al.,* 2017; Popov, 2011; Laeni *et al.,* 2020).

This study analyses the features of intellectual capacity in Dutch OWF development and their influence on knowledge uptake into policy by looking at Dutch OWF planning from 2015 on. The research design is a qualitative case study consisting of desk-research, interviews, observations, and focus groups. This study aims to unravel the current process of OWF development and the system of knowledge uptake in Dutch OWF development and MSP. Additionally, it aims to identify opportunities and barriers to knowledge uptake, and provide recommendations for the systematic improvement of knowledge uptake in subsequent decision making and policy.

The rest of this study will be structured as follows: Chapter 2 elaborates on the paradigmatic lens of the study, Chapter 3 considers the conceptual framework, and existing literature. The research methodology and ethics are discussed in chapter 4. Chapter 5 presents the results of this research. Chapter 6 elaborates on our findings by discussing results on intellectual capacity and knowledge uptake. Chapter 7 will conclude this thesis by answering the research questions and providing a summary of the findings. A separate chapter 8 presents recommendations for policy, and future

research. Finally, a reflection is provided on the use of theory and methods and the limitations of results in chapter 9.

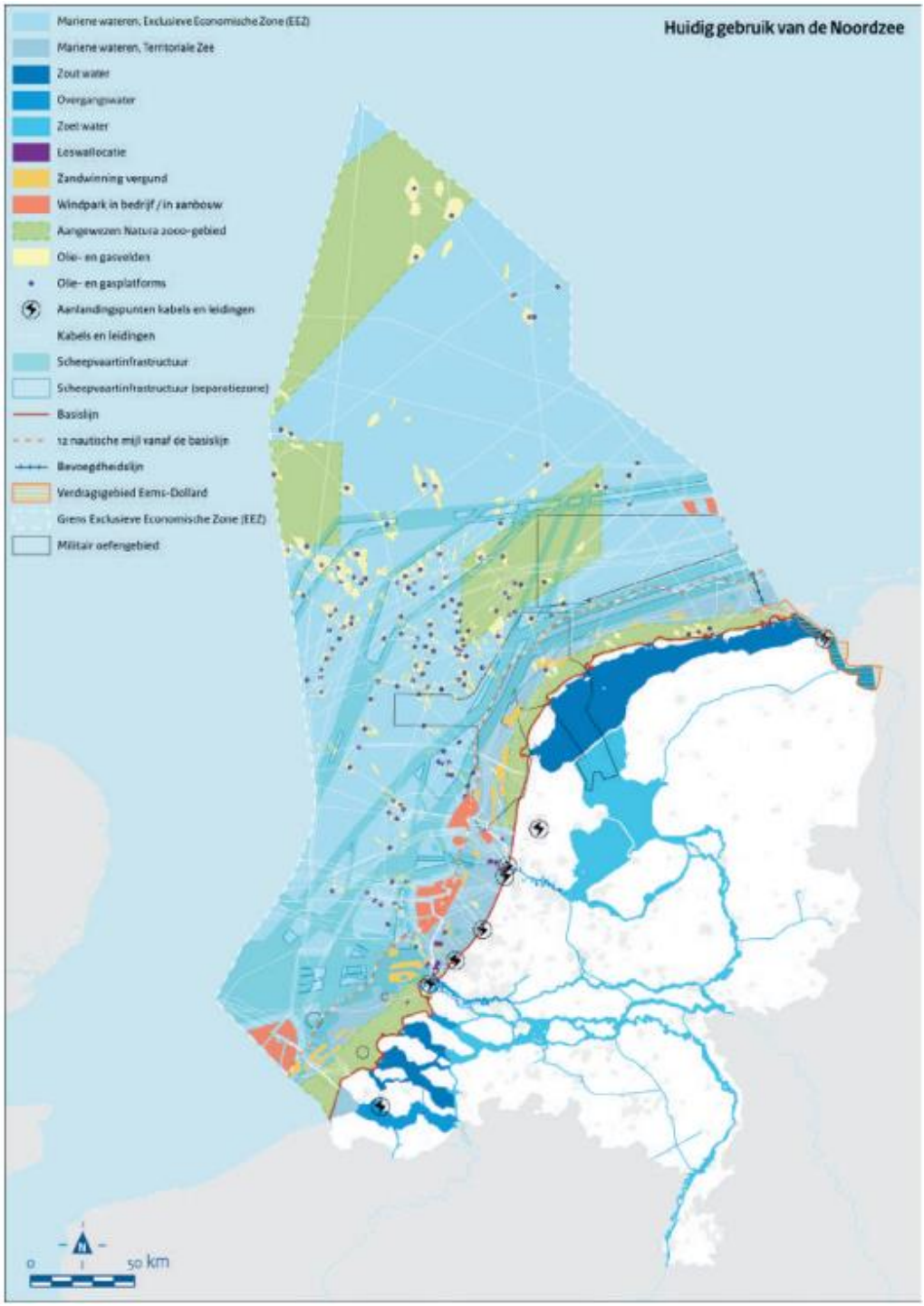


Figure 1: The current uses of the Dutch North Sea (I&W *et al.,* 2021).

2. PARADIGMATIC REFLECTION

The focus of this study is on the acquisition and use of knowledge in the multidisciplinary environment of MSP and OWF development. As such, it is helpful to identify a uniform definition of knowledge upon which actors from the different disciplines involved can agree. Many definitions of knowledge exist, describing it as: contextual facts, information, skills, insight, experiences, values, or a combination of these concepts. While sometimes portrayed as a free-flowing commodity, knowledge is different from physical objects in that its existence depends on a "knower" (Nagel, 2014). As such, there is a strong connection between an individual's conception of what counts as knowledge and the knowledge they consider to possess, causing contradistinctions in the perception of knowledge between individuals and groups with different views and paradigms. Since these differing knowledge bases are mentioned as a barrier for efficient knowledge uptake, this study means to be inclusive of different knowledge views, and knowledge types. As such, a classification of knowledge types is provided: 1. Factual knowledge concerns empirically observed details, 2. Conceptual knowledge concerns categories, functions and theories, or how facts can be organized, 3. Procedural knowledge is derived from experience, and often considers subject-specific skills, 4. Metacognitive knowledge can be seen as recognising contextual and conditional differences, understanding (personal) biases, realizing the complexities in a system, and being able to strategically deal with them (Krathwohl, 2002).

Epistemology is the branch of philosophy which studies the knowledge needed to examine reality or knowing. While epistemology considers knowledge, or how reality can be examined and understood, ontology is the branch of philosophy which examines the nature of reality itself. The epistemological paradigms which influence the knowledge views of different organisations and disciplines analysed in this study have to be kept in mind to gain insight in possibilities for developing joint knowledge views. As such, it is useful to consider epistemology separately from ontology. Many paradigms consider epistemology and ontology to extend into each other, the paradigm used in this study, critical realism, argues for their separation, and therefore for a separation of the observable and the real world. Critical realism argues that any statements about what is real, have to be reduced to what we understand about it in epistemological terms; that knowledge has to be interpreted to discover its underlying meaning. As such, whether something exists, what it is, and what causes it, is reduced to our knowledge of its existence, how we can know it, and what knowledge presupposes different knowledge. This allows for a focus on knowledge perception, a very open conception of knowledge perception, and a conception of development as occurring through discoveries or social changes, without abstaining from the idea of an objective reality (Bhaskar, 1975; Danermark *et al.,* 2002).

The policy contexts and underlying conceptions in organisations and institutions can differ to such a degree that knowledge can be interpreted, used, and prioritized differently, according to different epistemological paradigms or viewpoints, leading to different perceptions from the same information (Rosenberg, 2016; Dunne *et al,* 2016; Janssen *et al.,* 2014). As such, epistemological paradigms influencing the viewpoints of stakeholders are expected to take many different forms, which can pose a barrier for holistic knowledge uptake. These paradigms are expected to range from positivist to interpretivist, subsequently leading to a stronger focus on factual, or metacognitive knowledge. These focusses on different knowledge types exemplify the difficulty of forming joint knowledge bases (Müller *et al*, 2017; Grossoni and Bussotti, 2005; Janssen *et al.*, 2014; Ehler and Douverre, 2009).

When analysing the different knowledge views involved in MSP and OWF development, it could be helpful to keep the different paradigms which might influence their viewpoints in mind when looking

at the positions of different stakeholders. Realizing whether an organisation or stakeholder adheres to a pragmatist or interpretivist standpoint can provide a good insight in their motivation, and may even help to arrive at agreements between differently minded parties. Such insight may be employed to work towards a jointly accepted knowledge base by using the definition of critical realism, and therefore simplify knowledge-bases to improve practical cooperation.

3. LITERATURE AND THEORY

This chapter consists of roughly three parts: it starts with a literature review concerning the current definition and use of knowledge and knowledge uptake in MSP and OWF literature, and a comparison with similar issues in terrestrial spatial planning. After operationalising these concepts, the second section of the chapter elaborates on intellectual capacity as a framework used in planning and development literature, and how the framework will be used to analyse knowledge uptake. In this second section, the three aspects of intellectual capacity are explained: *system understanding, knowledge integration, and learning*. Finally, the specific interrelations between the aspects of intellectual capacity are elaborated on in the context of MSP and OWF development. This chapter ends with a visualisation of the conceptual framework.

3.1. KNOWLEDGE AND ITS UPTAKE IN MSP

This section elaborates on the MSP approach and its inclusion of knowledge and knowledge uptake.
To deal with the increase of anthropogenic activities at sea, the concept of Marine Spatial Planning (MSP) has been increasingly applied in both scholarly research and governance over the last decades. MSP is now recognized as the main concept and institutional design for the coordination of activities in marine space (Jay, 2010; Jay *et al.,* 2012). Due to the increasing use of marine space, existing sectoral policies have struggled to coordinate and provide transparency in the interrelations between sea uses and their cumulative effects on the ecology (Kannen, 2014). MSP aims for strategic, participative, integrated, area-based, adaptive, and ecosystem-based development of sea space, and is defined as: "*The process of designing and redesigning the rules of the game at sea with the purpose of coordinating sea-uses within specific sea-areas"* (Spijkerboer *et al.*, 2020, p.2). However, some academics indicate that MSP is unable to govern fast-growing and powerful sectors like OWF (Jones and Liebknecht, 2016; De Vrees, 2019).

The need for knowledge and the critique on knowledge uptake concerning the impact of OWFs on physical and socio-economic systems is often repeated (Ehler, 2018; Keijser *et al.*, 2020; Spijkerboer, 2020; Gazzola *et al.,* 2015). However, considerations of knowledge about the governance system, and the influence of viewpoints, biases and procedures, as discussed in Chapter 2, are largely absent from literature (Keijser *et al,* 2020; Van Tatenhove, 2011). In most MSP literature, knowledge considerations imply a lack of factual and conceptual understanding of the system to properly inform the current scale of intervention (Dannheim *et al.,* 2021; Ehler and Douverre, 2009; Gazzola, 2015). In their detailed guide for the evaluation of MSP policy and design, Ehler and Douverre (2009) indicate the need to integrate a broad array of necessary types of knowledge, and develop procedural knowledge. Some scholars like Keijser *et al.,* (2020), Van Tatenhove (2011), and Paramana *et al.,* (2021), do consider procedural and metacognitive knowledge, as well as implications for knowledge uptake. They include the need for knowledge about governance and knowledge systems, and how uncertainty and inefficiency can increase through contextual factors and biases in knowledge and its uptake.

Keijser *et al.,* (2020), present a learning paradox in MSP; according to them, learning, or the process by which change, skills and knowledge is acquired, providing the ability to adapt goals and strategies to new knowledge or contextual factors, is insufficiently developed in MSP to clearly and jointly formulate strategic goals, approaches, and outcomes (Keijser *et al.,* 2020). This situation deters collaboration between groups and individuals. To solve this, groups and individuals have to learn by doing, and from eachother (Keijser *et al.,* 2020). While a need for knowledge generation is apparent, its subsequent interpretation, valuation, and application in policy making, or *knowledge uptake*, is

equally important and limitedly considered in MSP literature (Keijser *et al,* 2020; Gazzola *et al*, 2015; Paramana *et al*, 2021).

Knowledge uptake in this case is a more useful term for the dynamic knowledge situation in OWF-development and MSP. The static term knowledge only refers to the existence of knowledge, and thus a knower while knowledge uptake considers the whole process of developing, interpreting, valuing and using knowledge, making it suitable for the analysis of knowledge processes in a dynamic context. However, knowledge uptake does not yet have a clear definition in MSP and planning literature (Ehler, 2009; Paramana *et al.,* 2021; Flyvbjerg, 2021). To include all relevant knowledge processes for informing policy, this thesis defines knowledge uptake as: *the active acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy*. This definition is based on the definition of Van Ryneveld and McCutcheon (1997): *'the active acquisition of disseminated information, the comprehension of the information and the ability of practitioners to apply the information in the field'* (Van Ryneveld and McCutheon, 1997, p. 1). The definition is slightly adapted in this study. The ability to interpret and value knowledge are added to demonstrate that knowledge uptake should go beyond the practical appliances of knowledge to foster long-term, cooperation between relevant institutions. Additionally, the term diffuse is used instead of disseminated since it is not just the spread of different knowledge that cause difficulties but also the vagueness of different interpretations. Knowledge uptake is indicated to play an important role in the move away from service delivery based solely on technical standards (Ryneveld and Sproule, 2006). This definition is therefore useful in the current Dutch situation where knowledge limitedly reaches technical professionals and policy makers; and where a move away from technical standards of production might be necessary to preserve the North Sea ecosystem and the societal systems tied to it. This study will focus on barriers and opportunities to knowledge uptake in OWF planning and how institutions practicing MSP can increase their capacity for knowledge uptake.

3.1.1. Reflections of knowledge uptake in spatial planning literature, the similarities and differences with MSP

A lack of knowledge uptake is increasingly blamed for issues in terrestial spatial planning as well; while the understanding of physical systems and interventions is much more developed, interventions still cause many unexpected issues, resulting in inefficiency and cost-overruns (Klakegg *et al.,* 2016; Van Doren *et al.,* 2016; Brugnach *et al.*, 2008; Morisson-Saunders and Arts. 2004; Farooq, 2018; Willems *et al.*, 2018; van Doren *et al.*, 2016). To increase societal value when developing infrastructure such as OWFs, the physical and socio-economic systems involved need to be understood. In this way the effect of interventions can be determined and adapted to minimize negative effects and capitalize on opportunities (Ehler and Douverre, 2009). This need for knowledge is recognized in terrestrial spatial planning as well (Faludi, 2000). In spatial planning, decades of research have led to a better understanding of systems and interventions. However, while efforts are increasing, the marine environment is not only hard to research and monitor, but has not been studied as intensively (Dannheim *et al.*, 2020; Gazzola *et al.*, 2015; Paramana *et al.,* 2021). While knowledge generation can be sped up with modern modelling and improved monitoring techniques, understanding marine systems is still extremely challenging and requires time and investment (NWO, no date; Keijser, *et al.,* 2020; Dassenakis *et al.*, 2019). As the physical system, and socio-economic systems involved continue to be studied, there will be a constant stream of new knowledge, which will be vital for the formation of effective policy. To govern OWF placement and development, institutions require the willingness and capacity to cooperate and include new knowledge into future policy.

Paramana *et al.,* (2021), underline the great improvements made by the EU Marine strategy framework directive (MSFD), in pushing towards an integrated understanding of the cumulative effects made by different anthropogenic uses. However, Spijkerboer *et al.,* (2020), and Gusatu *et al.,* (2020), indicate that this integration is far from sufficient, both nationally and for the North-Sea region. As such, the current level of knowledge integration and system understanding can be deemed insufficient for large scale OWF placements, especially when considering that OWFs will remain for a long period (RWS, 2016, 2019, 2022). However, OWF placement will continue out of necessity in light of the urgent energy transition (Rijksoverheid, 2022). Therefore, it is important to accommodate the mentioned stream of new knowledge about the North Sea system into policy as efficiently as possible. Especially when adaptation and mitigation can still add value or prevent harm after placement.

The notions above demonstrate that efforts to understand the physical system of the North-Sea are increasing, and while governance procedures and contextual factors are increasingly included in research, understanding of governance and socio-economic systems involved in MSP is underrepresented (Ehler and Douverre, 2009; Douverre, 2018; NWO, no date). As such, this study will consider the uptake of knowledge concerning the biophysical system of the North Sea, but also knowledge relating to socioeconomic developments and the governance of the North Sea.

3.2. THEORETICAL FRAMEWORK: MEASURING THE CAPACITY FOR KNOWLEDGE UPTAKE

To answer the main research question of this thesis; (*What opportunities and barriers exist for the development of knowledge uptake in Dutch MSP, and how can the capacity for knowledge uptake concerning the placement and operation of Offshore Wind Farms in Dutch MSP be enhanced*), an operationalisation of the concept of knowledge uptake is necessary to analyse the capacity of Dutch institutions to apply it in MSP and OWF development. As mentioned, no overarching framework of knowledge and knowledge uptake has yet been provided in literature. The definition of knowledge uptake in this research is extensive and encapsules several processes: *the acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy*. As such any concept used to analyse the ability of organisations, institutions, or governments to take up knowledge into policy, must include several aspects. These aspects should jointly describe the ability of taking knowledge through development, all the way to its efficient inclusion into policy. According to Ryneveld and Sproule (2006), knowledge uptake in individuals and institutions can only be measured with their competence to use this knowledge. As such, when measuring the ability for knowledge uptake of institutions, the different capacities related to the active acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy, can be analysed to measure the degree of knowledge uptake by institutions. These capacities are referred to as intellectual capacities in planning and development literature (Healey, 1998; Cars *et al.,* 2017; Popov, 2011). This study employs the framework of intellectual capacity to sketch a comprehensive image of the aspects of knowledge-based capacities currently present in Dutch MSP and OWF planning. The concept of intellectual capacity is explained below, followed up by a description of the different aspects of intellectual capacity, and an explanation of the relations between these aspects.

3.2.1. Intellectual capacity

Capacity, is defined as the ability to add value to a system by using the potential of skills, knowledge, and resources (Isaza *et al.,* 2016; Ansong *et al.,* 2021; Veitayaki and South, 2001; Clarke and Flannery,

2020; Gilek, 2016). Intellectual capacity then, specifically concerns the ability to add value through the development and use of knowledge, or: "*the ability of organisations to set and achieve goals through knowledge, and skills*", an ability which this study measures as knowledge uptake (UNDP, 2009, p. 1). In spatial planning and development literature, intellectual capacity is used to measure the knowledge related capacities of institutions (Healey, 1998; Cars *et al.,* 2017; Popov, 2011; Laeni *et al* 2019). Intellectual capacity is recognized as vital for the development of institutional capacity, which is used to analyse an institution's capacity to develop integrated governance arrangements and shared discourses (van Tatenhove, 2013). Apart from intellectual capacity, institutional capacity consists of *legal, socio-political,* and *technical* capacity (Cars *et al.,* 2017; Popov, 2011). The reason that this study focusses on intellectual capacity and not on the other capacities cited, is the mentioned identification of knowledge and knowledge uptake as the main restrictive factors in the planning and development of marine space (Van Tatenhove, 2011; Keijser *et al.,* 2011; Ehler and Douverre, 2009, Paramana *et al.,* 2021; Gazzaola, 2015). Intellectual capacity, due to its focus on the identification of knowledge-based capacities is taken as a suitable and overseeable concept for the analysis of knowledge and knowledge uptake of OWF development in policy and decision making in MSP, since it demonstrates the competence to acquire, comprehend, evaluate, and use knowledge.

Intellectual capacity focuses on the knowledge related capacities of *system understanding, knowledge integration, and learning,* to analyse the generation and use of knowledge, see table 1 (Cars *et al.,* 2017; Popov, 2011; Laeni, 2019). These aspects of intellectual capacity are often considered separately, but according to Cars and Healey (2017; 1998), any single aspect of intellectual capacity draws knowledge and strength from the others. These aspects should thus be analysed in tandem (Cars, *et al.,* 2017; Healey, 1998). While intellectual capacity as an umbrella concept for knowledge capacities has not yet been used in MSP research, its separate aspects have been used in MSP and planning research making intellectual capacity a suitable concept for the structural analysis of knowledge uptake in Policy and decision making in MSP. See for example Dannheim *et al* (2021), for an example of increased system understanding, see Janssen *et al.,* (2014), for an example of how knowledge integration can improve planning practice, and see Willems *et al.,* (2018, 2019), and Keijser *et al.,* (2020), for the use of learning in spatial planning and MSP. Below, the three aspects of knowledge uptake are discussed in depth.

Table 3.1: A framework for analysing the aspects of intellectual capacity.

concept	aspect	Sub-aspects	goals	Main sources
-intellectual capacity	-system understanding		-Developing knowledge about the societal and ecological mechanisms involved, and how they influence one another.	*Taljaard et al., 2013* *Dannheim et al., 2021* *Cars* et al., *2017* *Flyvbjerg, 2003* *Popov, 2011*
	-knowledge integration		-Developing the joint understanding, and valuation of knowledge between	*Farooq, 2013* *Edelenbos et al., 2011* *Edelenbos and Teisman, 2013* *Janssen et al., 2014* *Zeigermann, 2021*

			different disciplines, and knowledge and policy sectors.	*Böcher & Krott, 2016*
	-organisational learning	-single-loop organisational learning	-Acquiring, retaining, and transferring knowledge to perfect existing process and attain current policy goals according to existing frames.	*Willems et al., 2018* *Senge, 1990* *Weick, 1995* *Weick and Westley. 1996* *Berkhout et al., 2006* *Brown, 2020* Keijser *et al., 2021* *Van Tatenhove, 2017*
		-double-loop organisational learning	- Acquiring, retaining, and transferring knowledge to reflect on, and adapt policy goals and frames to include newfound knowledge and innovative processes. All in order to adapt policy and governance to changing contextual and environmental factors.	*Flyvbjerg, 2003* *Willems et al., 2018* *Willems et al., 2019* *Argote, 2011* *Taljaard et al., 2013* Keijser *et al., 2021* *Van Tatenhove, 2017*

3.2.2. System understanding

System understanding focusses on the content of knowledge. It is necessary to understand systems and their reactions on intervention, if interventions are to add societal value without causing issues (Isaza *et al.,* 2016; Ehler and Douverre, 2009). Without the appropriate context, knowledge is not complete, thus requiring understanding of the system at large. Governance and socio-economic systems have been interwoven with the physical system of the North-Sea for centuries. Understanding the effect of these systems on the formation of policy is vital to understand the interventions made in the physical system. This is challenging since systems are often complex with many unknown influences and consequences (De Roo, 2018). As such, uncertainties are inherent to system-considerations. Potential uncertainties have to be kept in mind when deciding on goals and strategies. However, uncertainties are hard to include in policy due to their limited acceptation in the public sphere (Brugnach *et al*, 2008). As such, understanding is required about which systems we might influence through our interventions, what effects our interventions might have, and how these effects can be put in the perspective of agreed-upon, system-based values in order to develop acceptable solutions (Dannheim *et al.,* 2021; Taljaard *et al.,* 2013). As mentioned, the biophysical system of the North Sea is insufficiently understood to judge the effects of large-scale OWF placement, and how these interventions affect the governance and knowledge systems receives little attention (Gusatu, 2021; NWO, 2020; Dannheim *et al.,* 2020; Cash *et al.,* 2002; Stange, 2017). Therefore, decision making

and policy in MSP have to be prepared to include improved understanding in future policy arrangements, both when allocating new OWFs, and when monitoring, compensating, and mitigating in existing ones. This will be further discussed in section 3.3 where the conceptual model of this study is developed.

3.2.3. Knowledge integration

The mentioned need for agreed-upon values demonstrates the link between system understanding and knowledge integration. Through processes of knowledge integration, holistic understanding, and cooperation, better knowledge uptake in decision-making and policy can be attained. Ultimately, when understanding is shared, conflict about the meaning of knowledge is kept to a minimum, streamlining the development of joint and transparent goals and practices (Janssen *et al.,* 2014; Laeni *et al.,* 2020; Keijser *et al.,* 2021). If conflicts and unaligned policies are to be avoided, it is just as important to align policy contexts through joint interpretation among authorities and experts (Weick and Westly, 1996).

To allow for a detailed analysis of knowledge integration between different groups, and the goal of shared agreement, three processes of integration are generally considered in literature: 1. The integration of knowledge between scientific disciplines. For organisations to learn and policy makers to develop frames and decisions, there is a need to align and bundle knowledge between different academic disciplines to promote holistic views among scientists and policy-makers (Ehler and Douverre, 2009), 2. The integration of knowledge between scientific disciplines and policy-makers is vital for the uptake of knowledge, and 3. The agreement of how knowledge is valued and used among decision and policy makers simplifies the subsequent decision-making process (Farooq, 2017; Edelenbos and Teisman, 2013; Zeigermann, 2021).

To help solve the learning paradox, the improvement of clear goals and understanding between organisations and disciplines is vital. As indicated already by Keijser *et al., (2020),* learning does not only involve experience, but also learning from others. Knowledge integration can align policy-contexts and knowledge views, helping to determine joint policy goals and approaches (Janssen, 2014). Such joint goals and approaches allow for long-term, integrated, and adaptive governance. As such, participatory approaches between different organisations and disciplines increases both knowledge and functional integration resulting in improved understanding and cooperation between organisations. This is reflected by Janssen, *et al.,* (2014), who indicates several conditions for knowledge integration; *"(1) knowledge development should take place at close distance to the policy process and include intensive interaction, (2) multiple iterations are needed, (3) integration at policy level requires structural embedding to endure, and (4) tools are required that allow for an integrated assessment",* (Janssen *et al.,* 2014, p. 1) These conditions will be used to analyse the current level of knowledge integration in Dutch OWF development in MSP. This will be combined with the identification of barriers and enablers of double-loop learning to consider the development of new goals and practices.

3.2.4 Learning

While developing processes of policy and decision making, experience and evaluation contribute to their improvement (Argote, 2011; Willems *et al.,* 2018). In the creation and use of knowledge, Flyvbjerg (2003), accentuates the Aristotelian notion of phronesis, which emphasizes experience, judgment and context. Different from theoretical and practical knowledge types, making judgements

depends on experience. This view is supported by Latour and Paris (2005), who indicate that knowledge is not created by overcoming gaps, but by amassing experience over time, and making judgements based on experience in a certain context. This experience-based process of adaptation in approaches and goals is seen as the essence of learning (Argote, 2011; Flyvbjerg, 2003; Armitage *et al.,* 2008; Latour and Paris, 2005). Keijser *et al* (2020), indicate that learning in MSP does not only happen through experience but also by doing, and sharing with others, demonstrating *the strong connection between learning and knowledge integration* in building intellectual capacity. Literature distinguishes individual, policy, and organisational learning. Individuals learn, as organisations create the conditions of learning. Policy-learning happens when acquired knowledge about policies and their effect on the topic at hand leads to policy-changes (Keijser *et al.,* 2020; Willems *et al.,* 2018, 2019; Bakir, 2017). Since this study analyses Dutch policy-makers and their organisations, organisational and policy learning are employed.

Learning entails *the process of creating, retaining, and transferring knowledge, leading to change in behaviour, skills, and attitude*. Thus, learning not only involves the acquisition of knowledge, but also the behavioural adaptation of people, organisations and ultimately policy based on this new knowledge. As such, organisational learning can lead to policy learning (Keijser *et al,* 2020). According to Argote (2011), and in line with Latour *et al,* and Flyvbjerg (2003, 2007), learning in organisations is dependent on experiences, and how these are dealt with. Both successes and failures can lead to multidimensional learning experiences including aspects of content, process, and knowledge itself (Blaak, 2021). Since learning happens through individuals, due to the mentioned need of a "knower", the creation, retainment, and transferring of knowledge can be encouraged with organisational design, policy design, and changing contexts. For example: an orientation on learning instead of merely performance, whether individuals feel safe to contribute to policy goals and approaches, a shared identity, and power relationships, all have influence on an organisations' learning capacity (Argote, 2011). By influencing this context, experiences can be dealt with in different ways. Therefore, organisational design can affect an organisations' learning capacity and influence learning in policy.

Institutional capacity building theory considers two learning loops (Cars *et al., 2017;* Popov, 2011), whereas learning theory considers three loops (Willems *et al.,* 2018; Armitage *et al.,* 2008). As described in table 1, single loop learning concerns the optimisation of processes to attain goals, whereas double loop learning concerns the adaptation of these goals to new environmental or knowledge contexts. When aligning these loops with the temporal scales of institutional change, single-loop learning can be accommodated under the continuous process of optimising marginal conditions (Williamson, 1998). Double-loop learning relates to the process of changing the fundamental way in which the game is played. Double loop learning does not necessarily refer to the change of rules, it can also entail a systematic change in behaviour, mindset, or change another feature of the current system. Changing these more fundamental features is a 1-to-10-year process, see figure 2 (Fabricius & Cundill, 2014; Williamson, 1998; Willems *et al.*, 2018). Both single loop and double loop learning can be analysed with currently available data. Where double loop learning changes formal institutions, triple loop learning considers the design of underlying institutional norms, this can include an increase in the inherent value of knowledge for the better functioning of double and single loop learning. However, this process can also change fundamental societal norms like humanism, individualism, or naturalism. According to Williamsons theory of institutional change this can take decades or even centuries to unfold, and is therefore unfit for the scope of this thesis (Williamson, 1998).

Single Loop Learning

Single loop learning focusses on the adjustment of prevailing practices and strategies which are determined through system understanding, knowledge integration, and double-loop learning (Brown *et al*., 2020; Cars, 2017). In single loop learning, the functioning of dominant action strategies and practices are monitored and analysed according to existing frameworks, to see if they live up to pre-determined goals. As such, it is a feedback loop, aiming to optimize organisations and reconstruct practices for better outcomes according to existing goals and values (Willems *et al.,* 2018).

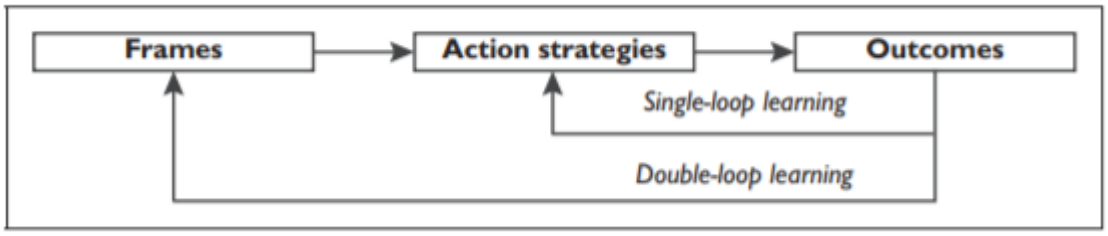


Figure 2. Organisational learning as represented by two loops (Willems *et al.,* 2018).

Double loop organisational learning

Double loop learning occurs when new knowledge changes the context of policy through e.g., new system understanding or knowledge integration. Such a change requires the adaptation of goals and strategies (Fazey *et al.,* 2005; Willems *et al.,* 2018, 2019). Double loop learning aims for the re-interpretation of existing knowledge views in policy and organisations and goals to match newfound knowledge, or changing contexts. To anticipate uncertainties, policy makers have to "*continuously re-interpret their environments and take subsequent action to ensure environmental alignment"* (Willems *et al.,* 2018 p. 1089). As such, knowledge frames, values, and organisational structures on which practices are based have to be reconsidered according to changing contexts, see fig 2. Reconsideration allows for the questioning of dominant frames, which is necessary since merely anticipating long-term uncertainties is not enough (Willems *et al.,* 2018). In this manner, knowledge should be developed and taken up into policy to ensure the alignment with changing contexts. It is particularly difficult to consider the uptake of knowledge in spatial goals relating to OWF development since institutions may highlight aspects which fit in the existing frame, while downplaying others (Entman, 1993). To consider new systems, frames and goals being adapted through double loop learning, attention will be paid to adaptations of goals in MSP and OWF development, shocks in institutional views, changes in organisational structures, and other systematic adaptations.

3.3. More than the sum of its parts, intellectual capacity in a dynamic knowledge situation

The explanation of the different aspects of intellectual capacity above already shows some overlap. As mentioned, these aspects cannot be considered separately when determining the institutional capacity for knowledge uptake. The need for this holistic view of knowledge capacities can for example be seen in how system understanding of a large and complex system like the North Sea requires the integration of knowledge bases of different disciplines and organisations (Cars *et al., 2017;* Popov, 2011; Edelenbos *et* al., 2011; Edelenbos and Teisman, 2013). For policy to remain effective in the rapidly changing context of OWF development in MSP, the integration of knowledge from different disciplines is essential for the formation of goals and strategies. The perfection of such strategies requires iterative improvement in all policy phases through single-loop learning. If contexts change, double loop learning or the adaptation of goals and frameworks is required for policy to remain

effective (Willems *et al.,* 2018). However, despite the need for a holistic view of intellectual capacity, not all of these features are recognized and acted upon to the same degree. Often, institutions focus on the adaptation of action strategies based on better system understanding, but the integration of knowledge and adaptation of frameworks receives far less attention in practice while they are important for the development of knowledge uptake in the current dynamic knowledge situation (I&W *et al.,* 2021).

In OWF development and MSP, learning involves the constant monitoring of the influence that OWFs have on the biophysical and societal systems as well as changes in policy contexts. If the effect of interventions is anticipated before the construction phase, a lot of environmental harm and mitigation costs can be prevented. However, the plans of OWFs will not be optimally informed before their placement due to a lack of time and the urgency of the energy transition. In Dutch OWF development, licenses apply for 25-40 years, this is necessary to ensure the roll-out, providing developers and investors the certainty they require to make major investments (OFL, 2020A, 2020B; wet wind op zee, 2015). Thus, limited long-term perspectives are included in OWF policy since there is insufficient understanding of the long-term effects on systems involved and little recognition of the uncertainties ahead. This results in a necessity to anticipate uncertainties, and develop the capacity to adapt to them. Renewal of policy is often seen as a critical time for re-development, including new knowledge concerning social and biophysical systems, and newly recognized uncertainties in strategic plans (Willems *et al.,* 2018).

Due to the dynamic knowledge situation, renewed policy-insights need to be taken up in anticipation of this re-development as soon as possible. This can prepare authorities for new and uncertain contexts, both physical and organisational. For this same reason, knowledge bases and spatial planning strategies should already be developed for the decommissioning phase, to ensure better understanding and jointly agreed goals during the decommissioning phase (Loos *et al.,* 2021). If proportional to the costs, any new knowledge about improved efficiency of spatial use or environmental protection should lead to adaptations of existing OWF's through mitigation and compensation. However, the mentioned lack of joint understanding and transparency leads to a lack of generally accepted knowledge goals. Good or bad is often politically determined, based on which less objective knowledge is developed and due to which a short-term focus dominates (Van Tatenhove, 2013).

The dynamic knowledge situation and rapid development of OWFs cause issues which could be improved with more significant knowledge integration and double loop learning. The value and current lack of double loop learning and knowledge integration renders these topics particularly interesting for analysis. Despite the recognition of double loop learning and knowledge integration as requiring further research in particular, the study will hold true to the indications of Cars (2017), and Healey (1998). The features of intellectual capacity cannot be analysed separately, and will therefore all be taken up in the analytical framework, see figure 3.

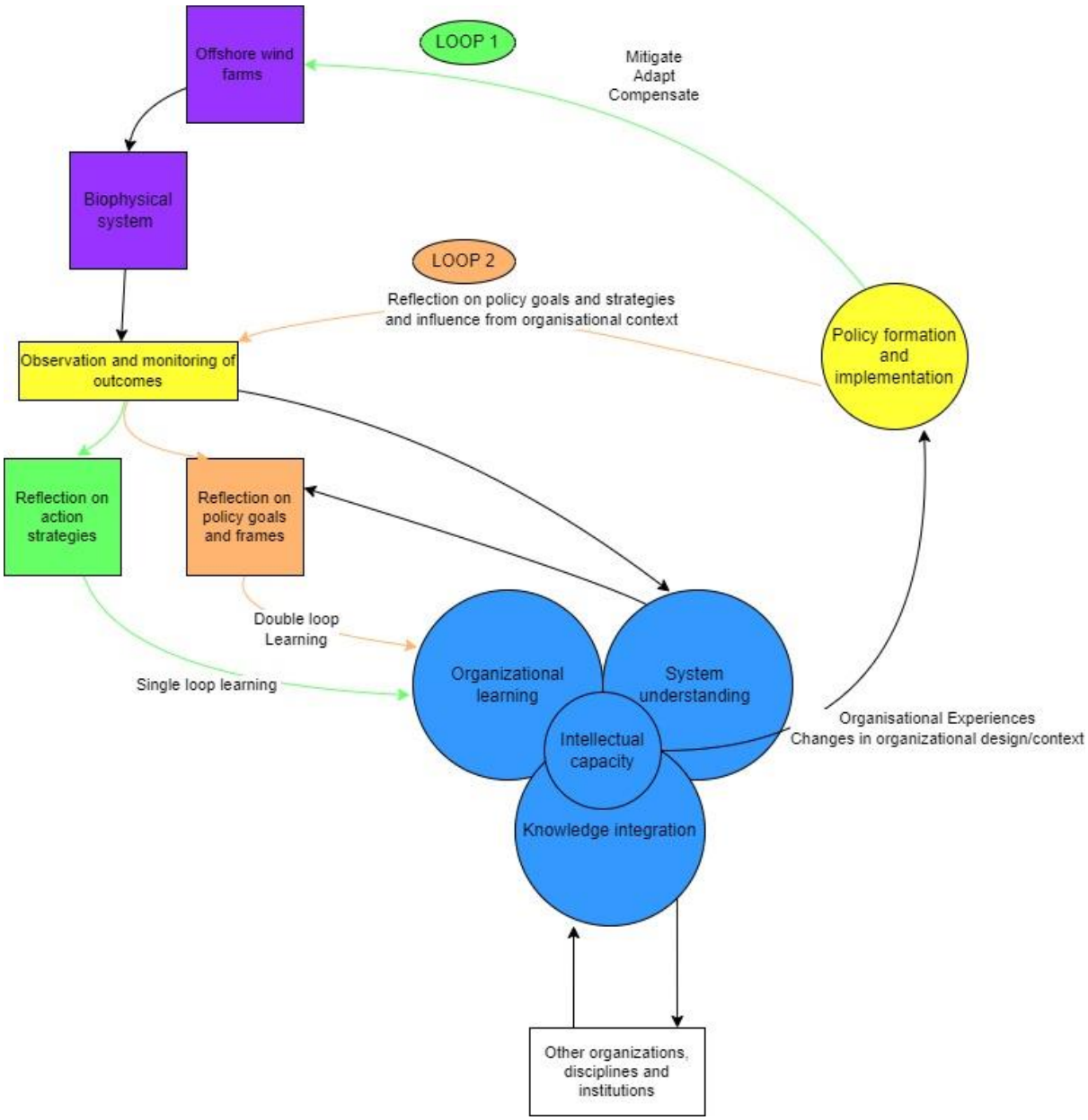


Figure 3: This figure demonstrates the position of intellectual capacity and its features for the creation of adaptive policy. The figure demonstrates how knowledge from several sources finds its way into policy through different aspects of intellectual capacity. The three main aspects of intellectual capacity (Blue) are demonstrated as being connected, combining insights from processes and players connected to individual aspects. The physical systems that need to be understood are depicted in purple. The formation and monitoring of policy is depicted in yellow. Additionally, single loop learning is depicted in green and double loop learning in orange. The figure depicts how single loop learning can lead to different action strategies in the physical domain, whereas double loop learning pertains to the outcomes and as such, to possible changes in context. interaction with other players leading to knowledge integration is depicted in white. (Author).

The framework in figure 3 makes use of the dual adaptive cycles (Taljaard *et al.,* 2018; Vreugdenhill *et al.,* no date) and organisational learning models (Willems *et al.,* 2018), and shows the position of intellectual capacity in the creation of policy (Willems *et al,* 2018; Taljaard *et al.,* 2013; Vreugdenhil *et al.,* no date; Liefferink, 2006). The larger cycle represents the effect of OWF placement on the North Sea system indicated with loop 1 in green. Reflection on the influence of these placements immediately contributes to system understanding, indicated with the black arrow going towards system understanding, which on its turn can inform a change in policy goals through double loop

learning, indicated in orange. The observation and monitoring of outcomes, indicated in yellow, also inform organisational learning directly if the effectiveness of interventions is understood, see the black arrow. Additionally, more intellectual capacity is obtained through knowledge integration with other groups indicated with the white block. The results of the processes of learning, knowledge integration and system understanding are combined and used to inform policy formation and implementation. The arrow going towards policy formation and implementation demonstrates how policy arrangements are influenced. Finally, changes in policy formation and implementation lead to adaptations in planning, placement, mitigation, and compensation, which impacts the placement of OWFs, which in its turn affects the biophysical system demonstrated in purple. These changes are subsequently monitored and observed, closing the cycle.

After considering the theory and literature, the expectation arises that system understanding receives particular attention in the current OWF development framework. Single loop learning is expected to be used, but not always effectively, and double loop learning and knowledge integration are expected not to be considered at all in the framework. Based on literature we expect that not the amount of knowledge, but mostly the way in which knowledge is used, to cause problems in practice. As such, expectations are that values and learning capacities will be very different across disciplines and organisations. More specifically, we expect policy-makers to be influenced more by political goals than by expert advice, we expect physical scientists to underestimate the importance of governance research, and we expect scientists in general to be insufficiently open to communication with policy-makers. Finally, this thesis hypothesizes that limited clarity exists concerning the different viewpoints on knowledge held by different parties.

4. METHODOLOGY

This section provides an outline of the research design, strategy and methodologies used in this study. First, choices for the research strategy and different methods are discussed. Afterwards, the case selection is briefly elaborated on (a full description of the case can be found in the results). Then, the different methods of data collection are discussed, and finally, the design for data analysis is explained.

4.1.1. Methodological considerations and research strategy

This thesis analysed the system of knowledge uptake in OWF development and MSP in the Netherlands. The thesis analysed the position of the different aspects of intellectual capacity and identified barriers and opportunities for its development in order to make recommendations. The research questions in this thesis require in-depth understanding and exploration of knowledge uptake in MSP and OWF development. The consideration of different knowledge viewpoints and deep understanding of knowledge uptake in Dutch OWF development and MSP indicate a need for in-depth, qualitative data concerning the relevant processes. The value of a qualitative strategy for this topic mostly lies in the understanding acquired of why choices are made by certain individuals and organisations, revealing deeper insight concerning their paradigmatic stance and motivation (Hennink *et al.,* 2021; Baxter and Jack, 2008). Due to the novelty of research into knowledge uptake, preceding research has predominantly employed document and literature research (Keijser *et al.,* 2021; Tatenhove, 2013; Gazzola, 2015). Since so little research had been done concerning this topic, an extensive data gathering process of several rounds and methods was considered to be an important condition for this thesis to provide a complete analysis to limit the possibility of biased results. As such, this study has first gathered insights through document analysis and the observation of consortium meetings, these were used to inform interview guides. Finally, findings from interview guides were tested in focus groups.

Several research methods were considered for the collection of this in-depth data. Due to the need for in-depth data about the current process of knowledge uptake in the Netherlands, and the desire to understand the positions of different stakeholders, a qualitative case study was considered. This would employ document analysis, focus groups, observations, and in-depth interviews. In focus groups the uptake of knowledge between different groups could be closely studied and put in perspective. This method would allow for the conscious consideration of the complex phenomena in their own context (Baxter and Jack, 2008).

Another method considered was Q methodology. In this methodology, controversial statements are identified based on interviews, which are subsequently provided back to participants who are asked to rate them according to a Likert scale (Van Exel and de Graaf, 2005; Molenveld *et al.,* 2020). This method is particularly suitable for the consideration of epistomological viewpoints, and allows for the statistical analysis of results (Ripken *et al.*, 2018). Finally, the Delphi method was considered. After doing interviews and document research, this method asks experts to fill in questionaires anonymously, and subsequently comment on each others answers. This would have been suitable due to its in depth analysis and anonymous structure, which helps to prevent social biases (Hallowell, 2009).

It was decided that an extensive document and literature analysis, and interviews of 10-20 participants would be nedessary for an overview of the perceived issues of knowledge uptake from different viewpoints. Due to the limited timespan of this research, the feasibility of a Q-method or delphi

method, in which severall rounds of analysis are necessary after the initial interviews, seemed low. The qualitative case study was selected as research strategy to allow for severall rounds without being too dependend on the schedules of participants. Additionally, the focus groups would allow for insight of the perception of knowledge uptake between players in OWF development and a close consideration of the issue in its own context.

Several methods were combined to triangulate data and counterbalance potential biases and weaknesses of analysis by converging different lines of inquiry (Jick, 1979). In the end, 5 methods of data selection were used: The literature review allows for a broader consideration of the use of knowledge in MSP; The document analysis provides the transparent and systematic analysis of existing policy concerning knowledge uptake, preventing biases like presuppositions and prevalent knowledge of the researcher; Observations were done to gain a first insight in the dynamics of OWF research and how knowledge is dealt with; In-depth interviews were performed to gain insight in the opportunities and barriers to knowledge uptake as perceived by different stakeholders, less formal aspects of knowledge use, and to test the findings of document analysis (Hennink *et al.*, 2020; Babbie, 2013). The second part of the study was based on participative research; focus group sessions were organized where participants from different institutions, organisations, and disciplines engaged to create agreed upon visualizations of knowledge generation and uptake in OWF development (Basco-Carrera *et al.*, 2017; Hovmand, 2013).

4.1.2. Case selection

A qualitative case study, considers complex phenomena in an in-depth manner to gain understanding of these phenomena in their own context. As such, a suitable case needed to be selected to study knowledge uptake in offshore wind policy and MSP. With the North Sea being one of the busiest maritime areas in the world, and Dutch MSP going back as far as 2004, Dutch OWF development is suitable for the analysis of knowledge uptake in OWF development and policy and decision making in MSP. The publication of marine spatial plans and documents like the North Sea dialogues allowed this study to analyse knowledge use and knowledge uptake in OWF development and MSP in the Netherlands. The study focussed on three particular cases in the third round of OWF development after the passing of the new law, wind energy at sea, in 2015. These three cases were selected to provide an image of the development of knowledge uptake in the Netherlands overtime (Babbie, 2013). Borssele was selected because it was the first plot decision made after the passing of the new wind energy at sea law. A plot decision is a decision by the government on the design of OWFs in a predetermined part of sea, based on research concerning the current environmental value and other uses in and around the area. The next two are selected as a pair: Hollandse kust Noord is the last plot decision made for which development has started already, and Hollandse Kust West is the last plot decision, but construction has not yet commenced. Comparing these plot decisions allowed for the analysis of the progress made in the years between their development, and especially whether issues in development lead to new goals or action strategies in the plot decision concerning the new wind park.

4.2. DATA COLLECTION

As mentioned, the use of triangulation provides a strong validity of data by drawing from multiple sources of evidence. To this end, document analysis, semi-structured interviews, observations, and focus groups based on group model building exercises were employed in the data collection phase of this study (Jick, 1979; Babbie, 2013).

4.2.1. Documents

With several steps of data collection, this research has a complex design. The first step is to look for manifestations of Dutch MSP and OWF planning, regulations for knowledge uptake, and signs of barriers and opportunities for aspects of intellectual capacity. The document analysis therefore has the joint goals of providing an overview concerning the OWF planning and MSP frameworks in the Netherlands, and considering the status of intellectual capacity and its separate aspects. Documents were considered relevant for this thesis if they contained, spatial plans, policy briefings, area selection documents, plot decisions, and legal acts, concerning the placement of OWFs in the Dutch part of the North-Sea, see appendix 1. Documents were selected from official websites of the government and organisations involved. These were thoroughly analysed for aspects of intellectual capacity, signs of knowledge uptake, and their influence on policy arrangements was interpreted. Documents were selected through keyword research and by snowballing, and by asking experts involved for relevant documents. Case studies are particularly useful for studying the development of phenomena over time. For this reason, policy documents from a longer period were selected in order to analyse the uptake of new knowledge over time. Later on in the process, new sources were discovered, mostly provided by interviewees, leading to a second round of document analysis and coding.

4.2.2. Observations

Observations were made of discussions of the NWO research consortium for the project: *effects of windfarms on the marine ecosystem and implications for governance* (NWO, 2020). The goal of these observations was to get a first insight of the issues connected to OWF development and the position of scientists towards knowledge, as well as insight in the way different scientific disciplines overlap and how scientists integrate knowledge. Since this method was performed to generate first insights and not to answer particular questions it had a very open character without a structured observation guide (Hennink, Hutter, and Bailey, 2020; Babbie, 2013). This format helped to identify important topics concerning OWF development and knowledge, which were inductively used to organise the notes gathered.

4.2.2. Semi-structured interviews

In-depth interviews were held with experts from different scientific disciplines, and policy makers, (Hennink, Hutter, and Bailey, 2020; Babbie, 2013). The goal of these interviews is to further deepen the understanding of knowledge uptake in Dutch MSP and OWF planning. The expert participants for these interviews were selected from the NWO research consortium on the impact of OWF's on the Dutch part of the North Sea. This consortium consisted of work packages on the Hydrology, sediment flows, bottom ecology, and general ecology in relation to the North Sea, providing an array of experts from different disciplines. Other scientists were approached due to their research concerning the North-Sea system, maritime governance, or OWF development. Policy makers were selected from the different ministries and executive agencies involved in Dutch OWF policy making. All interviews were recorded and transcribed with explicit consent. Meetings of the NWO research consortium were observed, and notes were taken during meetings (recording was not agreed upon). 21 interviews were performed in total; 13 with scientists, and 8 with policy makers. Table 4.1. provides an overview of participants and meetings observed as well as how they will be referenced in the rest of the thesis. Table 4.1 demonstrates the goals of the interviews held with scientists and policy makers.

Table 4.1: An overview of participants interviews and observations

Reference of participant in text	Position participant	organisation	Date
P1 Scientist estuaries and delta systems	Professor Spatial Water Quality and Aquatic Systems		25/10/2021
P2 Scientist sediment dynamics modelling	Advisor/Researcher sediment, ecosystem and sediment	Deltares	31/08/2021
P3 Scientist ecosystem modelling	Senior researcher Ecosystem modelling		26/08/2021
P4 Scientist-ecosystem and hydrology	Advisor/Researcher Ecosystems and hydrology		22/07/2021
P5 Scientist marine ecology	professor Marine ecology		22/04/2022
P6 Scientist reef biodiversity	Dr in Marine ecology reef biodiversity and benthic populations		02/11/2021
P7 Scientist ecosystems and sediment dynamics	Sediment dynamics	Deltares	25/05/2021
P8 Scientist-environmental assessments	Senior advisor/researcher environmental impact assesments	Deltares	22/06/2021
P9 Scientist- Marine systems and MSP	Professor MSP and marine systems.		02/05/2022
P10 Scientist marine and coastal management	Senior advisor marine and coastal management	Deltares	04/05/2022
P11 Scientist- coastal and offshore engineering	Advisor harbour, Coastal and offshore engineering	Deltares	19/04/2022
P12 Scientist marine and coastal management	Senior hydrologist, marine and coastal management	Deltares	14/06/2021
P13 Scientist Marine Spatial Planning	Advisor environmental policy and marine spatial planning.		14/06/2022
P14 Policy maker Marine management	Policy maker marine management		25/03/2022
P15 Policy maker Offshore wind.	Program manager wind at sea		18/05/2022
P16 Policy maker North Sea policy and research	Senior advisor North Sea policy and research		21/04/2022
P17 Policy maker nature and North Sea	Coordinating policy officer nature and North Sea		12/01/2022
P18 Policy maker North Sea	Senior advisor North Sea Rijkswaterstaat		05/04/2022

P19 policy maker public management	Chairman North Sea talks		07/06/2022
P20 Policy maker environmental management	Environmental manager RWS		05/03/2022
	Consortium/groups	**Notes**	
O1	NWO *effects of windfarms on the marine ecosystem and implications for governance*	A first meeting setting up the initial division of tasks and familiarizing between different work packages	05/11/2021
O2	*effects of windfarms on the marine ecosystem and implications for governance*	Presenting progress per work package and discussing further action	04/04/2022
O3	NWO	Presenting progress per work package and discussing findings in retrospect from different viewpoints.	13/05/2022
FG1	Focus Group Knowledge uptake	Presenting and discussing the processes and progress of Dutch OWF development	21/03/2022
FG2	Focus Group Knowledge uptake	Discussing possible improvements and zooming in on the role of knowledge.	28/06/2022

Table 4.2: Types of experts invited, and goals of interviews

expert interviewed	**Interview goals**
Scientists researching the physical system of the North-Sea.	1. Gain an in depth understanding of the current knowledge being developed regarding the North-Sea system. 2. Gain in depth understanding of the views of scientists regarding knowledge and its uptake and the barriers and opportunities they perceive.
Scientists researching Marine spatial planning and other	1. Gain an in depth understanding of the Marine spatial planning process of developing OWFs.

organisational aspects of OWF planning.	2. Gain in depth understanding of the views of scientists regarding knowledge and its uptake and the barriers and opportunities they perceive.
Policy-makers involved in the policy making process of OWF development.	1. Gain an in depth understanding of the decision-making process regarding OWF development 2. Gain an in depth understanding of the views of policy makers regarding knowledge and its uptake and perceived opportunities and barriers.

4.2.3. Focus groups based on Group model building

Since one of the aims of this research is to look for ways of improving intellectual capacity in institutions and organisations researching and governing OWF, a participative research method is performed. This is useful since representatives from relevant disciplines, organisations and institutions are brought together, and are stimulated to consider important topics and methods for cooperation and the establishment of joint knowledge bases (Babbie, 2013). As such, the focus groups held in this research are based on group model building. Group model building is a system dynamics-based approach, with the goal to create a model based on jointly accepted knowledge and values to increase the likeliness of implementation (Hovmand, 2013). As such it is an extension on joint fact-finding approaches, aiming to define which problems institutions face and which boundary objects, or dependencies exist between organisations and disciplines (Hovmand and Richardson, 2011; Hovmand, 2013; Basco-Carrera *et al.*, 2017). The focus groups were organised in this way for its focus on agreement through well-guided rounds of discussion, clear outcomes of agreed representations, and its ability to foster communication between participants through visual models and exercises (McCreary, Gamman and Brooks, 2001). This is in itself a step towards better integration, can inform policy making by providing insight in the needs of experts and policymakers, and is specifically suitable for generating agreed upon statements (Basco-Carrera *et al.,* 2017). Group model building involves the careful construction of question guides beforehand, in this research these were informed by observations, scientific literature, policy documents, and interviews with participants, see appendix 2. Group model building sessions were organised by Deltares, the author of this research was involved in developing the question guide, regulating the sessions, and preparing the report. Due to the timing of the research, the final models were not ready in time for use in this thesis, but ample insight was gained from these sessions.

4.3. DATA ANALYSIS

The goal of data analysis was to gain insight in the current situation regarding knowledge and its uptake in OWF related policy and decision making in MSP. Other goals were to identify opportunities and barriers, and develop advice for the improvement of knowledge uptake. This was performed using the theoretical framework in chapter 3.3. While all methods contributed to the answering of the main question and all separate sub questions, some specific methods were predominantly used to answer certain questions or consider certain aspects of intellectual capacity, an oversight is provided in table 4.2.

Table 4.3: Specific uses of methods for answering certain questions

Method	Specific use
Observation	This method was particularly useful for gaining insight about existing intellectual capacity and the organisation of knowledge development. Therefore, this method was particularly useful for answering sub questions 2 and 3.
Literature review	This method was used to answer the first sub question, since this question indicates the use of knowledge and knowledge uptake in literature.
Document analysis	This method was used to consider the current knowledge uptake system, and was therefore suitable for answering the second sub question. The method was also used to find additional data for the third sub question and main research question. However, due to the less explicit use of double loop learning and knowledge integration in documents, this method was specifically useful for the consideration of single loop learning and system understanding.
In-depth Interviews	This method was particularly useful for identifying barriers, opportunities, and recommendations, and getting insight in the practical considerations of knowledge uptake. As such allowing for better insight in certain aspects of intellectual capacity, making the method very useful for considering sub question 2 and 3. In addition, since this method allowed for a deeper consideration of complex phenomena, the method gave particular insight in double loop learning and knowledge integration.
Focus Groups	This method was not used to answer a specific question but was particularly useful in working towards a joint knowledge base, identifying barriers, opportunities, and recommendations, and getting insight in the practical considerations of knowledge uptake. In addition, the method gave particular insight in knowledge integration since it allowed for the consideration of more complex phenomena.

4.3.1. Document analysis

Data analysis commenced with policy document analysis to explore formal knowledge bases, frames, and values. A document analysis is a process of systematically reviewing and evaluating documents, often used in qualitative studies (Hennink *et al.,* 2020). The document analysis provided insight in the development of spatial plans for the Dutch North-Sea, and the way in which knowledge gaps were considered, identified and filled. Additionally, the use of new knowledge was analysed by considering

subsequent plans, laws, and plot-decisions over time. Insights from this step were used in the development of interview, observation, and the group model building guide, see appendix 2 and 3.
Documents were coded in Atlas.ti, using a deductive coding strategy based on the theoretical framework developed. After the analysis of interviews, a second round of document analysis was performed based on new, inductive insights concerning the nature of knowledge uptake, see figure 4. In this second round, insights about existing new knowledge were looked for in policy documents to consider their uptake over time, see figure 4.

4.3.2. Interviews and observations

The interview analysis was used to gain a deeper insight in the (in)formal structure of knowledge uptake concerning OWF development in decision making and policy in MSP. Additionally, the interviews and observations were meant to provide insight in the views regarding knowledge and knowledge uptake of participants. Interviews and observations were transcribed and analysed using Atlas.ti (version 9) using a mixed coding strategy of first round deductive codes from literature and policy document analysis, and second round inductive codes inspired by respondents, see table 4.1 and appendix 2 (Hennink *et al.,* 2020). The coding strategy was directed to look for knowledge types, knowledge flows, features of intellectual capacity, and other aspects related to the generation and uptake of knowledge (Hsieh and Sharon, 2005). Coding networks were developed around the different features of intellectual capacity and policy arrangements. These were used to identify important barriers and opportunities as well as conditions for knowledge uptake, and how widely they were perceived among participants. Findings from interviews were used in tandem with other methods to look for the integration of knowledge and identify instances of learning by considering policy changes based on newly found knowledge, see figure 4.

4.3.3. Focus group: Group model building

The analysis of the results of group model building was meant to provide insight in the possible dynamics between policy makers and scientists. It was meant to gain insights in barriers and opportunities, as well as joint solutions and ways in which to capitalize on opportunities. Notes were analysed concerning the discussions between participants and the different viewpoints on knowledge and knowledge uptake, providing ideas on how to work towards a jointly accepted knowledge base.
Visualizations of knowledge per OWF development phase and possible solutions were analysed and used to add to findings from document analysis and interviews.

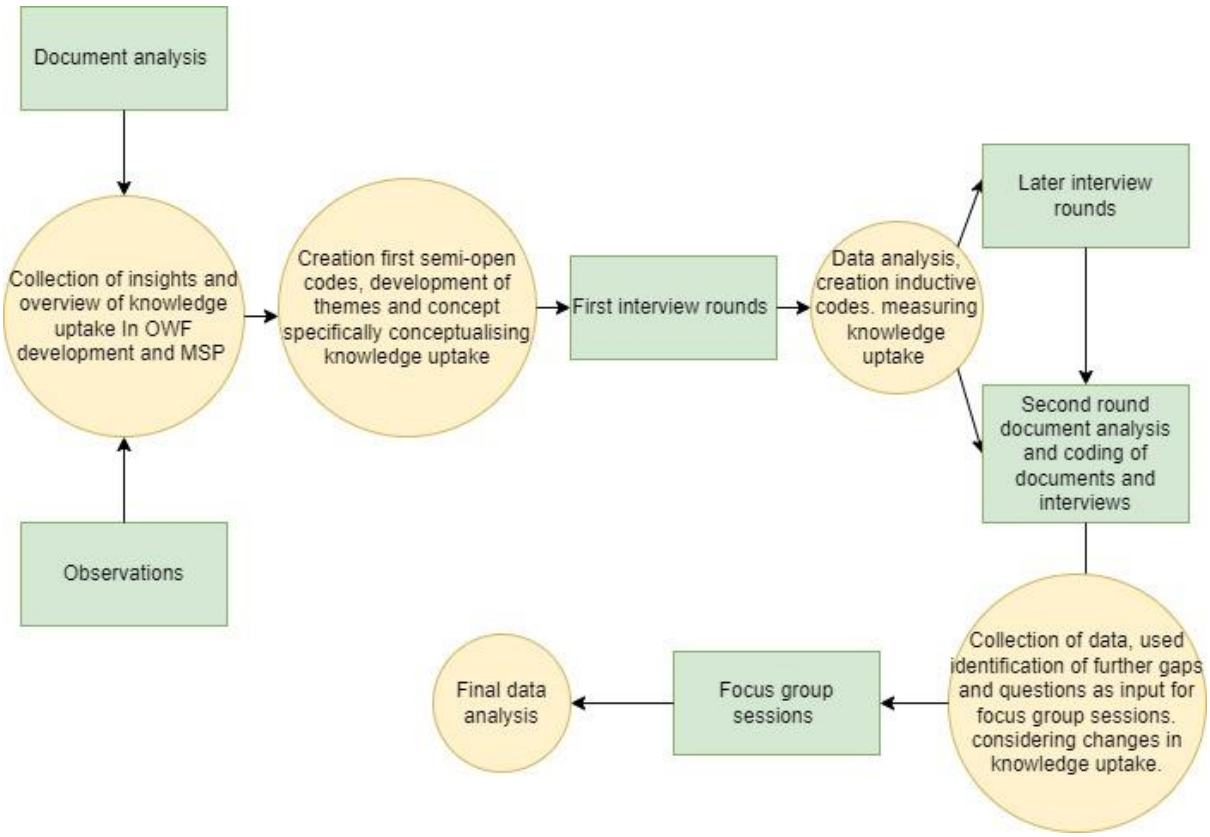


Figure 4: A visual representation of the steps in this research and the development of knowledge uptake as a concept. As can be seen several methods of data collection are used in rounds of analysis to verify data from different lines of inquiry.

4.4. CONSIDERATIONS AND ETHICS

Regarding the interviews and group-model building sessions, there are two ethical considerations, a consideration on data quality from interviews, and several considerations on possible biases which have to be made.

1. Concerning ethics, confidentiality and anonymity have to be ensured (Hennink *et al,* 2020):
Participants will be thoroughly informed about the research beforehand and will have the option to stop the interview, or prevent the use of certain answers at any time. Since full anonymisation will diminish the value of findings (knowledge of the organisation, discipline, function, and epistemic communities in which the interviewees are involved can provide significant insight for the reader), we will ask interviewees if we can publish their functions. Any respondent who refuses the publication of their function due to traceability issues, is fully anonymised in the final publication of this thesis. To ensure confidentiality to a reasonable degree, lists of quotes and insights derived from participants will be send to them for confirmation. All interviews, transcripts, recordings, and insights will be kept in a password protected space.

2. Concerning data quality: Due to the Covid-19 pandemic, most interviews, and the group model building sessions have been performed and recorded online. The lack of personal contact may have led to a slight decrease in the researcher's ability to interpret certain signs.

3. Concerning research bias: It has to be kept in mind that when comparing the opinions of policy-makers and scientists, my personal position as a researcher makes the knowledge views and

recognized opportunities and barriers by scientists more relatable. Despite my utmost intent to remain objective and consider the position of policy-makers to the same degree, this possible bias is duly worth noting. Another possible bias is the selection of participants. Most scientists have either been selected from the NWO consortium researching the physical effects of OWFs at sea, through the network developed at my internship at Deltares, or at the Conference for Windfarms and Wildlife impacts. While this concerns three methods of participant selection, a large number of participants works at, or is connected to Deltares, which may result in a data bias. Finally, the selection of policy-makers for interviews was significantly more difficult than that of scientists. The difficulty of finding policy-makers who are willing to talk about the topic of knowledge integration may have led to the final selection of participants, being particularly interested in and open about the topic. This may have led to the exclusion of policy-makers with more conservative views about knowledge sharing, which can lead to a certain bias (Slonim *et al.,* 2013).

5. RESULTS

This chapter presents and discusses the findings from analysis in separate sections. The first section elaborates on the Case study of OWF planning on the Dutch North Sea, using data from desk and literature research. This first section creates overview concerning existing OWFs in the Netherlands and the current planning framework for OWFs, and what kinds of knowledge are considered during this planning framework, greatly contributing to the answering of the second sub question. With this knowledge about the planning system in mind, the second part of this chapter aims to unravel the current system of knowledge uptake in Dutch OWF development and MSP. In the second chapter, an explanation is provided of the different knowledge developers and programmes, as well as an indication of knowledge use in different phases of OWF policy making. This helps to answer sub question two and especially sub question three. The final section of this chapter presents findings concerning the different aspects of intellectual capacity, providing an answer for sub question three. Separate sections are presented for each aspect, demonstrating its development in Dutch OWF placement and decision making and policy in MSP. Some overlap between the different aspects is unavoidable due to their interrelatedness. In this third section, opportunities and barriers to knowledge uptake are identified, as well as some considerations for the improvement of knowledge uptake. These will be further discussed in the chapter 6 and 7 to answer the research questions and provide recommendations for the improvement of intellectual capacity in OWF development and MSP.

5.1. CASE STUDY: THE DUTCH PART OF THE NORTH SEA; OWF PLANNING, MSP, AND KNOWLEDGE

The North Sea has been one of the busiest seas of the world for centuries. During the last centuries, extensive shipping, military activity, and especially fishing practices have changed large parts of the North Sea from hard-substrate like oyster banks, to dynamic sand dunes, changing the ecosystem along with it (Lindeboom, 2008). Over the last century, anthropogenic influence has been steadily increasing with activities like sand, oil, and gas extraction, underwater infrastructure, aqua culture, and in the last decades, the exponential growth of the offshore wind sector (Ehler & Douverre, 2009). In the last decade, marine governance has received increasing attention (Gazzola *et al.,* 2015). With the blue economy supporting 3.5 million jobs across the EU, providing potential for economic growth, European and national legislation has been developed to govern human activities in the North Sea basin (European commission, 2017). Most of the relevant EU directives pertain to ecological protection, like the habitats and birds' directives, but since 2014, the Marine Spatial Planning directive aims for more detailed governance of European sea basins. This section explains how this governance has developed in the Dutch part of the North Sea. The existing and planned OWFs are listed, and the governance of OWF placement and operation are discussed and visualized. Particular attention is paid to the steps involved in the planning process, and which types of knowledge play a part.

5.1.1. The Dutch Exclusive Economic Zone

The Dutch EEZ, extends between 12 and 200 nautical miles into the North Sea basin and is a 58000km^2 area where the Netherlands has jurisdiction over water column, seabed, and subsoil (UNCLOS, 1982, S.4.48). The area is 1.5 times larger than the Netherlands' mainland, see figure 5 (European MSP platform, 2022). The Dutch North-Sea area is particularly suitable for studying intellectual capacity in MSP and its ability to govern OWF development. This suitability is due to the relatively early use of MSP from 2004 on (with adoption of the spatial planning memorandum), and the extremely extensive

use of Dutch sea-space (Spijkerboer *et al.,* 2020). Due to the expectations that existing sectors will grow, and new sectors will emerge, space in the Dutch EEZ becomes increasingly scarce, and stakeholders more plentiful. This increases the complexity of devising strategic and integrated spatial plans, policies, and knowledge.

Figure 5: A simple representation of the Dutch EEZ within the wider North-Sea (European MSP platform, 2022).

5.1.2. OWF development and planning from 1991 to 2022 and beyond

Before the first commercial OWF was developed several wind turbines were placed as pilot projects Between 1991 and 2004, in Dutch waters (Rijksoverheid, 2022). The first commercial OWF (Windpark Egmond aan zee) came in operation in 2007 within territorial waters (Rijksoverheid, 2022). Since the year 2000, the national waterworks management act (Wet beheer rijkswaterstaatswerken), now the water act (waterwet), also applies to the EEZ (WTW, 2009). The water law clarified the rules for the first wind park outside of territorial waters, wind park Amalia, operational since 2008. In 2004, the water law was adapted allowing OWF developers to apply for licenses anywhere in the Dutch EEZ, constituting the first instance of Dutch MSP (Wet windenergie op zee, 2015). In 2009, a government-led structure with special wind energy areas replaced the system of OWF planning. Special wind energy areas are assigned in the national water plan, which is revised every six years (Wet windenergie op zee, 2015; Spijkerboer *et al.*, 2020: I&W & EZK, 2015; I&W *et al., 2021*). The new, government led planning system was refined and clarified with the offshore wind act (wet windenergie op zee) in 2015, see figure 1 for the current use of the Dutch North Sea where special wind energy areas are clearly delineated.

5.1.3. The current OWF planning system

This section explains and visualises the current OWF planning system and what knowledge is taken into consideration during which planning phase, see figure 6 for a visual representation of the process described. The current system of OWF planning starts with the appointment of OWF searching areas. These areas are selected using strategic environmental assessments to minimize the impact on nature and the obstruction of other uses of national importance, like shipping, sand extraction, and defence.

This assessment is based on the EU habitats directive and considers cumulative effects on the environment (I&W *et al.,* 2021). During the area selection phase, a preliminary allotment is established. Before the final allotment and plot decisions are made, more research is done concerning the possible functions of the area. The state has opened up OWFs for multi-use, and using several frameworks[1], an area passport is developed after the selection of areas. An area passport is a new policy tool introduced in the 2020 North Sea accord, and presents the preferred activities for multi-use, based on area-specific characteristics (I&W *et al.,* 2021; OFL, 2020; BZK, 2020). The tool has been used limitedly in practice due to its recent development, but aims to balance different North Sea activities and ecological values based on area-specific characteristics. This allows for better adapted MSP, since multi-use activities can be decided on beforehand. When determined as suitable for OWF development, areas are subsequently taken up in the North Sea program, a part of the Dutch national water plan which serves as the current MSP framework of the Netherlands (I&W *et al.,* 2021). This plan is revised every six years and contains the main lines for Dutch water policy and adhering spatial policies. Sometimes the plan can be revised, e.g., with the addition of the OWFs Hollandse kust Noord and Zuid in 2016. This also involves the setting up of a route map and publishing an order of tenders to allow the industry to prepare for the tendering rounds (I&W *et al.,* 2022). Afterwards, TenneT, the national energy grid-connector, starts working on the connection to newly selected OWF areas. During this period, specific plot decisions are made.

Plot decisions are legally required since 2015 by the offshore wind act, setting standards for production efficiency, safety, environmental protection, and coordination with other activities. In practice, this means that after area selection and the setting up of area passports by the government, extensive Environmental Impact Assessment (EIA) procedures are executed. These procedures are based on the environmental management act and are aimed to decide which conditions are required for the project to be licensed according to environmental standards. These EIAs are available for public inspection and appeal (staatsblad, 2015; OFL, 2022; RVO & BZ, 2022). After the EIA is completed, a plot for OWF development is decided. Subsequently, tenders are organised, allowing the winning party to obtain a license from 25 to 40 years, and start construction. This long-term operating license provides security for investors in the OWF sector. In the licensing phase, RWS functions as a one stop shop for licensing to make the process more efficient and transparent. Otherwise, OWF owners would need to acquire several licenses from an array of departments and governmental agencies (I&W., 2020B). RWS also performs the monitoring after construction in the WOZEP program which aims to understand the ecological impact of OWFs and is further elaborated in section 5.2. Both construction and operation are supervised by government agencies, construction can take up to five years (Rijksoverheid, 2022C).

While environmental conditions in EIA's have to be lived up to, cost-benefit calculations have high priority in tendering so far. Plots, which average at 350MW, go to the bidder with the highest expected productivity based on the Offshore Wind Act (wet wind op zee, 2015; EZK, 2015). In the latest plot decisions, the increased efficiency of turbines allowed for conditions of nature inclusive building and multi-use to take higher priority (RWS, 2022A). According to participants in focus groups, this trend of increasing ecological priorities is like to continue in the future. Plots are connected to electricity outlets constructed in the selected areas, which feed the produced power into the energy grid. Afterwards, the operation of OWFs is closely monitored to look for conditions of productivity, safety,

[1] Policy framework passage and multi-use. Policy framework multi-use, Area reconnaissance and area passports, Framework usage areas reserved for sand-extraction, and framework license-required activities North Sea.

and effects on the bio-physical system. Finally, after licenses expire, OWFs have to be decommissioned. Currently, the only consideration for decommissioning is the obligatory full removal of the OWF, for which the owner has to proof financial capacity during the operation period. For a visualization of the planning phases described above, see figure 6.

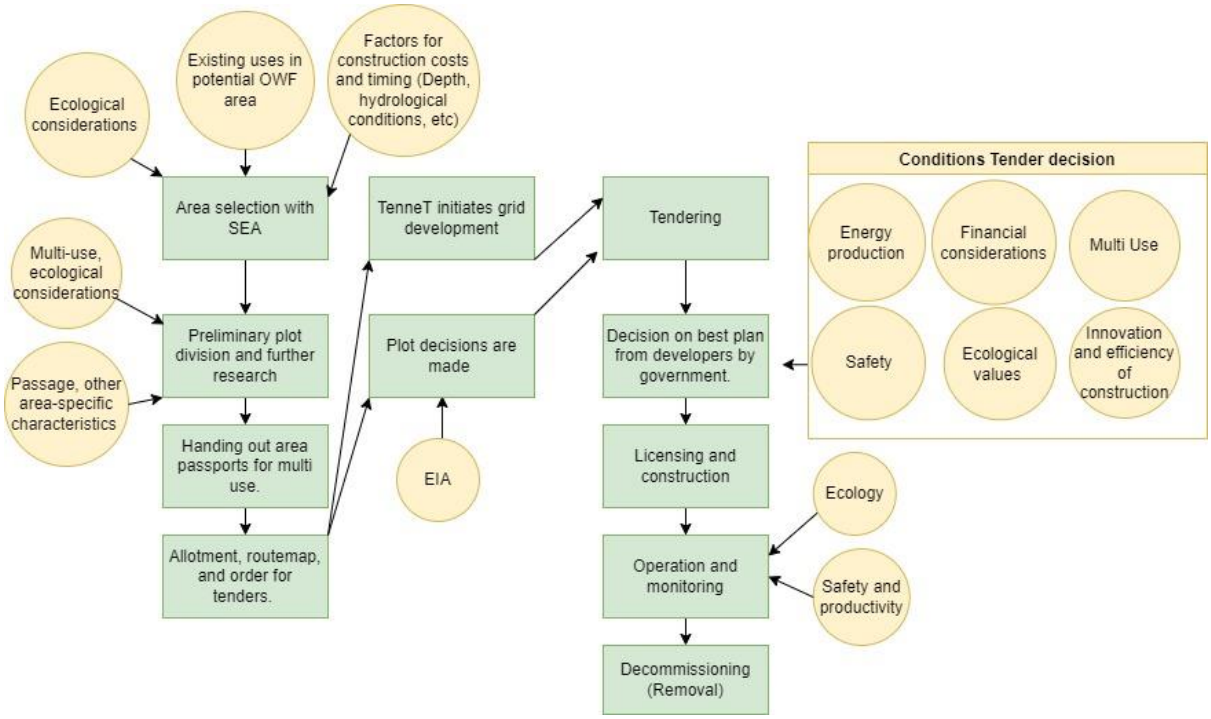


Figure 6: A visual representation of the Dutch OWF planning process, the rectangles indicate steps of the process, the circles indicate considerations which are used for decision making in the step (Source: Author). As explained in this section, the figure demonstrates which steps are made in the planning process, and which considerations influence the decisions made. This gives an overview of which knowledge is used in what part of the planning process. It is important to keep in mind the extensive critique on the knowledge bases and inclusion in this process.

Concerning the OWF development system, several relevant plans are currently being developed and discussed: the wind energy at sea route map 2023, plans for Dutch energy self-sufficiency in 2050, a timeline for tenders till 2030, and the wind at sea route map 2040, which contains plans for the development of 38-to74 GW worth of OWFs in the Dutch North Sea (RVO 2022). Additionally, the geopolitical threat and rise in energy prices resulting from Russia's invasion of Ukraine, have given cause for the Dutch government to double the planned capacity of OWFs by 2030 to 21 GW in March 2022 (Rijksoverheid, 2022; European commission, 2022). These developments are taken up in the national water programme 2027 (I&W *et al.,* 2021). A list of all established and planned OWFs in the Dutch North-Sea is provided in table 5.1.

Finally, concerning the division of OWF development phases, it becomes clear that there is great attention for ensuring quick development and innovation by ensuring the inclusion of the sector. Efficient, transparent, and secure development for investment is ensured and basic legal requirements for ecological protection are rooted in the system. It has to be mentioned however, that during focus groups FG1 and FG2, some critique was uttered concerning the facilitation of knowledge uptake in the OWF development process. Scientists and policy makers alike indicated that political ambitions are sometimes unrealistic when put in the context of scientific possibilities.

Additionally, the limited time available for knowledge uptake was often shorter than necessary due to the lack of early inclusion of scientists in the policy process. As such, participants indicated that it is very important for policy makers to know what the ambitions of politicians are, this is largely driven by international agreements. Additionally, it was indicated that: science is needed to develop realistic ambitions and to counter disrupting ideas. Participants also mentioned that politicians should start by looking ahead and deciding which knowledge they will roughly need at what point so that scientists can adapt to it. Currently, this is often asked in too short a term. The key is therefore proper timing in commissioning knowledge tasks.

Table 5.1: A list of all OWFs developed and planned in the Dutch part of the North Sea (RVO, 2022; EZK, 2021; I&W *et al.,* 2021).

Windpark	owner	Turbines	Output (MW) turbine	Output (MW) Park	Date plot decision	(expected) Date of commissioning	Distance to shore (Km)	Year of Decommissioning
Egmond aan zee (OWEZ).	Noordzee Wind	36	3	108	Does not apply	2007	13	2027
Princess Amalia.	Eneco	60	2	120	Does not apply	2008	23	2028
Luchterduinen	Eneco	43	3	129	Does not apply	2015	23	2035
Gemini	Northland power	150	4	600	Does not apply	2017	85	2037*
Borssele 1&2	Ørsted	94	8	753	08/04/2016	2020	23	2046
Borssele 3&4	Blauwwind	77	9,5	731	03/09/2016	2021	55	2047*
Borselle 5	Two towers	2	9,5	19	03/09/2016	2021	20	2047*
Hollandse kust Zuid 1&2	Vattenfall	76	11	760	08/12/2016	2021	18,5	2047*
Hollandse kust zuid, 3&4	Vattenfall	76	11	760	19/01/2018	2023	18,5	2050*
Hollandse kust Noord, 5	CrossWind	69	11	759	09/05/2019	2023	18,5	2050*
Hollandse kust west	**	***	***	1400	01/04/2022	2024	51	2051*
Ten noorden van de waddeneilanden	**	***	***	700		2026	56	
IJmuiden ver	**	***	***	4000		2027	53	
Lagelander	**	***	***	4000		<2030		
Nederwiek	**	***	***	6000		<2030		
Doordewiek	**	***	***	4000		<2030		
NorthH2	Gasunie/Shell	***	***	10.000		2040		

*The exact years of decommissioning for these windfarms were not discovered, as such decommissioning years are based on the length of the license provided.
**The owners of these wind parks, still have to be determined in tendering rounds, see figure 7.
***While we do not know the technical specifications of these future windfarms, the current maximum number of turbines in an OWF is 60, while the minimum MW per turbine is set at 14 (RWS, 2022A). This could change in the future and NorthH2 is probably an exemption due to its high planned capacity.

5.2. UNDERSTANDING THE SYSTEM OF KNOWLEDGE PRODUCTION AND UPTAKE OF DUTCH OWF DEVELOPMENT IN POLICY AND DECISION MAKING IN MSP

After creating an overview of the Dutch OWF planning process in the section above, this section aims to foster understanding of the system of knowledge uptake in Dutch OWF development and policy and decision making in MSP. The section presents an overview of knowledge uptake, the organisations and institutions involved, and a classification and description of relevant knowledge programs for OWF planning. Understanding the complex and dynamic system of knowledge uptake is vital to consider the roles played by the aspects of intellectual capacity, which is done in section 5.3. This section attempts to unravel the current knowledge flows, using findings from document research, interviews, observations and focus groups. While the next chapter will present results on the aspects of intellectual capacity in more detail, some indications of the aspects' situatedness in the Dutch system are already provided here.

The development and uptake of knowledge in Dutch OWF planning and policy and decision making in MSP is complex. Many parties, stakeholders, and governmental organisations and departments are involved. Additionally, the dynamic knowledge situation leads to constant changes in both content and process. To make sense of this process, the knowledge uptake process is presented in several parts. First, the overarching socio-political system is presented, special attention is paid to the role of the NZO as stakeholder platform (figure 7). Afterwards, the different organisations involved are discussed, separated in knowledge developers (figure 8), and knowledge users (figure 9). Afterwards, the knowledge programs are categorized and their relation to the organisations involved are explained (Figure 10). Then, the relation of knowledge users to knowledge uptake in the different phases of the OWF planning process is elaborated, and the different policies resulting from the process are presented (figure 12). All parts are combined in figure 13, which presents a simplified visualisation of the knowledge uptake process in OWF development and policy and decision-making in MSP.

5.2.1. Socio-political context

The need for better knowledge uptake discussed and analysed in this thesis ultimately stems from changes in socio-political priorities. The desire to halt climate change, and ensure energy security are strong socio-political priorities which politicians include in policy objectives, as mentioned in the introduction of this thesis (Rijksoverheid, 2021b; Rijksoverheid, 2022). These policy objectives influence ministerial departments and government institutions, conceptualised as knowledge users in this overview. Additionally, policy objectives serve as input for knowledge developers, like universities or research institutes, who are sometimes financed by knowledge users, and sometimes aim to do societally relevant research, see figure 7. The recent realisation that more knowledge is necessary, leading to increased budgets for research on the North Sea, can also be seen as a priority increasing in prevalence (I&W, 2020A).

For the further discussion on North Sea related policy objectives, Ministerial departments, public organisations, NGOs, and market stakeholders, come together in the Dutch North Sea talks. This stakeholder discussion body is of course influenced by policy objectives, but also jointly decides on new objectives in the North-Sea Agreement. The NZO also determines the research agenda of the newly envisioned MONS program (OFL, 2018, 2020A, 2020B, 2021; I&W *et al.,* 2021). The NZO therefore plays an important role in the Socio-political context, and in the integration of knowledge into policy, as well as between the parties involved. The NZO is elaborated on below.

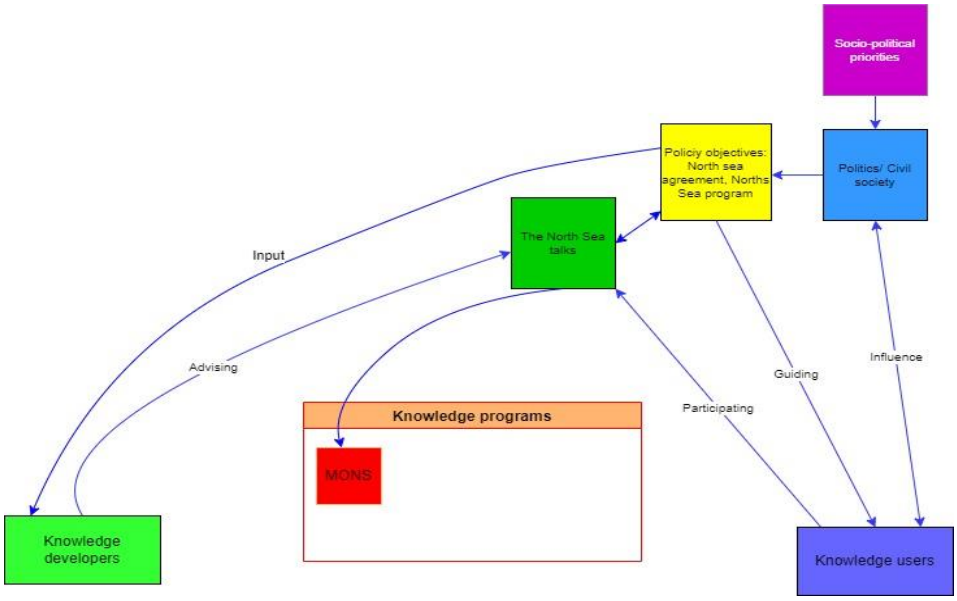


Figure 7: a visualisation of the interactions between the overarching socio-political context, and the knowledge uptake process, the figure will be put into a broader perspective later in the chapter (see figures 8,9,10,11, and 13). As can be seen, the NZO plays an important role (Source: author).

The North Sea Talks

A relatively new institution in the decision making on MSP which has significant influence on OWF development and other marine activities is the Dutch North Sea talks (NZO). The North Sea talks foster consensus-based discussion on the development of the North Sea Accord, in which the completion of three large transitions: energy, food security, and nature, are decided upon (I&W *et al.,* 2021; OFL, 2018). An interesting aspect of the North Sea talks is that it was not initiated by the state, but by a collection of stakeholders. According to P19, a policy maker in public managemet, these stakeholders came together at the behest of the North Sea foundation (Stichting de Noordzee), and took the initiative to form the NZO as a discussion body. The body does not have the status of a consultative body for the government, but as a discussion body where stakeholders and the government discuss on equal level. The initial members of the body were: Greenpeace, TenneT, NWEA, Visned, Nederlandse Vissersbond, Havenbedrijf Rotterdam, EBN, WNF, Vogelbescherming Nederland, NOGEPA, Natuur & Milieu, Stichting De Noordzee, KNAW, and the ministries of EZK, LNV, and IenW (OFL, 2018; OFL, 2020A).

The body is explicitly developed to foster cooperation and integrate knowledge between the different parties to develop a joint knowledge base and vision for the development of North Sea policy and the planning of the Dutch EEZ (OFL, 2018,2020A; I&W, 2020A). To ensure the effectivity, efficiency and continuity of the body, 15-20 members with high responsibility in their respective sector, are permanently assigned. Practice demonstrated that a joint sense of responsibility and trust is most apparent with a group of 15-20 members. Having too many members can pose a barrier to knowledge integration, while familiarity develops trust, as such membership time is set at a minimum of two years (OFL, 2020B). Another rule to ensure trust is the minimum extend of membership being two years, ensuring the development of personal relations between members. Relevant stakeholders outside of the NZO, like the ministries of BZK, OCW, and defence are included when decisions may affect them (I&W, 2020A).

Reciprocal effectivity for all stakeholders and procedural efficiency are key goals of the NZO (OFL, 2020B). As such, the North Sea Accord establishes joint responsibility for the process and agenda of the body. To attain efficiency, the NZO meets at the beginning of policy processes. This early meeting is seen as more efficient than critiquing policy in hindsight. It also ensures easier and more effective adaptation of policy by synchronising the policy processes of different stakeholders (OFL, 2018, 2020B). Aside from synchronising policy processes, the figuration of the NZO also compelled parties to develop joint positions. P19, policy maker public management for example indicated that: *'The different departments had to form a joint position. Ministries were initially not used to sharing the agenda setting of research programmes, taking long discussions to agree*'. The result is that a new system of deciding on research topics has not only been jointly agreed upon, but stipulates a new system of cooperation and knowledge integration. P19, policy maker public management also mentioned: '*government departments have different agendas concerning the North Sea, for some topics the political will to discuss it is limited, that is why we took up a passage that if the state develops policy which is not taken up in the North Sea accord, new talks have to be had.'* Through this focus on the process of the NZO, the permanently established North Sea Talks now ensure that new developments are being discussed with all stakeholders, contributing to the formation of joint goals and understanding. In light of the different knowledge types described in chapter two, this focus clearly demonstrates the recognition and uptake of procedural knowledge.

The NZO made a significant contribution to the integration of knowledge. The explicit goal of finding joint facts and common understanding, led to an integrated and comprehensive knowledge accord in which, according to P19, policy maker public management: *'the process was recognised to be as important as the content*'. During this process, stakeholders, while initially aiming for as large a part of the North Sea as possible were pushed to consider each other's positions through the structural and intensive interactions of the NZO. An interesting finding is the focus on knowledge of this body, agreeing on almost a quarter of the budget for the planning of the North Sea (€55 million) going to research in the MONS programme, a significant increase of the total amounts being spend on North Sea research. The body jointly agreed on the research agenda of the new MONS programme. The valuation of knowledge is also seen in the inclusion of an independent advisory board of scientists which advise with or without request, resulting in many examples where knowledge integration led to novel solutions (OFL, 2018; I&W *et al.,* 2021). This new standing as a discussion body leads to a balance of power where interests have to be weighed according to the existing contexts, which provides opportunities for knowledge integration, possibly even on a metacognitive level. These opportunities arise since parties jointly amass experience, jointly decide on (knowledge) goals and frameworks, and can learn from each other, which may lead to a recognition of different contexts, influences and circumstances (Keijser *et al.,* 2021; Flyvbjerg, 2003).

5.2.2. The organisations and institutions involved

The different groups involved in the process of knowledge uptake in OWF development can be categorized based on findings from interviews, focus groups, and document research: *knowledge developers* are organisations consisting of scholars, scientists, and researchers who study the biophysical system of the North Sea and the governance and socio-economic systems involved. Consultancies, research institutes, and universities fall under this category. These organisations provide research questions and personnel to knowledge programs.

Knowledge users are institutions and organisations like ministerial departments (LNV, I&W, EZK), government agencies (RWS), and the OWF industry (OFL, 2020A; I&W *et al.,* 2021; RVO, 2021). The governmental institutions and organisations use knowledge for the development of policy in the different phases of OWF development, and the industry uses knowledge to innovate OWF development and energy production (I&W *et al.,* 2021). Users provide financing, personnel, and research questions to the knowledge programs. Some overlap exists between knowledge developers and users since institutions like RWS, and ministerial departments also employ researchers of their own (Van splunder & Graafland, 2022).

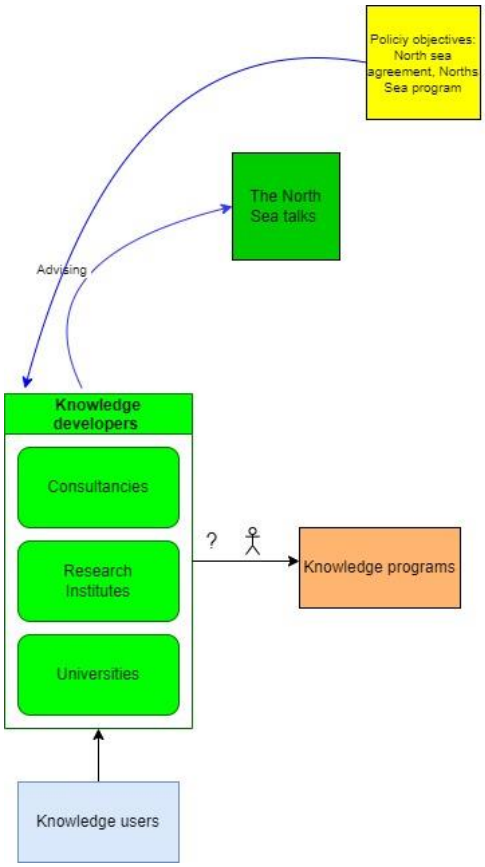


Figure 8: Knowledge developers, a simplified visualization of the organisations involved and their role in the knowledge uptake process (Source: author).

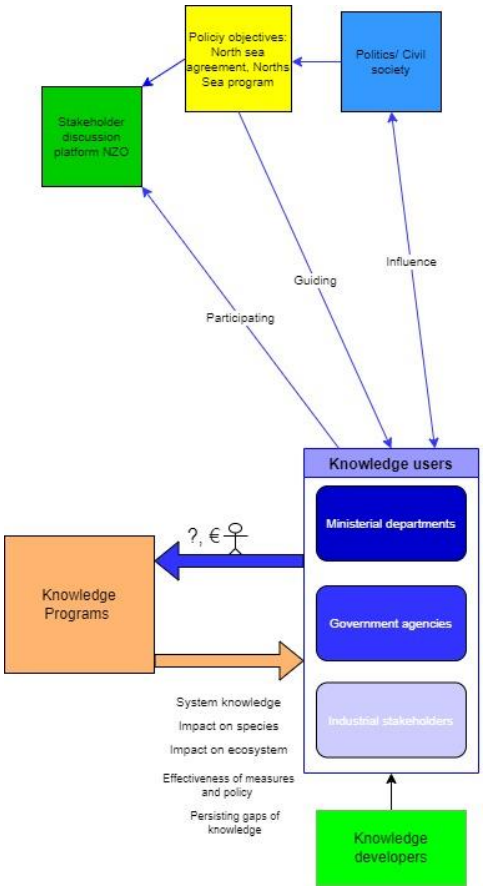


Figure 9: Knowledge users, and the factors that guide and influence them (Source: author).

5.2.3. Knowledge programs

Knowledge programs can be subdivided according to several categories: *legally driven programs* like MONS, KEC, WOZEP, MWTL, KNMI-Whiffle, and mission driven departmental programs, which are set up and financed by governmental organisation; *Programmes Subsidised by institutions* like EU, KNAW, and NWO; *Programmes subsidized with industrial funds*, including public-private cooperation like TKI-WOZ, and private programs; Finally, *universities* like the WUR, TU Delft, and RUG, also have their own research programs, sometimes financed by the universities themselves, and sometimes by knowledge users. Knowledge programs often employ knowledge developers and are often financed by knowledge users. Knowledge programs receive input from politics and stakeholders according to participant interviews and document research (NWO, 2020; OFL, 2018). Important findings for many knowledge programs are findings from monitoring research, which can shed light on the impact of OWF's and the effect of measures, this is further elaborated on in section 5.2.8. Knowledge produced in knowledge

programs, predominantly concerns impacts on the biophysical system, technological knowledge, and the effectiveness of measures. Considering the types of knowledge mentioned in chapter two it is noticeable that the official descriptions of knowledge programs predominantly mention factual and some conceptual knowledge. Particularly research subsidized by other organisations, universities, and the MONS, also show more use of procedural and metacognitive knowledge (Noordzeeloket, 2016; van Splunder and Graafland, 2022; RWS, 2019, 2022; I&W *et al.,* 2021; Informatiehuis marine, 2022; OFL, 2021; NWO, 2020, 2022). Due to the immense amount of research programs and projects concerning OWF development on the North Sea, this section cannot possibly describe them all. Therefore, the most relevant for institutional knowledge uptake are described below.

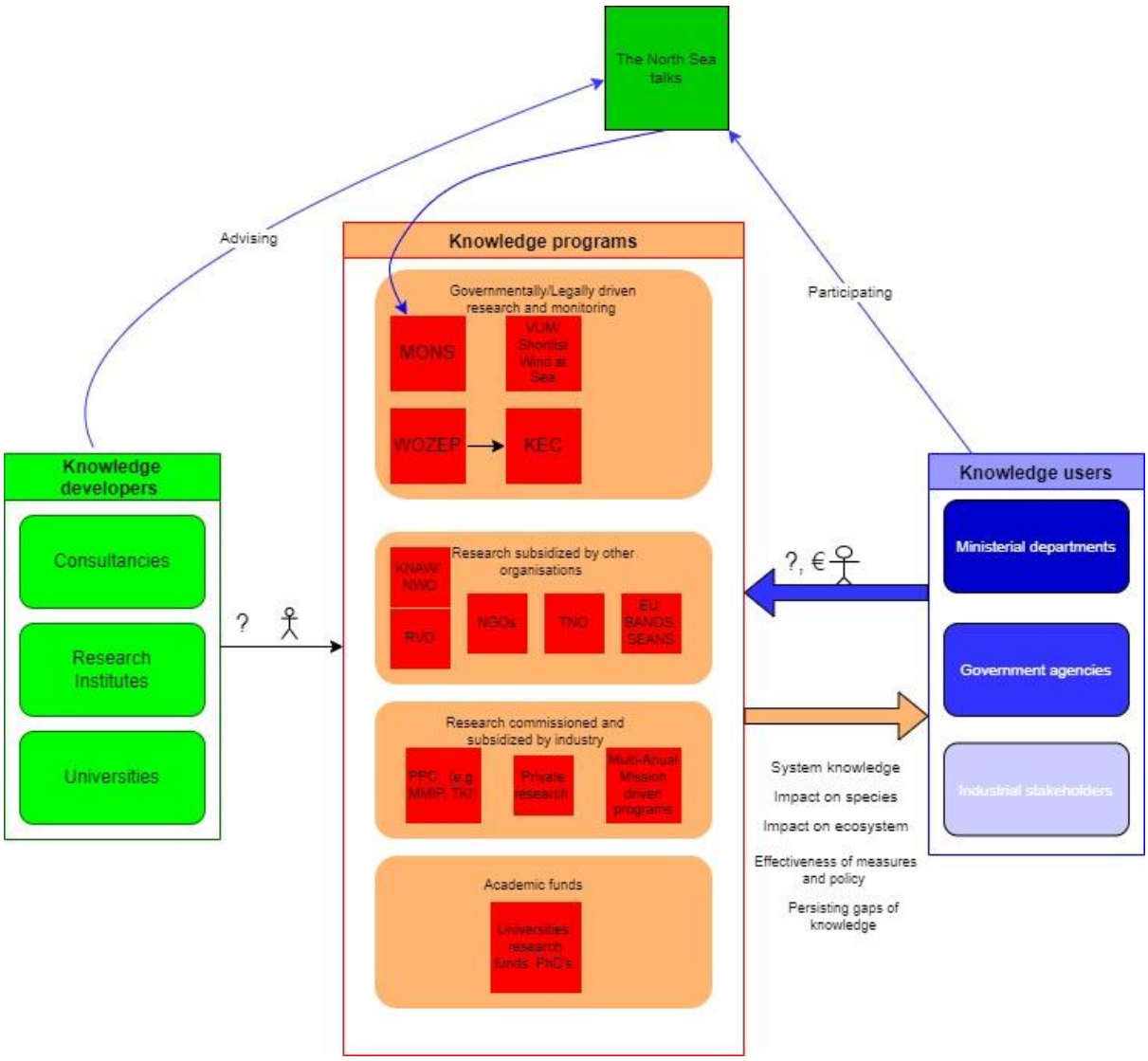


Figure 10: A simplified visualization of knowledge programs and their connection to Knowledge developers, knowledge users and the NZO (source: author).

5.2.4. Legally driven knowledge programs

Legally driven knowledge programs are initiated by governmental institutions like ministerial departments and other government agencies. These institutions are also the main users of the knowledge produced in these programs. The most prominent programs are described below.

WOZEP

The wind at sea ecological program was initiated in 2016 to streamline the monitoring and evaluation of OWF impact on the ecology (Noordzeeloket, 2016). Initially, this was separately done by OWF owners before being centrally organised by EZK in WOZEP. This system allows for more transparency and reduces costs. The goals of the programme are to improve the current ecological situation, provide future insights, reduce uncertainties about the effect on populations, and evaluate mitigation measures (van Splunder and Graafland, 2022). EZK is the main knowledge user of WOZEP, who initiated it to ensure that OWF development remains within the boundaries of ecological capacity. The programme is executed by RWS, which is responsible for contact with knowledge developers[2] through window-contracts.[3] The program is meant as a mediating body between policy-makers (Knowledge users) and researchers (knowledge developers), ensuring the efficient use of knowledge over time, see figure 8. The programme is focussed on the cumulative effects of OWFs, and does not consider other activities. Since not everything on the North Sea can be studied, the programme is geared towards the identification of bottlenecks which hold back policy.

P16, a policy maker North Sea policy and research indicated several examples of how knowledge from WOZEP is taken up in policy*: 'The results of WOZEP can be used in several ways: 1. Mitigating for nature by adapting placement conditions, 2. Putting down norms, 3. Specifically protecting species through directly applied mitigation'.* Document research demonstrated that in several occasions knowledge from WOZEP found its way into policy that protects species and habitats taken up in EU directives: 1. The amendment of plot decisions for Borssele and Hollandse kust, getting rid of the maximum size of Wind turbines; 2. New norms for construction sound in plot decisions which keep in mind the temporally fluctuating vulnerability of species (RWS, 2019, 2022); 3. Based on accepted Level Impacts (ALI's) and flight patterns, the management of rotor speed has been adapted to bat flying patterns, resulting in less fatal collisions with less loss of efficiency for the parks (van Splunder and Graafland, 2022; RWS, 2021). This demonstrates that existing policy-goals of habitat and species protection indeed enjoy knowledge uptake from the new WOZEP programme in a transparent manner. WOZEP is based on the nature conservation act. According to P7 an ecosystems and sediment dynamics scientist, the programme is to be integrated into MONS in 2024. This will lead to a more integrated and holistic overarching programme which keeps the impact of OWFs and other activities in mind. While the programme itself deals mostly with factual and conceptual knowledge, its improved setup and the increased focus on cumulative effects demonstrate the inclusion of procedural and metacognitive knowledge.

[2] Deltares, NIOZ, and Wageningen Marine

[3] A window contract is a contract that guarantees investment, ensuring assignments over time. In this case it allows knowledge developers some certainty, which ensures the reservation of capacity for this specific task.

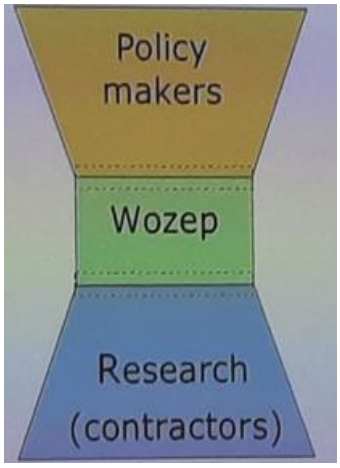


Figure 11: WOZEP functions as a mediating organisation, aggregating, interpreting, and selecting knowledge before it is provided to policy makers (Source: van Splunder & Graafland, 2022).

KEC

The Framework for Ecology and Cumulation was first drafted in 2015, and has known a total of 3 revisions (I&W *et al.,* 2021). The current version, KEC 4.0 2021-2022, was initiated in 2021 (Noordzeeloket, 2021). KEC uses the findings from WOZEP to consider the cumulative effects of OWF construction and operation on protected species in the North Sea until 2030, as such it has a heavy focus on conceptual knowledge. KEC has to be consulted in the decision making concerning OWF placement and operation in selected areas for OWF production (I&W *et al.,* 2021). KEC is specifically meant to be reframed based on future findings from WOZEP. KEC only considers OWFs, and focusses on protected species instead of the North Sea ecology as a whole. Therefore, it cannot be called fully holistic or integrated. However, the position of KEC demonstrates a focus on knowledge uptake. It demonstrates that newfound knowledge on cumulative effects will be directly included into new plot decisions. The goal of KEC is to prevent cumulative issues in the future leading to limits of development. It therefore also includes future, non-licensed OWFs, see table 5.1 (Van Splunder & Graafland, 2021; I&W *et al.,* 2021). Despite the limited scope on OWFs only, the long-term goals of KEC contribute significantly to knowledge uptake, since it has to be directly consulted when performing EIAs for specific site decisions. KEC is based on the nature conservation act (RWS, 2022B).

Program digital twin of the North Sea

RWS is developing a digital twin of the North Sea. The project requires great amounts of data to model the biophysical system of the North Sea. This includes ecological, hydrological, meteorological, and technological data as well as data on shipping, sand extraction, fishing, and other activities. Through the maritime information provision service point (MIVSP), measuring technology is deployed all over the North Sea to attain the goal of a digital twin, the data driven nature means a focus on factual knowledge (Informatiehuis marine, 2022). In the Netherlands many of the different activities at sea are overseen by different ministries, I&W is for example responsible for shipping and LNV for natural protection. Therefore, it is interesting to note that P20, Policy maker environmental management indicated that the specific research being done in the program depends on funding from ministries '*In previous years a lot of shipping data was collected since I&W paid a lot, now LNV has finally joined and more ecological data gathering points are installed'.* This demonstrates that the sectoral divisions between ministries also influence the development and uptake of knowledge in those sectors. For an integrated project like the digital twin this can cause delays, biases, or incomplete data concerning certain activities.

MONS

The newly established research program MONS, is aimed at determining the ecological carrying capacity of the North Sea. The program is to provide an overarching framework for research programs and impacts in the North Sea, (OFL, 2021). The research programme of the MONS is decided by the NZO in cooperation with experts to research the effects of the *energy, food, and nature transitions* on the North Sea. As such, this program looks at cumulative effects of many activities in the North-Sea, not just OWF construction and operation. However, considerations of MSP, and other spatial issues like sand extraction are not included, which constitutes a serious lack of integration when considering the North Sea as a whole (OFL, 2021). During focus groups it was indicated that MONS knows little continuity during its short existence, due to the rapid change of members and structure in its program committee, and expert group. If MONS is to fulfil its aims, a more continuous and structured set-up is needed. However, since departments and stakeholders jointly determine the research agenda, the integration of different knowledge, and establishment of joint knowledge bases and goals could be greatly improved by this program.

5.2.5. Research subsidized by other institutions.

Aside from knowledge programs based on legislation and funded by departments, several other research programs exist which are subsidized by institutions like the EU, NOW, and KNAW. While this knowledge is less often taken up in policy, these programs often look deeper into specific issues and solutions for these issues. Some examples are given below.

National scientific program ecology and North Sea

This program is set up and funded by the NWO. Its goal is to develop knowledge about the interaction between the ecology and the physical aspects of OWFs. Several projects are funded by this programme, the aim of which is to be inter and trans-disciplinary. Examples of these projects are *effects of windfarms on the marine ecosystem, and implications for governance,* and, *acoustic ecology of pelagic fish communities (Apelafico).*

Effects of windfarms on the marine ecosystem and implications for governance combines work packages on hydro and sediment dynamics, ecosystem modelling, benthic populations and governance to consider a holistic image of the impact of OWFs and how this can be considered in governance (NWO, 2020). *Apelafico* is aimed at considering the effect of Noise made by OWFs on pelagic fish communities and the development of an acoustic deterrent device that can prevent damage on these species (NWO, 2022).

Both these projects include many different knowledge developers, and from observations in consortium meetings of the first project, it becomes clear that through knowledge sharing in these consortia, researchers become more likely to consider knowledge from other disciplines and in this case the implications for governance. These considerations foster understanding according to participants interviewed, and can therefore simplify communication in knowledge uptake.

Strategic Environmental Assessment on North Sea Energy SEANSE

SEANSE is funded by the European Maritime and Fisheries Fund (EMFF), and focusses on the creation of a common environmental assessment framework for North Sea countries on which to base their MSP strategies and create better (knowledge) cooperation between European countries concerning OWF development (EMFFEU, 2020). The project took place between 2018 and 2020 and establishes

communication agreements, and joint targets for nature protection and OWF development in the North Sea. The program can therefore be seen as providing a joint knowledge base for the current status of the North Sea, fostering knowledge integration between countries in the region.

5.2.6. Research subsidized by industry

Industry is involved in research programs, some of which private and some of which through public private Cooperation like the TKI-WOZ and MMIP described below. Private research programs can be meant for innovation or to comply with ecological protection standards.

Multi-Annual Mission driven programs (MMIP)

Multi-annual Mission driven programs are based on Long-term visions deemed important for the development of the Netherlands. These programs are funded by government departments and industry and are an example of public-private cooperation. Based on the climate accord, the top sector for energy developed a MMIP for knowledge development for the optimization of Offshore energy production (Topsector energie, 2019). This program mostly concerns the technical optimisation of safety, energy production, multi-use, and integration into the energy system and the knowledge is mostly used by the industry and organisations like TenneT, focussing on factual knowledge (Topsector energie, 2019).

TKI-WOZ

Top Consortium for Knowledge and Innovation Wind at Sea connects to the MMIP by doing research into innovation, implementation and Match-making for OWF development. The programme cooperates with RVO and contributes to knowledge uptake by facilitating connections between knowledge developers and users through their practical research programs and match-making (Topsector energie, 2020).

5.2.7. Research by universities.

Universities often contribute to Knowledge programs as knowledge developers. Many universities like WUR and TU Delft Have specific OWF research pages, and do extensive research into the subject. Another way through which universities do research is by funding PhD candidate who study the topic, several PhD students are working on the topic at the RUG, WUR, TU-Delft, University of Leiden and Radboud University, according to respondents in FG2.

5.2.8. Knowledge uptake into policy; the different phases of OWF development and operation

Knowledge from the array of research programs mentioned is used by knowledge users to improve the planning and operation of OWF. Ministerial departments and government agencies take this knowledge up into policy. When new knowledge is considered valuable by departments, it can lead to changes in policy, as mentioned, different policy adheres to different phases of OWF development and operation, see figure 13.

Planning

Several different policy types influence the planning phase of *OWF development*. This phase is most often considered, since the fast and efficient development of OWFs is a main priority. Apart from its importance for Marine Spatial Plans, this phase receives so much attention since the placement of OWFs needs to be done right, the average turbine will stay in place for 25-40 years, and little can be

changed after its placement (RWS, 2016, 2019, 2022). Concerning the planning phase, area selection criteria can change based on new findings from Strategic Environmental Assessments during area selection procedures in MSP (I&W *et al,* 2021). Plot decisions also take place during the planning phase. An example of a change during this phase was mentioned by P17, policy maker nature and North Sea, who indicated that in some occasions less turbines were placed to leave space for birds to pass safely. Another example is the constant increase of the minimum size for wind turbines, which was found to reduce impacts on the environment, demonstrating the uptake of factual knowledge (RWS, 2016, 2019, 2022; EZK, 2021). The usage of knowledge in subsequent plot-decisions can facilitate a fast rate of knowledge uptake since a plot decision is necessary for every new license and new OWFs are licensed at a rate of 1 or two a year, see table 5.1.

Finally, during FG1 and FG2, participants indicated that the early inclusion of scientists in the policy process is extremely important for the tempering and enhancement of political ambitions. This could lead to more realistic policy ambitions, and a better inclusion of uncertainties, risks, and novel opportunities from research.

Construction and operation

Besides influencing the planning phase, plot decisions have a lot of influence on the manner of *construction*, for example the mitigation of noise and safety requirements. By monitoring the impact of construction, programs like WOZEP and MONS are able to determine improvements in the prevention of ecological impacts. An example is the obligatory adaptation of 20% of foundations to local wildlife as determined by EIAs in the plot decision for Hollandse Kust West (RWS, 2022). Other programs, like private programs, the MMIP, and TKI-WOZ, look at the efficiency of construction and operation, which is taken up by the industry. Aside from the plot decisions, knowledge finds its way into policy in the construction and operation phase, through the adaptation of license conditions, done by RWS. For example, the management of Rotor blade speed based on new findings on flying patterns by bats, and the obligation to cooperate with research for all OWF owners (RWS, 2019, 2022).

Decommissioning

For the decommissioning phase, plot decisions currently only stipulate obligatory financial means to remove the OWF, see figure 13 (RWS, 2016, 2019, 2022). However, many of the participants in this research indicated that a lot can be won by considering decommissioning now, e.g., artificial reefs could be made into new nature reserves.

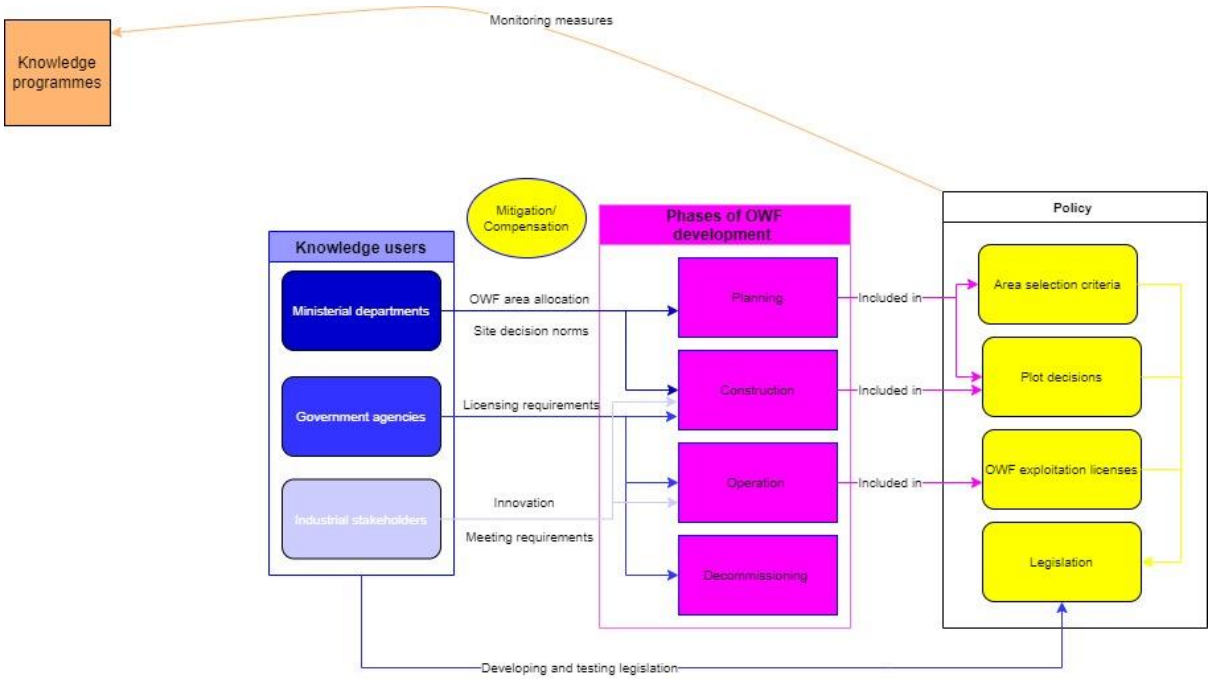


Figure 12: How knowledge users use knowledge to change policy for different phases of OWF development. As can be seen, departments can change policy based on new knowledge, sometimes these changes come in the form of mitigation and compensation after the initial construction. This can take the shape of amendments like the amendment of plot decisions (Source: author).

New knowledge Changing goals on the supranational level

Finally, changes to policy can be made by way of a revision of EU directives which identify goals to be attained by member states in their own right. Directives can be amended through delegated acts. Additionally specific decisions can be made, forcing a member state to take certain actions, but this has not yet occurred in MSP (McCormick, 2014). Another way to change legislation from a supranational level is through decisions at OSPAR[4], these come in place through unanimous vote and are basically voluntary per member state (BZ, 1993). These changes still have to be transposed into national law, which causes legislation to change (BZ, 1993; Foster, 2014; European commission, 2014). These changes often take place because new findings change the predominant socio-political objective at the European or North Sea region level (McCormick, 2014). Cooperation between North-Sea countries also gets increasing attention, for example with the creation of an official working group Marine Spatial Planning to improve this cooperation (I&W *et al.,* 2022). Since this study focusses on the Dutch case, inter- and supranational decisions will not be regarded in detail.

[4] OSPAR, or Oil Spill Prevention, Administration, and Response, is the Convention for the Protection of the Marine Environment of the North-East Atlantic. 15 Countries bordering the North Sea and its surroundings are members. The organisation has yearly meetings, and several sub-committees and is meant to establish better regional cooperation concerning the environmental protection of the North-Eastern Atlantic.

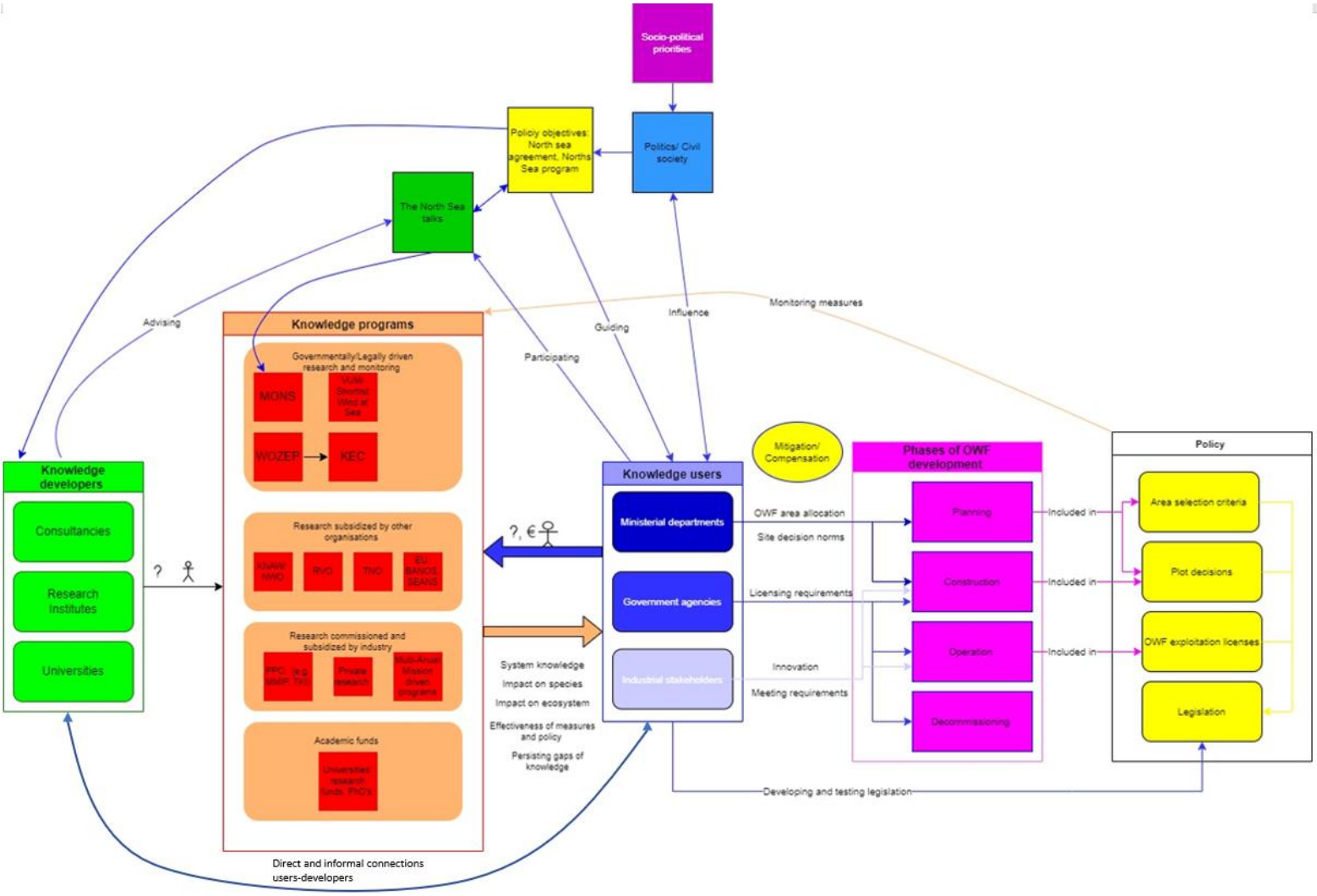


Figure 13: an overview of knowledge uptake and generation in Dutch OWF development. Together with the descriptions of its separate sections above this figure helps to unravel the current process of knowledge uptake in MSP (based on: Vreugdenhil *et al.,* unpublished).

Amending, compensating and adapting

As mentioned, significant changes in OWF policy and legislation are difficult. OWFs require large investments of both time and money, and the energy produced is extremely important for our society. As such, licenses are given for periods of up to 40 years to provide security for investors and energy production. But what happens when existing OWFs no longer comply with updated policy requirements? Officially, the Ministry of LNV (Landbouw Natuur en Voedselkwaliteit; Agriculture, Nature, and Food quality), can indicate the necessity of compensation and mitigation measures in case of negative environmental effects, going as far as revoking the license entirely according to article 17 of the offshore wind act (Wet wind op zee, 2015). As indicated by P17, policy maker nature and North Sea: '*we are looking into the possibility to compel new decisions to existing wind parks, but in reality, this depends on collaboration with market parties and is difficult to enforce legally. As such, new findings are usually added when placing new wind farms in the next round*'. Additionally, several participants noted that adapting OWFs after construction is always more costly than including new designs during construction. This practical reality further underlines the need to include as much knowledge as possible in the plot decision and area selection, since adaptation when OWFs are built is always more expensive and legally complex. Some changes have been made to the licenses of

existing OWFs with the 2021 amendment of plot decisions for borssele 1,2,3, and 4, as well as Hollandse kust North and south, but these are minor. Examples can be the adding of measuring installations, changing rotor blade speeds in certain circumstances, or slightly adapting plot boundaries (RWS, 2021). Mostly new findings are thus brought into policy in new plot decisions and national water programmes, although this seems to happen mostly based on factual knowledge. This demonstrates that while there is a legal possibility to make adaptations to OWFs after construction, the inclusion of knowledge in policy before construction is always preferable. As such, while opportunities for adaptation later in the planning process should be explored, the planning phase of OWF development is the most suitable for knowledge uptake. Especially when keeping in mind the mentioned desire of focus group participants to include scientists in the development of ambitions.

5.3. KNOWLEDGE UPTAKE: FINDINGS CONCERNING THE ASPECTS OF INTELLECTUAL CAPACITY

In this section, the results concerning the different aspects of intellectual capacity gathered from desk research, interviews, observations, and group model building are presented and discussed. Based on the theoretical framework, this section presents the presence of aspects of intellectual capacity in Dutch OWF development and MSP. The results are presented in the following order: knowledge integration, double loop learning, single loop learning, and system understanding. This order is based on the significance of the results concerning knowledge uptake, allowing later sections to refer back to findings with implications for multiple aspects. The section considers the current inclusion of the aspects of intellectual capacity in the Dutch MSP and OWF development frameworks. This will be considered by presenting policy goals, system changes, and changing frameworks as well as efforts and instances of knowledge integration mentioned in sources. The findings are triangulated with the indications of experts from interviews and focus groups to reflect their actual contribution to knowledge integration and learning.

In some cases, findings pertain to several aspects of intellectual capacity or to the relation between them, the structure of discussing findings per aspect is therefore not always adhered to. The implications of these findings for knowledge uptake are discussed at the end of every section. What this entails for knowledge uptake as a whole including a consideration of opportunities and barriers, is further discussed in the chapter six.

5.3.1. Knowledge integration

According to knowledge integration theories, the alignment and bundling of knowledge are necessary to holistically inform policy and promote joint, integrated visions among scientists, among policy-makers, and between scientists and policy makers (Farooq, 2018; Healey, 1998; Cars *et al.*, 2017). The theory of this thesis stipulates four conditions for knowledge integration by Janssen *et al.,* (2014), as establishing the integration of knowledge into policy: *1. knowledge development should take place at close distance to the policy process and include intensive interaction, 2. Multiple iterations are needed to foster policy integration, 3. Integration at policy level requires structural embeddedness to endure, and 4. Tools are required that allow for an integrated assessment.*

This thesis does not aim to identify specific bodies of knowledge like ecological knowledge, hydrodynamics etc., and the exact manner of their integration into policy. The focus is on the capacity for knowledge integration in the processes of OWF development and knowledge uptake, see figure 6 and figure 13. This section therefore considers whether the conditions of knowledge integration are

fulfilled by the current system and whether this differs among scientific disciplines, among policy makers, and between scientists and policy makers. Additionally, this section presents institutional efforts to improve knowledge integration, and how policy documents and participants suggest to organise its improvement. The four conditions for successful knowledge integration will be used to structure findings. Then, findings are presented on international knowledge integration. Afterwards this section pays specific attention to the communicative relationship between scientists and policy makers, and its effect on joint goal setting and knowledge integration. The section ends with a discussion on the implications of this section's findings for knowledge uptake in Dutch OWF development and MSP.

(1) Knowledge development should take place at close distance to the policy process and include intensive interaction.

Below, findings are presented concerning the distance between science and the policy process, and the degree of interaction between them. Several insights and their implications for knowledge integration and uptake are presented. Participants indicated that both governments and scientific organisations are paying increasing attention to the integration of knowledge between organisations. This is also increasingly seen in policy documents (I&W & EZK, 2015; I&W *et al.,* 2021). Below we first consider the integration of knowledge between government departments, then between scientific disciplines, and finally between scientists and policy makers.

First, concerning the interaction between policy-makers, several policy advisors specialising in the North Sea and OWF policy all mentioned intensive interaction between departments. Additionally, the joint position of departments in the NZO mentioned in section 5.2, also compels interaction, and the formation of joint positions between departments. As such, departments indicate intensive interaction, but from the responses of policy makers we can deduce that shifts of responsibility between policy makers reduce the opportunity for developing joint visions, methods and goals between departments. These shifts are seen during the last couple of parliaments, where different departments have had the responsibility over the North Sea.

Second, when looking at the interaction between different disciplines it becomes apparent, as mentioned in section 5.2, that the creation of interdisciplinary consortia contributes much to joint understanding between different parties. From O1, O2, and O3, as well as interviews with its participants, this research found that most scientists are significantly interested in the research of their colleagues. Generally, it was clear that most scientists had less affinity with the governance part of the research, but were very interested in its implications. This demonstrates that the inclusion of a governance work package in a research consortium might increase the interest in and understanding of government implications among scientists, furthering the capacity for knowledge uptake.

Third, when asked about the interaction between scientists and policy makers, most scientists and policy makers among the respondents indicated that a close interaction between policy makers and scientists greatly contributes to knowledge uptake. P9, a Marine systems and MSP scientist for example mentioned: '*In my current position I have more direct contact with policy makers, often based on policy questions, this makes cooperation a lot easier. The manner of contact is often dependent on the governmental body and the case'.* P18 Policy maker North Sea indicated: '*I do not see the separation between research and policy so clearly, at WOZEP we feel the research headache when uncertainties arise about the placement of more OWFs'.* P10, a marine and coastal management scientist said it in a very direct manner: '*Trust between organisations and individuals is the first*

condition for knowledge integration to be successful, therefore, personal relations contribute to knowledge uptake' participants from several departments and government agencies mentioned specific contact with research institutes, P18 Policy maker North Sea for example mentioned: '*We have a lot of contact with institutes like NIOZ and Deltares about turbidity, this helps to get answers efficiently'.*

A great contribution to the closeness between different parties is the described structure of the NZO. While the NZO is not a knowledge body, it demonstrates a high valuation of knowledge, explicitly formulating the integration of knowledge as a goal. Subsequently, the rules of the NZO, made to foster knowledge integration and trust between parties, significantly contributed to the closeness of interaction between the parties involved. The rules mentioned in section 5.2. enforce a minimal membership of 2 years, considerations of the size of the body, regular meetings of stakeholders, and the high responsibility of members in their particular departments and sectors all contributed to proximity between the discussion body and the policy process. Combined with the mentioned position of the scientific committee, these regulations demonstrate the ambition of the NZO to establish joint understanding and integrate knowledge. Such regulations demonstrate awareness of procedural knowledge and can contribute to improved knowledge uptake by fostering joint understanding.

However, not all institutions seem to be closing this distance between science and policy. Based on results, the mentioned structure of the WOZEP programme, as an intermediary interpreting body before integrating knowledge, can be seen as increasing the distance between science and policy, despite the increased policy efficiency that it brings, see figure 7. It is therefore important for WOZEP to keep scientists and policy makers well-connected, separate research in the effect of WOZEP of intermediary would be necessary before drawing conclusions (Van Splunder & Graafland, 2021).

All in all, intensive interaction was generally perceived as positive by both scientists and policy-makers among our participants, but not considered as sufficiently established by all. P16, a policy maker North Sea policy and research indicated that in general involvement of scientists in the workings and interests of policy are a great contribution, but some more of this involvement is desirable *'Scientists joining for policy conferences is for example a great addition to mutual understanding and cooperation between science and policy because scientists become involved in what is necessary for policy. For example, joining an OSPAR meeting on acidification of the sea, or a meeting on an assessment of natural capital in the sea. This really fosters understanding'.*

This desire for more involvement by scientists was mentioned by more policy makers. In some cases, the lack of joint understanding and trust can result in frustration. P17, policy maker nature and North Sea, notes '*Sometimes, more attention of scientists for the actual policy question at hand would really help us. In one case my department had a research assignment set out and when I called the research organisation to see how the research was going, they told me to wait until the release date'.* Another example of this is given by P15, a policy maker Offshore Wind: '*It is nice to have some informal contact with researchers, it is less nice when you ask an extra question for elaboration for example in a formal setting, and researchers ask automatically for extra money0000p'.* These quotes demonstrate that close relations, trust and efforts to understand each other between researchers and policy makers are appreciated, and a lack of them can lead to frustrations and diminishing knowledge uptake. Additionally, it becomes clear that not all scientists are willing or able to foster close communication, which is a barrier to be overcome if knowledge uptake is to improve.

Concerning the stimulation of close contact and intensive interaction through formal or informal interactions, quotes above demonstrate an appreciation of personal relations. P15, a policy maker Offshore Wind mentioned that for intensive interaction to be fruitful, formal contracts were necessary. Especially since these are required for the uptake into policy: '*Research tasks or projects are set out in a formal way. Having a contract also ensures that one can make (more) agreements about the degree of research quality and deliverables., While informal talks allow for some deepening or reflection of ideas about policy. In the end ecological and environmental'*. This was repeated by P16, a policy maker North Sea policy and research: *'In general formal contacts open the door for more informal contact between researchers and policy advisors. There is more opportunity for this when from the policy side the initiative is taken to present policy questions which need research to answer these questions. For example: we have WOZEP meetings twice a year with stakeholders to present progress made in WOZEP-research questions and to present new policy questions. with WOZEP. Researchers are then of course also present.* It becomes clear from these results that close informal contact contributes to the integration of knowledge. However, formal and structural agreements are necessary to ensure the quality of research and adherence to the assignment.

Finally, several scientists mentioned that they rather just have contact via documents. P16, a policy maker North Sea policy and research also mentioned that policy advisors sometimes are not interested in scientific reports or have no time to read these reports*: 'both groups just want to do their work'.* This dependence of the quality of knowledge integration on individuals' willingness and organisational cultures was repeated by several participants. As P19, policy maker public management mentioned about the process of the NZO: *'In the North Sea talks it was important to have objectively minded people to ask for advise, so we discussed this with the KNAW and organised a sounding board committee with different experts. The personalities of those involved matter a lot for the role of knowledge, if people are willing to communicate and listen to each other, solutions are more easily found'.* This demonstrates that while some of the mentioned examples bring science and policy closer together, the degree of success can depend a lot on the individuals and organisational cultures involved.

(2) Multiple iterations are needed to foster policy integration

To ensure organisational alignment based on knowledge in different phases of the policy process, there is a need for iterative interaction among scientists and policy makers. The realisation that multiple iterations are needed for knowledge to be properly integrated is understood by organisations involved. This understanding is demonstrated by the regular meeting of departments and consortia, as well as the regular meeting between departments and programs like WOZEP indicated by participants (I&W *et al.,* 2021; OFL, 2018). Participants reflected this understanding, P3 an ecosystem modelling scientist for example mentioned: '*Iterative discussions are needed to align models, research results, and processes if we want to develop good understanding. A structural information or interaction construction should be developed for this'.*

This is also seen in policy, plot decisions mention that to incentivise the wind sector's interests, events are regularly organised between the wind sector and governmental organisations to present conditions for OWF licenses. While scientists do visit these events, they are not structurally included in this interaction (RWS, 2015, 2019, 2022). This limits the presence of scientists in the policy process and therefore makes the uptake of newly found knowledge less likely. Scientists could play an important role here, reminding governmental and industrial parties of the facts and uncertainties at hand.

From the findings presented in section 5.2., it becomes clear that knowledge uptake can best take place in the planning phase of the policy process. This implies that the integration of knowledge should occur at the very start of the policy process. The NZO adheres to this by aligning goals and procedures at the start of the policy process, ensuring easy organisational and policy alignment and allowing for an establishment of similar views and goals (OFL, 2018, 2020). While the NZO has limited discussion time and can therefore not meet iteratively on every topic, the base lines of policy see multiple rounds of discussion. For example, new knowledge goals like the research agenda of MONS, or new conditional frameworks for offshore wind parks like multi-use and nature inclusiveness, which also contribute to double loop learning. However, more desires for more and more structural iterations were voiced, like P18 Policy maker North Sea indicating the possibility to continue discussing about implications and adapting policy during the construction phase of OWFs, and P17, policy maker nature and North Sea, mentioning the desire to be updated more regularly by research organisations, either formally or informally. This demonstrates the desire to integrate knowledge throughout the policy process. As mentioned in section 5.2, this might be difficult to take up after construction has started. However, during the construction phase, some adaptations might still be included, and the continuation of knowledge uptake through all phases of research and OWF development could help align goals between organisations, and prepare decisions for the next round of development.

Concerning the need for these iterations, it is imaginable that the speed of the roll out of OWFs, and the speed of knowledge acquisition limits the timeframe for policy makers and scientists to discuss. P15, a policy maker Offshore Wind mentioned: '*The learning curve in policy depends on the out-roll speed. In my opinion we are already quite efficient and effective in taking up knowledge, but with the current speed of out-roll, which happens due to just reasons, the price of this speed is that we are possibly less effective as we could have been at a slower roll-out pace. This learning curve might be shortened with the increased use of modelling, like the digital twin North Sea.* This quote underlines that simply not all knowledge can be taken up in the planning phase of OWF development. Knowledge development is continuous, and the results of research cannot be rushed if the quality of findings is to be trusted, demonstrating a dilemma between security and flexibility. As such, the constant integration of knowledge, appears to be the best way to prepare findings for the next planning phase of OWF development.

(3) Integration at policy level requires structural embedding to endure

The findings in this section demonstrate to which extend policy integration is structurally embedded in OWF development. Firstly, the necessity to perform and refer to SEAs and EIAs in the design of OWFs in the Dutch part of the North Sea demonstrates that the integration of the knowledge considered in those procedures is structurally embedded. However, the embeddedness of other knowledge programmes, and the integration of knowledge among knowledge developers and users is less apparent from the descriptions provided in chapters 5.1. and 5.2. However, Both the 2016-2021 and 2022-2027 Marine Spatial Plans of the Netherlands indicate the need to integrate knowledge from different programs to avoid wasting effort and funds. Accordingly, WOZEP, KEC, and MONS are mentioned for the realization of this structural embeddedness (I&W *et al.,* 2021; I&W & EZK, 2015). This demonstrates that this condition for knowledge integration is recognized and acted on by the government.

Secondly, the permanent establishment of the North Sea talks increases the structural embeddedness of knowledge at the policy level. As mentioned in chapter 5.2, this ensures that discussions and scientific advice are had about any new North Sea related policy. It also ensures that decision and

policy makers discuss earlier in the policy process and include stakeholders earlier in the process (OFL, 2018, 2020B). The North Sea accord also indicates that the MONS program will provide an oversight of all knowledge programs, and relevant events, which was seen as a very important structuring element by participants (I&W *et al.,* 2021). P3, a sediment and ecosystem modelling scientist for example mentions: *'It is good to organise recuring conferences and events for certain topics, but most importantly, make sure it is clear what knowledge and what events exist to everyone and that everyone can join'.* The NZO could play an overarching role in this regard, ensuring that people from all levels of OWF planning and decision making are aware of the same knowledge bases and can participate in the same events and discussions. Certainly, sector-specific events and knowledge bases are necessary for knowledge development and specific uses. Here too, an overarching programme could help to ensure the structural embeddedness of knowledge integration, allowing interested parties to receive information from different sectors and disciplines.

Another example of succesfull structural embeddedness of knowledge is clarity, P8, an environmental assessments scientist indicated that the Dutch planning system provides this: *'Transparency greatly increases possibilities of knowledge integration. In NL this is structured through the one stop shop and single monitoring programs of RWS. This works better than in germany for example where licensing is a bit of a black box. In Denmark this is arranged even better allowing for quicker rollout, better informed policy and easier adaptation'.* While this ensures the integration of policy requirements and monitoring findings, it does not fully guarantee knowledge integration at the policy-level since there is no structural law that compels the holistic inclusion of knowledge. P19, policy maker public management mentioned: *'Complying with a structured role of scientists in discussions is important. Departments should not just ask a professor who agrees with them, but also listen to counterarguments.* As such, an objective consideration of all relevant knowledge is not guaranteed, meaning that the integration of knowledge into policy can be structurally biased towards prevalent political goals. Thus, if policy is to be informed in an unbiased and fair manner, this barrier should be overcome.

This worry about political bias is not the only barrier in attaining well-structured knowledge integration. According to several participants, the mentioned examples of knowledge integration through the NZO, the KEC, and MONS are little and late. P9, a Marine systems and MSP scientist mentions that better discussions are necessary between institutions to consider what can be integrated. Especially the government could have boosted integration long ago and should take action now: "*If problems arise institutional cooperation should be adapted to them, the government should have taken more initiative to attain this"*. As such, the government as overarching organisation should take more responsibility to ensure knowledge integration.

Answers from other respondents indicated that structural knowledge integration was sometimes encumbered by the shifting governance structure. P15, a policy maker Offshore Wind mentioned: '*The overtake of the project to different ministries can be difficult. In cabinet Rutte 2, the ministries of I&W and EZK were responsible, in Rutte 3 the responsibility was shared with also LNV and BZK. 4 ministries result in more attention for the topic, but it can be a challenge to get 4 ministries on the same page. In Rutte 4, BZK handed its responsibilities for OWF back to I&W, but is still responsible for the general spatial planning policy. Having 4 ministries share responsibilities like this can lead to a lot of discussion in governance, I am not negative about this, but it can sometimes be difficult to make effective policy in a short amount of time (due to the roll-out pace) in this way'.* Additionally, P12, a marine and coastal management scientist mentioned: '*ministries sometimes have conflicting interests, due to the sectoral*

division of ministerial responsibility. This all went wrong when the ministry for spatial planning was disbanded, it is a spatial planning issue and should be considered as such, I&W is supposed to do this but simply does not. An overarching party looking at the spatial dimension of the North Sea would be in a perfect position to integrate knowledge. Currently the NZO is the largest overarching party, but some issues like sand-extraction and delta-protection are not included in these talks'. These findings demonstrate that the departmental division of labour was not particularly geared towards structural knowledge integration or uptake in OWF development and MSP. Political considerations change over time, endangering the continuity of knowledge integration. The absence of an overarching body leads to a deficiency of structure when it comes to knowledge integration in OWF development and MSP. The lack of such a body with the authority to structurally integrate relevant knowledge into spatial policy can be seen as a considerable barrier to effective knowledge uptake. However, considering the other findings mentioned, considerable improvement can be seen in the last decade. Overarching knowledge programs like MONS and WOZEP as well as the NZO positively affect cooperation and discussion between parties and increase the focus on knowledge leading to improved comprehension and valuation of diffuse knowledge.

(4) Tools are required that allow for an integrated assessment

To ensure the integration of knowledge, tools are required which assess the success of this integration. Several tools which allow for integrated assessment like the NZO, MONS, WOZEP, and KEC, have already been discussed. Below the findings concerning these tools' ability to perform integrated assessment are discussed. The North Sea talks, through its broad membership with different viewpoints, interests, and methods is in a good position to assess the integration of knowledge. A contribution to this is the objective oversight by the scientific sounding board committee's competence to advise the NZO at own initiative. This means that information is shared among all stakeholders of the NZO for consideration, allowing the inclusion of relevant knowledge from all parties involved before decisions are made. This contributes significantly to the integration of knowledge and was appreciated by many of our respondents. P12, a marine and coastal management scientist indicated: '*the presence of a scientific sounding board committee in the NZO is really important'.* However, the scientific committee is not paid, casting slight doubts on its future consistency. The indicated benefits this board has for knowledge integration present an opportunity for knowledge integration. The board in question could be permanently established with appropriate compensation. Similarly competent boards could also be set up for other institutions to increase their ability for integrated assessment.

The KEC's focus on cumulative effects of OWFs on the North-Sea ecology contributes to integrated assessment. Ensuring that the effects of existing and future OWFs are in line with the law on nature protection (wet Natuurbescherming), and birds and habitat directive (I&W *et al.,* 2021). Despite this integration of knowledge on the effects of OWFs, the KEC receives ample critique concerning the selection of knowledge developed, included, and presented. Concerning KEC and in general, several scientists who participated in this research indicate that certain types of knowledge about OWF impact are not considered or not even openly shared by ministerial departments due to their absence from the mentioned legislation. In practice, knowledge is sometimes left out when its implications are too controversial or expensive. Some participants active in policy making as mentioned by two policy makers that simply not all knowledge can be produced or integrated, since departments are already at their maximum capacity of knowledge uptake. P15, a policy maker Offshore Wind mentioned: *'It is like having an exam about a 500-page book and only one night to study every time. It is just not possible to do it to the same degree as if you had 3 weeks to study.'*

This is repeated by P16, a policy maker North Sea policy and research: *'there is not always time for policy advisors to read research reports, these reports have less priority in such a situation which is a pity as results are often useful. And reports are also being paid by the government. On the other hand, researchers often really don't like reading government papers. Sometimes I make the joke: 'did you read the document the minister has send to the House of Representatives' about the topic? In general: we have to be careful that we do not put out more knowledge assignments than we can actually process.'*

This distinction between frustrated scientists and overworked policy-makers once again underlines the need for joint knowledge views. The maximum capacity of knowledge integration puts restrictions on what knowledge can be taken up. Increasing this capacity is an obvious solution but will take significant amounts of time and resources. At the other hand, the selection of the most important knowledge could minimize the loss of effectivity in informing policy. It is important to prevent policy-makers from ignoring relevant but politically inconvenient information. As such, the selection of important knowledge should be jointly decided on by the parties involved, and scientists should be present in these decisions. Thus, a more consistent and transparent tool for the assessment of integrated knowledge use is necessary. Particularly one which represents the interests of both scientists and policy-makers. P19, policy maker public management mentioned: "*Especially when doing a PhD, academics are checked on the validity and completeness of their data, something like that could also be done for knowledge use by ministries. A window contract between the KNAW (royal Dutch Academy of Sciences) and the government could be made to ensure the fair use of data".* In practice this could take the shape of a committee that determines to which extend data used in policy is fairly portrayed and complete, based on relevant research reports and other scientific publications as well as policy priorities.

International knowledge integration

With the realisation that the North Sea is a single system and requires advanced cooperation between countries in the region if the basin is to be planned in an efficient and sustainable manner, the need for international knowledge cooperation receives increasing attention. Most of our respondents repeated the need for international cooperation and knowledge sharing. Additionally, the policy document on the North Sea 2016-2021 already mentions the need for better international cooperation. The North Sea programme 2022-2027, pays explicit attention to the need for increased knowledge cooperation with other North-Sea countries to increase the amount of knowledge and the efficiency of its development, and to improve strategic cooperation between countries when developing wind farms and other infrastructure at sea (I&W *et al.,* 2021; EZK & I&W, 2015). To attain this, a professional working group for North Sea MSP collaboration has been formed to establish cooperation between North Sea countries. However, no specific plans for knowledge cooperation are mentioned. It is clear that for proper regional knowledge and practical cooperation a lot needs to be done. P13, a Marine Spatial Planning Scientist mentioned: '*In the Baltic Sea, international cooperation in marine spatial planning through various international projects has been going on for much longer compared to the North Sea region. HELCOM plays an important role in this, in my opinion. This is in contrast to OSPAR'.* While the cooperation between North Sea countries concerning MSP is increasing, it is still underdeveloped. This lack of clear and structural knowledge cooperation at the regional scale is even more apparent than the lack of knowledge uptake in Dutch OWF development and MSP. As such the lack of regional knowledge cooperation is the most significant knowledge gap identified during this research.

Communication and involvement between scientists and policy makers

This part presents findings on knowledge integration concerning the experiences of participants during the knowledge integration process between policy makers and scientists. This part presents opinions about the current process and preferred ways of contact to gain insight in opportunities, barriers, and possible improvements in the communication between scientists and policy makers. Several topics are listed below: preferred ways of presenting or receiving knowledge, interest in the work of the other side, and a realisation of what the other side needs.

The mentioned importance of individual personalities and the case at hand became more obvious after asking participants about their preferred ways of communication. P1, a estuaries and delta systems scientist mentioned: *'sediment research is mostly taken up through scientific articles and data bases, there is little direct contact needed. These articles have to be properly represented in workshops, user groups and eventually policy'.* This presents a stark contrast with some of the findings in sections above indicating the intensive interaction between policy-makers and scientists. P9, a Marine systems and MSP scientist mentions: *'I prefer direct communication with policy makers over the indirect uptake through articles, although it depends on the nature of the topic, case, and institution'* P2, a sediment dynamics modelling scientist indicates that he is not in direct contact with policy makers, but indicates an interest in the policy making process when it comes to the interpretation of his results: '*Clarity in model documentation is very important, though policy makers will likely not focus on model details. As a scientist, it is crucial to explicitly mention the limitations of your research models.'* P3, a sediment and ecosystem modelling scientist reflects on this: *'Humility is important as a researcher, of course you want your research to be taken up in policy but its limitations have to be clear'*, and P5, A marine ecology scientist indicates: *'Politicians, managers and scientists have to be aware of their limitations and failures if problems are to be solved'.* P3, a sediment and ecosystem modelling scientist also indicates that his link with policy is indirect through documentation: '*My own work is busy enough. Additionally, policy makers and politicians are not much involved in my research'.*
These quotes demonstrate that depending on the topic, researchers seem to prefer different ways of communication. The Modellers quoted indicate a preference of communication through documentation. This is understandable due to the predominantly quantitative nature of the research. Scientists preoccupied with planning, political, or organisational studies however, are mainly occupied with governance-related research, for which more direct communication may be more suitable in conveying knowledge.

Findings from O1, O2, and O3 demonstrate that some scientists clearly show less interest in the implications for policy than others. P6, a reef biodiversity scientist indicates that he too, is mostly in contact with policy makers through reports, but demonstrates a deeper understanding of policy needs, and willingness to adapt to it: '*I realize that policy makers have a lot to read, so it is important to provide clear and short indications and visualizations of the scientific knowledge and data. When the reports are read, they are often followed up with questions to elaborate on certain findings, this is a few steps away from my primary research. When it concerns modelling reports with specific solutions or problems, policy-makers are more interested. Depending on the topic, shorter lines of communication exist. Awareness of ecosystem services might increase this interest.'* This recognition of policy needs in presentation, is exactly what was previously mentioned as desirable by policy makers. Similar differences in preferences can be found in the answers of policy makers. While our respondents were willing to communicate directly and get involved, they mentioned that this was not the case for all their colleagues.

Sometimes, communication issues between scientists and policy makers can lead to severe frustrations, as mentioned in quotations from policy advisors. Scientists can be particularly frustrated when their research appears to be ignored, and it is unclear why. P19, policy maker public management indicates: *'the relationship of researchers with the government is often a black box, it is often unclear how knowledge is dealt with'.* P5, A marine ecology scientist recalls: '*During my career I have experienced pressure from ministries and institutions to leave politically unwanted knowledge out of reports'.* As such, it becomes clear that some given factors like the functional view of knowledge in policy-making, are frustrating to others. All in all, it becomes more and more clear that the process of knowledge integration matters a lot for the eventual interpretation and use of this knowledge. As P17, policy maker nature and North Sea, mentioned: '*a large part of the role of knowledge is determined by how you deal with it'.*

The implication for knowledge uptake here is that the preferences of individual scientists and policy makers matter a lot for the quality of knowledge integration. We see evidence of different epistemic communities: modellers use more factual and conceptual knowledge and prefer to communicate through documentation. Their opinions differ when it comes to interest in policy. Ecologists seem more aware of the preferred presentation of policy-makers, and governance experts prefer closer contact if suitable. P9, a Marine systems and MSP scientist summarizes it nicely by indicating that while he prefers direct communication, it depends on the case at hand.

Policy makers have a more functional view of knowledge, while scientists prefer to focus on uncertainties, leading to more knowledge development instead of plugging into policy. This can lead to difficult situations, if communication merely exists through documentation, scientists become less present in the debate, this means the value of their research is less represented. Additionally, if researchers are in less contact with policy makers, they may focus less on functional knowledge gaps required for policy. As P18 Policy maker North Sea indicated: '*researchers could really help by staying independent, but keeping an eye on what is possible, and presenting concrete findings, OWF is a political topic and they walk straight over you if there are uncertainties mentioned.*

Implications for intellectual capacity and knowledge uptake

Below, the implications of findings concerning knowledge integration for the development of intellectual capacity and the effectivity of knowledge uptake in Dutch OWF development and MSP is summarized.

First, data suggests increased attention for knowledge integration in policy and among stakeholders, increasing the potential for intellectual capacity (I&W & EZK, 2015; I&W *et al.,* 2021). This is demonstrated with the explicit focus of the NZO on knowledge integration, which is deemed effective by participants. This success of the NZO, as well as findings from the observation of research consortia led to the conclusion that multi-disciplinary discussion bodies and consortia can facilitate knowledge integration and intellectual capacity, according to the four conditions mentioned in literature. Another finding from the NZO structure was that the scientific committee was a great influence on knowledge integration, especially due to its competence to advise on own initiative.

Second, while strong contacts exist among the different stakeholders, the continuity of OWF development and planning tasks among departments and in research programs and discussion bodies is not always guaranteed. This continuity is considered vital by participants and should be structurally guaranteed. As mentioned, one of the most important results of continuity is the development of

personal relations and trust. Trust between individuals and organisations was found to be an important additional condition for knowledge integration which came forward from the data. This trust was found to be fostered through close personal relations, however to cultivate such relations, formal, contract-based relations were found to be fundamental.

Third, the planning phase of OWF development is seen as the best moment for knowledge integration. However, multiple iterations were seen as fruitful for knowledge integration. To ensure better knowledge integration a structural overarching body creating oversight of existing knowledge, discussion bodies, meetings and events was mentioned as a good way to increase iterations and structure. The lack of such an overarching authority was mentioned as a major barrier for knowledge uptake. Multiple iterations are vital since the continuous development of knowledge and policy makes the alignment of policy processes in each phase of policy development more challenging. As mentioned, scientists are not always present in the debate, as such they do not cultivate awareness about the value of some research (more time investment by scientists needed). This further underlines the need for better integration of scientists in all steps of the policy process. This early inclusion of scientists was already implied by Janssen *et al* (2014).

Fourth, this willingness of individuals involved was described as necessary for knowledge integration. Another influence is organisational working cultures, and their valuation of external knowledge and interests. Both the content of contracts and working cultures can influence this as presented by the data.

Fifth, as mentioned in chapter 3, the maximum capacity for knowledge uptake of government departments was identified as an important barrier to knowledge uptake. Adaptations of the process of knowledge uptake and the increase of this capacity over time were identified as possible solutions. These will be discussed further in chapter 6. Currently these capacity issues result in a functional use of knowledge, which can be frustrating for scientists if their research is not used.

Sixth, Regional knowledge integration was identified as a major gap for the establishment of intellectual capacity concerning the North Sea basin, this was already mentioned in the consulted literature but data suggests that this is realised in national considerations (Ehler, 2009).

5.3.2. Double loop learning

The process of amassing experience over time, and making judgements based on experience in a certain context and interaction with others is the essence of learning (Argote, 2011; Flyvbjerg, 2003; Armitage *et al.,* 2008; Latour and Paris). Double-loop learning in particular concerns the re-interpretation of existing policy goals, systems and frameworks to match evolving contexts and knowledge bases (Healey, 1998; Cars *et al.,* 2017; Popov, 2011). Accordingly, this section will consider the capacity of Dutch institutions in MSP and OWF development to "*continuously re-interpret their environments and take subsequent action to ensure environmental alignment"* based on experience and knowledge integration (Willems *et al.,* 2018).

Therefore, findings are presented where existing policy, goals, frameworks, processes, or systems are re-interpreted based on learning from experience, or through the integration of knowledge between sectors and disciplines. Due to this emphasis on not only learning from experience, but also learning

together the connection between learning and knowledge integration becomes apparent. As such, this section will refer back to findings in the previous section to underline this connection.

As mentioned in chapter 5.2.1., fully realized changes in goals, frameworks, and systems are difficult to attain, and often depend on supranational legislation. Additionally, the theoretical framework indicates that double loop learning can be seen as a 1 to 10-year process (Williamson, 1998). As such, latent examples of double-loop learning are also presented in this chapter: examples are shocks to institutional viewpoints, the initiation of new frameworks and systems of knowledge uptake or policy making, and changes in organisational structures leading to different behaviours.

To structure this section, changes are presented under several thematic topics: how considerations of the physical system change goals and behaviour, and how systematic changes in governance structures arise from a realisation that institutional roles have to be reconsidered. Finally, the mentioned changes imposed by supranational governance are considered.

Biophysical considerations

This section demonstrates how newly found knowledge about the biophysical system of the North Sea basin leads to changes in policy goals, frameworks and systems. Gradual changes in how the North Sea is understood and governed, include more holistic and more marine-focussed approaches. However, while findings demonstrate the initiation of this shift, ample critique on current views, goals, systems and frameworks demonstrates that this shift is still in its infancy.

An important change in MSP and OWF development mentioned as necessary in literature and by several participants is to look at the North Sea as a holistic marine system (Dannheim *et al,* 2020; Lindeboom, 2008). Based on changes in the 2022-2027 North Sea program, Dutch policy seems to view the North-Sea basin in a more holistic way. The 2022-2027 document for example indicates the desire to base policy on cumulative effects in specific areas. The need to consider unique marine qualities instead of relying on terrestrial planning methods appears to be slowly seeping through in policy considerations (I&W & EZK, 2015; I&W *et al.,* 2021).

Compared to the 2015-2021 framework, the 2022-2027 North Sea program mentions the North Sea ecology to have more inherent values. This shift of views from the North-Sea as an area for resource extraction towards the realisation of its inherent value, demonstrates the adaptation of policy frameworks. The different formulations are more in line with system considerations of the EU directives on Marine spatial planning and Marine strategy frameworks (I&W & LNV, 2018, 2022; EC, 2008, 2014; EZK & I&W, 2015; I&W *et al.,* 2021). This shift can also be seen in the development of research programs. More attention is paid to integrated system-based approaches like unravelling the food web and considering cumulative effects. This is also followed up with the development of more integrated programs which focus on cumulative effects like WOZEP, MONS, and KEC. As such, there is a discursive shift based on the re-interpretation of the North Sea. While far from complete, this shift can be seen as a start of the necessary change indicated in literature and by our participants (van Tatenhove, 2013; Keijser *et al.,* 2021; Spijkerboer, 2021). An interesting example can be seen in noise regulations for OWF pile-driving. Initially, the policy goal was to minimize noise, later it became clear that these noise regulations were unattainable when constructing turbines of larger size. By considering that the goal is to prevent impact on sea mammals, a re-interpretation of knowledge demonstrated that porpoises are most vulnerable to noise when they have young. This re-

interpretation allowed for the adoption of new action strategies aimed at minimising noise when porpoises have young (RWS, 2019).

However, the process of changing goals and frameworks is far from complete. E.g., the 2022-2027 framework still predominantly bases its policy goals on specific habitats and species, while the dynamic nature of the ocean makes such considerations less characteristic for the system as a whole. As such, P9, a Marine systems and MSP scientist indicates that one of the biggest issues with current MSP policy remains that it is a reflection of terrestrial spatial planning: '*a revisualisation of MSP is necessary where we look from the perspective of the sea, not from land'.* Another example is how the Dutch Offshore Wind Act, bases the obligation to perform EIAs on the environmental management act, copying the regulation for terrestrial EIAs without keeping specific maritime dynamics in mind (wet wind op zee, 2015; Wet milieubeheer, 2017). However, the adaptation of fundamental views is a long process, and these first steps in the right direction are promising. This is reflected by P10, a marine and coastal management scientist who indicates that while the specifics of the seas are not kept in mind, '*developing this new concept takes time*'. This situation constitutes an opportunity for knowledge uptake. Continually including more viewpoints and knowledge in this policy-learning process can facilitate the shift towards more marine oriented planning. Much can be done to structurally improve this learning process, P5, A marine ecology scientist for example mentioned: '*Better definitions are needed of vague terms like the food web, or good environmental status, otherwise people will still not be cooperating'.* As such, better joint interpretations of ecological concepts could contribute to Learning and as such knowledge uptake, again demonstrating the importance of knowledge integration for double-loop learning (Keijser, *et al.,* 2021).

An example of an opportunity in the learning process for the North Sea ecology is mentioned by P6, a reef biodiversity scientist: '*The North Sea is like a field, where fishermen come to plough twice a year, destroying hard substrate habitats and making it more suitable for fishing. Originally, a much larger part of the North Sea bottom consisted of hard substrate, if we would allow artificial reefs on OWFs to remain intact after decommissioning, this could be great for the North Sea ecology.'* This idea of embracing the possibilities for the nature-inclusive development of OWFs, is increasingly seen in both the North Sea programme, and plot decisions (I&W *et al.,* 2021; RWS, 2022). Such a shift of goal setting, towards the possible creation of natural areas in the North Sea through multi-use constitutes a significant change. The newest, Hollandse kust west decision even compels 20% of the OWF areas to be covered in nature inclusive infrastructure, the exact design of which is to be determined by an EIA based on local circumstances. Since this nature inclusiveness is being considered as a goal and acted upon, we can see that policy makers are learning from research which highlights this opportunity.

However, issues concerning this artificial reef development arise when considering long term views. Decommissioning requirements still obligate wind park owners to remove parks after licenses expire. General planning considerations and the desire for space on the North-sea make it difficult for these parks to become legally accepted natural reserves after decommissioning. P15, a policy maker Offshore Wind mentioned mentions: '*the jury is still out on leaving (partly) OWF piles in the seas. The extra hard substrate might contribute to the ecology. But in the case of gas-drilling platforms, those are regarded as polluting and not in conjunction with the London Protocol while it is basically the same type of intervention. Additionally, such newly made habitats can't just get the same status as existing once, protected nature, and if all old OWFs become nature reserves, there will be more pressure on other areas due to (longer or permanent) displacement effects of other*

stakeholders and activities. We would have to look at research outcomes of first mover countries currently dealing with decommissioning to consider the effects. Another issue is that we already have issues with the division of space in the already busy North Sea, if all the decommissioned OWFs have to be left in the sea it will be difficult to find space for new energy production or other uses'. Due to the risks brought up by P15, a policy maker Offshore Wind who mentioned that the new policy goal has not been fully included yet in the sense that we do not know if artificial reefs are to remain after decommissioning. To solve the conflict between short-, and long-term considerations a long process of learning, and of weighing socio-political objectives is required. However, the facilitation of artificial reefs is taken up into policy and constitutes an adapted policy goal in the planning of OWFs. While the future development of this view is uncertain, it demonstrates the presence of a capacity for double loop learning, improving knowledge uptake.

Another example of double-loop learning derives from the realisation that space in the North Sea is limited. This culminates in the increased inclusion of multi-use for OWFs in policy goals and documents like plot decisions (I&W *et al.,* 2021; RWS, 2022) The awareness that multi-use can lead to more socio-economic gains while maintaining a healthy ecology and using scarce space more efficiently. This awareness has led to great interest in the possibilities of floating solar panels, sea weed farms, nature inclusive construction, and alternative fishing methods. The Netherlands wants to develop a specific monitoring programme to attain this (I&W *et al.,* 2021). This implies an adaptation to the increasingly scarce space in the Dutch part of the North Sea, demonstrating double loop learning and increased knowledge uptake when it comes to these socio-economic and ecological opportunities.

All in all, views of the North Sea as an area for resource extraction seem to be changing gradually, leading to more considerations of nature inclusive planning. The possibilities for this are uncertain though, requiring more research over the coming years. Finally, the realisation of limited North-Sea space leads to the inclusion of conditions for multi-use in research programs and policy documents.

Uncertainty

The need for policy to keep uncertainty in mind is often repeated by scientists amongst our participants. This is demonstrated in the section on communication between scientists and policy-makers. Additionally, every document and participant consulted for this research, indicated a severe lack of knowledge about the North-Sea, and the impact of OWFs. In this section results are presented to consider to what extend policy and organisations learn from, and try to align to, this uncertain context. Uncertainty is increasingly considered in policy documents, but understandably it is still hard to include in policy making due to precautionary principles, which require certainty in the formulation of policy.

A shift can be seen between the Marine spatial plans for 2016-2021, and 2022-2027. Uncertainty, knowledge uptake, knowledge gaps, are hardly mentioned in the former and to a greater extend in the latter which presents more existing knowledge gaps (I&W *et al.,* 2021; I&W & EZK, 2015). Specifically, the 2022-2027 version more explicitly mentions uncertainties and knowledge gaps about ecological impacts and sediment dynamics. Knowledge gaps about protected species were also seen in the 2016-2021 document.

Many of our participants indicated that governments generally do not want to admit uncertainty, while scientists underline the importance of admitting it. In the context of OWF development, uncertainties are admitted, but not always taken up into policy. The fact that uncertainty is more

readily admitted demonstrates a currently slow but important change in values being adapted to the current knowledge context. This re-alignment of values to the current context clearly demonstrates signs of double-loop learning according to theory (Willems *et al.,* 2018). Scientific standpoints seem to be more integrated in these considerations, demonstrating successful knowledge integration in learning (Keijser *et al.,* 2021). However, when considering the uptake of knowledge, the need for concrete advise is still explicitly mentioned in documents concerning the uptake of policy from the NZO (I&W *et al.,* 2021; OFL, 2018). As such, there is no change of the rules of the game, but the shift of values is visible (EZK, 2015; OFL, 2015; I&W & EZK, 2015; I&W *et al.,* 2021). P20, Policy maker environmental management and P18 Policy maker North Sea both indicated that numerical data is easier to put into policy, but uncertainties may be more important. P18 Policy maker North Sea said *'We are trying our best to include uncertainty in policy at WOZEP, but it is very hard to do'.* Additionally, several policy advisors mentioned that the precautionary principle in Dutch law means that scientific uncertainty about impact does not constitute a ground for declining precautionary action. Making it very difficult to include uncertainty in policy.

Additionally, in the strategic policy analysis 'the future of the North Sea', Matthijsen *et al.,* (2018), indicate that uncertainty is still not sufficiently considered in research programs like the expanded WOZEP research program. These programs are not extensive, inclusive, and integrated enough to answer the questions asked by the government. As such, the current policy, and legal systems are not able to deal with large amount of uncertainty. And governmental research in WOZEP is not able to reduce uncertainty sufficiently. While the MONS program is more integrated and deals with uncertainty to a greater extend, the lacking ability to deal with uncertainty poses a serious barrier for creating well-informed policy. According to the strategic document, more and better platforms for national and international knowledge cooperation are mentioned as necessary to answer the questions we have (Matthijsen *et al.,* 2018). As such, while the capacity for double loop learning is demonstrated to be insufficient when it comes to the inclusion of uncertainty, some improvements are made with uncertainty being mentioned in knowledge and policy goals.

Changes in governance-frameworks, processes and organisation

Aside from considerations about the ecological system and changes brought about by technological advancement, the governance system itself is also in flux due to the dynamic circumstances of OWF development and MSP. Realisations that roles of the government, institutions and stakeholders needed to be reconsidered have led to significant procedural changes in the institutional structures dealing with Dutch OWF development in MSP. Examples are the mentioned development of the NZO, and the desire to change the governance process in policy documents.

While the overall goal of a good North Sea ecological environment based on European directives has not changed much over the last decade, in some cases the systems regulating policy and defining good environmental status are considerably different. The biggest factor in this change is the role of the North Sea talks. Not all parties and activities relevant for the Dutch part of the North Sea are included, e.g., sand extraction and defence. However, for the participants of the NZO, goal setting is now happening jointly through the discussions in the platform, leading to the adaptation of goals, like the mentioned goal of reciprocal effectivity. Cooperative governance is further established with the permanence of the NZO, its obligatory involvement in future North Sea policy, and its responsibility to adapt its own process. This new system of decision making constitutes a significant change in the governance framework of Dutch MSP. Another change brought about by the NZO is how it jointly decides on the research agenda of MONS. Instead of relying mostly on government agencies and

ministries for the consideration and monitoring of developments, the North Sea talks now play a vital role in determining the research agenda, and monitoring the execution of policy (OFL, 2018; I&W *et al.,* 2021). Considering that, as mentioned in the introduction of this thesis, the lack of knowledge and its joint uptake and acceptance are seen as major barriers to effective MSP, the NZO demonstrates an adoption of a new system towards the overcoming of these barriers. This not only constitutes double loop learning, but also increases the capacity for all aspects of intellectual capacity, significantly improving knowledge uptake into policy. Opportunities for knowledge uptake therefore arise with the better inclusion of parties and activities currently left out of the NZO. As mentioned by Matthijsen *et al.,* (2018), more integrated discussion bodies are necessary to provide answers desired by the government. Another opportunity is for the NZO to take the role of an overarching institutional body, overseeing and regulating these discussions, as mentioned by P12, a marine and coastal management scientist, such a body is currently missing.

An example of changing frameworks through this joint interaction in the NZO is how knowledge integration enabled double loop learning, and led to a new framework of determining ecologically protected areas and fishing ground. While initially green organisations wanted 25% of the Dutch North Sea to be protected, this position was unattainable since other parties also had high demands, especially fishermen. P19, policy maker public management indicated that: '*I wanted a list of important areas from both sides to see which areas could best be used for which activity, actually, I was surprised that such a list did not exist yet'.* Both the fisheries and green sectors initially refused to make such a list. An ecologist from the scientific sounding board committee of the NZO indicated that it is definitely possible to identify more or less ecologically important areas and made a hierarchical list. After obtaining insights of important areas from fisheries as well, this led to some horse trading, but eventually a part of the fisheries sector agreed. As such, the integration of knowledge between ecologists and fishermen led to a new 'Hierarchy of natural and fishing areas' which was used to maximize the ecological value of protected areas while maintaining socio-economic value.

How this framework was used to encourage knowledge integration and find solutions was provided by P19, policy maker public management: '*The Closing of the important natural area, the Frisian Front, was disastrous for a small amount of lobster fishers. We asked where the lobster grounds were and a point in the middle of the area was indicated. After consulting the main ecological advisor, we came with a plan to open a corridor to this location, and compensating by enlarging the protected area to the South, a solution that benefitted both the fishermen and the ecology'.* In the mentioned example the importance of knowledge integration for double loop learning, or "*learning from others"* is demonstrated to be very effective and quite simple in practice. Parties have to trust each other with their goals and preferences, and look for mutually beneficial solutions. This need for learning together is reflected by P13, a Marine Spatial Planning scientist who mentioned: '*Trust is a very important condition for learning to be successful'.* When considering the strong reciprocal reinforcement between learning and knowledge integration seen above, the need for trust becomes apparent for both. This implies that the clear communication of interests, desires and preferences can lead to better knowledge uptake. Additionally, it demonstrates that trust can be regarded as truly fundamental for effective knowledge uptake.

The mentioned developments in the NZO demonstrate steps towards effective knowledge uptake. With the change of governmental roles, it works towards a new governance system for MSP. This need to evaluate existing roles is mentioned in more policy documents. The route map for wind

energy 2040 explicitly describes the intention to develop a new governance system for the development of OWFs. While the structure of this system is not yet mentioned, the evaluation of the roles of government, market, other stakeholders, and technical standards is indicated. Since the re-alignment to changing contexts starts with evaluation and the intention to learn, and change based on it is explicitly mentioned, this can be seen as a step towards double-loop learning (RVO, 2021). However, it remains to be seen how this will be realized.

The real Double loop: supranational governance in the EU

Despite the many environmental, energy, and knowledge goals mentioned in Dutch policy documents about MSP and OWF development, it has to be kept in mind that this all happens in the frameworks set by EU directives. The findings below demonstrate that stricter ecological goals and frameworks are mostly set by the EU, and not expanded in Dutch national policy.

EU directives for example obligate Member states to strife for good environmental status of the seas, which can be reinterpreted in national policy, but still needs to be attained. Implementing more stringent targets is allowed under EU law, but does not often happen in the context of marine governance (I&W & EZK, 2015; I&W *et al.,* 2021; EC, 2008, 2014). As P5, a marine ecology scientist mentioned: '*When it comes to the protection of the marine environment, the Netherlands only take action when they can be reprimanded'.* In the documents that implement EU directives into Dutch law, no goals of ecological protection knowledge integration, or cooperation are expanded beyond the EU targets (Wet windenergie op zee, 2015; I&W & LNV, 2018, 2022; I&W *et al.,* 2021; EC, 2008, 2014). In practice, only the species specifically protected under EU legislation are granted serious attention. While new research programs like WOZEP and MONS express the intention to look at the ecology as a whole, the benthos and food chain dynamics, this has not extensively been put in practice when looking at plot decisions, despite their mention in EU directives (I&W *et al.,* 2021; RWS, 2016; 2019; 2022). Double loop learning at the European level is demonstrated by the shift from terrestrially oriented to holistic marine oriented governance of the seas between the 2008 MSFD and 2014 MSP directives. Another example is how the 2008 MSFD framework mentions the need to consider cumulative effects. While this was only implemented in Dutch Policy with the KEC programme a decade later, it still resulted in a systematic change of how we look at threats to the North Sea ecology. These directives are the main reason for the already meagre change in national frameworks (EC, 2008, 2014). The MSP directive clearly separates terrestrial and maritime planning, which is to a lesser degree taken up in the Dutch North Sea Programme 2022-2027, but hardly in any other Dutch MSP documents (I&W *et al.,* 2021). We can therefore conclude that double-loop learning predominantly occurs at the European level.

As a response on this situation, P9, a Marine systems and MSP scientist indicates a principal weakness in European MSP policy: '*The EU could have played a more active role in the establishment of MSP in Member states. Terms like good environmental status should have been more clearly defined and more tangible measures for the shift towards blue growth and an oceanic orientation could have been provided'.* This position is reflected by the MSP directive which leaves the formulation of MSP completely to member states (EC, 2014). P7 an ecosystems and sediment dynamics scientist adds to this: '*The EU provides good guidelines, the problem arises where member states can fill these in in their own way, as a result all countries have different methods for dealing with the guidelines'.* Here we once again see that the clarification of concepts could significantly contribute to knowledge uptake. But the main implication for knowledge uptake is that the loose wording of the MSP directive can be seen as a barrier to knowledge uptake.

As a result of determining region-wide visions and policy goals, the best examples of double loop learning can be found at the EU level (EC, 2008; I&W *et al.,* 2021). An opportunity for knowledge uptake presents itself in the clarification of terms and concepts used in EU directives, and a more pro-active active approach by the EU in the establishment of MSP frameworks in member states. A more active role of the EU could lead to better aggregation of member state knowledge, and the quicker adaptation of goals, which is desirable in the current dynamic knowledge context.

Implications for knowledge uptake

First, conceptions of the North Sea as a holistic system and sea-based planning views appear to be increasing, but it is too early to say if and how these will change policy goals. However, the development of jointly accepted terms and knowledge basis, as well as the gradual inclusion of more research on the biophysical system can help to speed up this process as mentioned in chapter 3. Similar to these biophysical considerations, the inclusion of uncertainty in the expression of policy goals, frames and values is increasing. However, the current policy system is geared towards certain, factual knowledge, making it difficult to put uncertainties in policy practice, since uncertainties often concern metacognitive and long-term procedural knowledge. These findings demonstrate an increase of intellectual capacity which is for a considerable part facilitated by the NZO. While the NZO does not include all activities and parties relevant for MSP it does lead to better knowledge uptake.

Second, sharing information, double loop learning, and trust is fundamental for this process of learning-together, this need for trust was not specifically mentioned in literature but becomes apparent in the data.

Third, the desire expressed by the RVO to re-evaluate the roles of governments, markets, stakeholders and technical standards in MSP may lead to double loop learning in the future, if this re-evaluation is done objectively and thoroughly. An example is he increased inclusion of multi-use in policy goals and documents. This represents an adaptation to the limited space of the Dutch part of the North Sea.

Fourth, despite gradual changes and desires for re-interpretation, results demonstrate that the real adaptations in policy goals and frameworks happen at the supranational level, as already demonstrated by Ehler (2009), and Paramana *et al.,* (2021). However, ecological and MSP goals are limitedly taken up in Dutch MSP and OWF development policy. The lack of a pro-active approach by the EU, and the loose wording of the MSP directive can be seen as a barrier to the uptake of EU goals based on new knowledge.

5.3.3. Single loop learning

Single loop learning is the adaptation of action strategies to existing frameworks and policy goals. The previous section on double loop learning already provides evidence that action strategies in OWF planning policy are adapted to attain newly installed policy goals. An example is the exchange of preferred areas between natural protection and fisheries according to the new spatial hierarchy framework. Another example is the obligation to develop nature inclusive foundations for at least 20% of new areas in plot decisions to attain goals of nature reservation and multi-use. Findings demonstrate that single loop learning occurs often in Dutch OWF development and MSP, when new action strategies described in documents or by participants, are changed to better achieve goals or

adhere to frameworks. As expected, this happens significantly more often than double loop learning. Codes identifying instances of single loop learning were coded 109 times in the document analysis, as opposed to 32 instances of coding pertaining to double loop learning. For neither type of learning all examples could be mentioned in this analysis. As such, this section presents some of the best examples of single loop learning found in plot decisions and area selection.

An example of single-loop learning is the consistent increase in minimum turbine size indicated in plot decisions over the years. OWFs were found to have less impact on the ecology if there were less turbines in them. This resulted in the decision to place less, but larger turbines in subsequent rounds of plot decisions. Less and larger turbines mean less impact on the ocean floor, a shorter period of piledriving, and more space between turbines for birds to migrate through. Turbines in the Borsselle wind park had an average individual capacity of 8MW, and no specific regulations on their size were indicated (RWS, 2016). For the described reasons, the Borssele plot decision already included a maximum number of turbines. Another finding is how between 2016 and 2019 new practices were developed to prevent noise pollution during construction. The 2016 Borssele decision mentions the need for a slow start of pile driving and acoustic deterrent devices (RWS, 2016). Later it was discovered that pile driving only leads to significant issues for protected species like porpoises and grey seals when they have young, issues for other species remain largely undocumented (RWS, 2019, 2022). As such, P17, policy maker nature and North Sea, indicated that: *'louder construction noises can be less harmful if planned in the right season making the construction of less, but larger turbines less harmful for both birds and mammals'.* Policy has been adopted to include these findings: in the 2019 plot decision for Hollandse kust Noord, the minimum turbine size was 11MW; in 2022 for Hollandse kust West, it was 14MW (RWS, 2019, 2022). At the same time, the amendment of existing plots cancelled the maximum size of turbines for any existing or future park (EZK, 2021B).

Another result was that noise regulations allow for higher decibels in seasons when mammals are not rearing young, and are strict in seasons when mammals have young, working towards the attainment of environmental goals based on factual knowledge (RWS, 2019, 2022; I&W *et al.,* 2021; I&W). In this manner, larger and more efficient turbines can be built, which would have been problematic if noise regulations are always equally stringent. Many other findings from monitoring concerning e.g., fish stocks, pollution, newfound archaeological locations, safety for shipping and during repairs, efficient power transformation and transport, sand extraction, and flight patterns of bird populations lead to minor adjustments between the plot decisions (RWS, 2016, 2019, 2022; EZK, 2021A, 2021B; EZK & I&W, 2014,2015; I&W *et al.,* 2021).

In another example of single loop learning, adaptations of action strategies have led to less damage to birds and bats than expected in KEC (RWS, 2022A). Based on migration models and observations, policy introducing cut-in speeds, limiting rotor speed in times and seasons of high bat activity (RWS, 2019). However, research is currently done to further increase the efficiency of this policy, by introducing cut-in speeds at the exact times of bat activity to minimize collisions and maximize energy output (EZK, 2021B; RWS, 2022A; van Splunder and Graafland, 2022). This demonstrates an active pursuit of single loop-learning to attain ecological goals from the population's directive.

The examples described above demonstrate single loop learning in the development of plot-decisions. As mentioned, these are suitable for analysing policy change due to their rapid successive release. Area selection decisions are updated less often, but clearly demonstrate signs of single loop learning. Instances of single loop learning in area selection procedures are for example the rejection of areas

due to their import for other uses. Another example is the adaptation of area selection to allow more buffer space for shipping corridors, based on findings that demonstrated possible risks of collision. This was done in area selections for Hollandse kust (RWS, 2022; I&W *et al.,* 2021). New area selection research has also led to vacant space being identified in existing wind farms, where 0.7GW worth of turbines could be placed, optimizing the use of OWF areas (I&W *et al.,* 2021). Due to the large number of activities in front of the Dutch west coast, area selection is currently being moved to the North of the Wadden Sea. This is based on goals to allow for other activities in the area, and because north of the Wadden Sea, less other activities take place and ecological values are mentioned to be lower, see figure 14 (I&W *et al.,* 2021; EZK, 2021B; RWS, 2022A). However, these lesser ecological values North of the Wadden Sea are highly contested by ecologists among our participants.

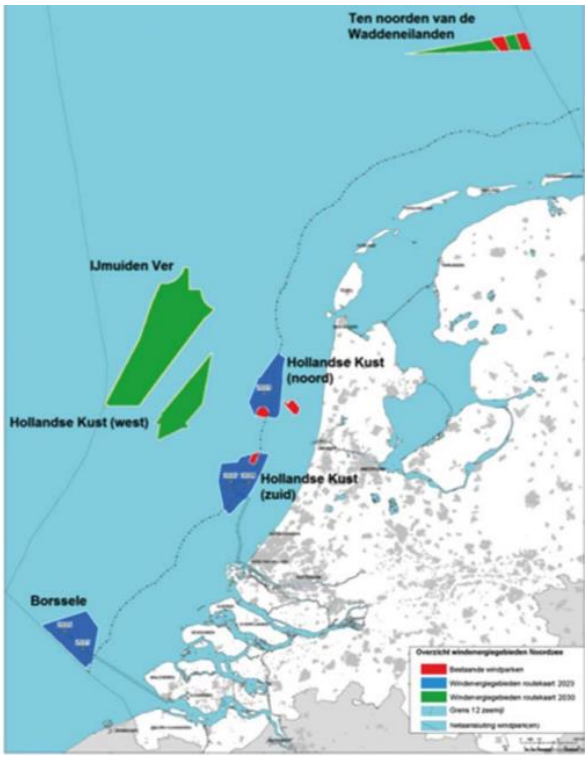


Figure 14: A figure of planned wind areas. As can be seen the later area decisions (green) are further away than existing wind farms and those under construction (Source: RWS, 2019).

Implications for knowledge uptake

Single loop learning often occurs based on factual knowledge like the described flight patterns of birds and bats, or the findings which demonstrate that larger turbines have less natural impact. Since these types of findings reduce uncertainty, the adaptation of policy is a lot more likely. There are less barriers to its uptake than in many instances of double loop learning, where the adaptation of views and visions still encounter many uncertainties and are therefore not compatible with the precautionary principle. All in all, single loop learning demonstrates to be strongly present in the current OWF development and MSP process, demonstrating intellectual capacity and leading to better knowledge uptake in action strategies. It was also demonstrated that for single loop learning to be effective, policy goals have to be informed well. The formation of effective policy goals requires system understanding and knowledge integration as concluded in the section on double loop learning. This finding underlines the need for all aspects of intellectual capacity to be jointly considered.

5.3.4. System understanding

System understanding entails the comprehension of how a system works and how it will react to interventions. This understanding, is a vital aspect of intellectual and knowledge uptake since knowledge needs to be acquired before it can be interpreted, or applied. As mentioned, understanding of the biophysical system of the North Sea is currently insufficient, especially when considering the influences of socio-economic systems on the North Sea basin. The dynamic nature of our current understanding of the North Sea system, makes it almost impossible to sketch an image of the total of existing knowledge. In MONS alone, 141 different research proposals were considered, and that is only one program. Especially since much of the research being done remains sectoral, sketching a holistic image of our understanding is difficult. This problem with sectoral approaches demonstrates how important knowledge integration between disciplines already is for understanding the biophysical system. Sketching an image of the existing knowledge of these systems is outside of the aim of this thesis. The section below will therefore present results on the perceived completeness, efforts, and methods concerning the understanding of the North Sea basin, the relevant socio-economic systems, and the governance of the Dutch part of the North Sea.

The lack of knowledge of the North Sea system is mentioned by almost all participants and policy-documents considered. This lack was indicated to cause structural problems in creating policy for ecological protection, and sustainable use of OWFs, forming a barrier for the development of intellectual capacity. The universal recognition of a need for better system understanding can therefore be seen in current developments. Research grants of millions are spend by the Dutch government, the European Union, and other organisations, see figure 14 (NWO, no date, OFL, 2018, EC, 2017), and the NZO dedicated 25% of its budget to research (OFL, 2018). Additionally, MSP related policy documents greatly increased their attention for knowledge development in the last six years (I&W & EZK, 2015; I&W *et al.,* 2021). These findings point towards a strong focus on knowledge development to increase system understanding.

However, as mentioned in previous sections, the manner in which research is done is often considered to be to sectoral and too focussed on factual knowledge to develop the necessary understanding for OWF development and MSP. An example of these inconsistencies is that due to the massive number of species in the North Sea, the effects on biodiversity are often tested by looking at umbrella species. These are often generally appreciated species like codfish and the flat oyster (RWS, 2022A). P5, A marine ecology scientist mentions: '*Research priorities are skewed, there is mainly attention for certain species or crisis situations, with the current budget and capacity this leaves too little room for the research that is really needed to understand the environment. There is for example a lot of research concerning birds and bats and sea mammals since these are taken up in legal guidelines and these species cannot be harmed by OWF's. However, the broader ecology gets less priority, partly because it is so complicated to monitor'.* This opinion is not present among all participants, P14 a policy maker Marine management indicated: '*Based on the newfound knowledge, well considered decisions can be made about the conditions and size of OWFs'.* But according to P5, a marine ecology scientist, the policy requirements are not adequate: *'While current research lives up to policy requirements, it is still way too little to understand the system, all those involved need to realize the importance of integral knowledge'.* P10, a marine and coastal management scientist relates to this by indicating that: '*Knowledge uptake is driven by crisis, when large scale interventions or problems are imminent, interest starts to rise'.* This demonstrates that while there is great attention for system understanding, research efforts seem to have different goals and are not always sufficiently integral to attain true system understanding. Participants of FG2 indicated that this difference between research can be

conceptualised as the difference between *fundamental research*, and *policy-oriented research.* Fundamental research aims to understand the system of the North Sea, including more conceptual and metacognitive considerations. Policy oriented research aims to provide enough, often factual, information to live up to policy goals.

Adaptations in the research goals and systems of policy requirements (double loop learning) are necessary to increase the focus on fundamental research. Still, significant contributions have been made to intellectual capacity with current knowledge development, especially considering the shift towards more integral and fundamental research approaches in WOZEP and MONS.

Apart from the issues concerning the distribution of funds and research agenda, issues also arise due to the difficult circumstances of research in the North Sea basin. Findings demonstrated several barriers for the development of system understanding of the North Sea Basin. An example is that, depending on the system researched, there can be many different influences besides windfarms. Thus, it is difficult to measure the exact impact of any individual activity on some systems. P7 an ecosystems and sediment dynamics scientist mentioned: '*There are impacts which can be measured and attributed to wind parks, physical impacts like sediment dynamics for example. In other contexts, like that of birds, many factors can weigh in, like climate change impacting food stocks, the prohibition on fishing in wind farms, but also the new law that prohibits fishermen from discarding undersized fish. And then there are the direct effects like collisions and habitat reduction. Since all these happen simultaneously, it is hard measure the exact impact of OWF's'.* Additionally, the dynamic nature of the sea itself can make monitoring and modelling more challenging according to participants. P4, an ecosystem and hydrology scientist mentioned that the coupling of ecosystem and hydraulic models is no easy feat and requires cooperation between scientists. Another issue with understanding the North Sea system is mentioned by P2, a sediment dynamics modelling scientist: *'The different physical elements of the North Sea adhere to different time scales, for example diurnal tides, fortnightly spring-neap cycles work on a different scale than storms (irregular but more frequent in winter) or even generational cycles of marine populations. Another issue is that the small scale and short term have to be understood if the large scale and long-term are to be interpreted well'.* This demonstrates the challenges for system understanding and improved intellectual capacity.

On top of this difficulty with developing knowledge about the North Sea, is the dynamic knowledge situation. The required out-roll speed of OWFs makes it impossible to do exhaustive research and include all knowledge that is being developed. P15, a policy maker Offshore Wind indicated: '*In the short term a lot of OWF's are being rolled out. We currently have to finish a total of 21 GW of offshore wind capacity in 8 years. There are smaller infrastructure projects that take 20-30 years. You could say these are the delta works of the 21st century. We have to prevent people in 2075 from regretting our choices. Of course, there can be critique expected with the luxury of hindsight in 30 to 40 years. Innovation will be more developed in 40 years. But we have to ensure that we look ahead as far as possible when it comes to impact and future freedom of choice. It is good to have a running start with the out roll, but it is important to keep the future in mind.'*

This limited time-frame is a barrier to intellectual capacity due to the need for long term research mentioned in chapter 3. Efforts are being made to reduce the necessary research time, but it is important to keep the integrity of results in mind. Modelling was already mentioned as a way to speed up the system understanding of the North Sea basin. The need to beware of the limitations of

these models has been mentioned as well. Another insight from P2, a sediment dynamics modelling scientist demonstrates that to attain system understanding, this is taken into account to a certain extend: '*Previously, there were high expectations of the predictive capabilities of models. This perception is slowly changing, as the value of validation is recognized more and more. This validation is very expensive though, so it remains to be seen if it will always happen. It is essential for policy makers to be aware of the possible uncertainties in models and as such allow for adaptations and bandwidth in policy*'.

On top of this recognition of validation in science, the efforts to improve system understanding were also found in plot decision documents. In Hollandse kust West, OWF owners are obliged to help in the research activities of WOZEP, without financial recompense (RWS, 2022A). This includes support during the construction and reparation of installations, and providing researchers linked to WOZEP with access to the OWF. Additionally, some cable capacity has to be reserved for the transportation of data to the main land (RWS, 2019, 2022). While this promotes knowledge development and strengthens the institutional basis for intellectual capacity, this policy could be more extensive. P6, a reef biodiversity scientist indicated that for his research he requires access to OWF foundations, but is constantly denied access by OWF owners. If Plot decisions would oblige OWF owners to allow access for all research, greater amounts of knowledge and more diverse knowledge development would be facilitated, further strengthening the development of system understanding and intellectual capacity. This would also contribute to the overcoming of skewed research priorities mentioned by P5, a marine ecology scientist, since smaller knowledge developpers would have equal access to sites.

When considering these answers, it becomes clear that the Netherlands is speeding up its knowledge acquisition, and intellectual capacity is being improved through system understanding. However, it remains important to keep considering the way in which research programs are organised and how the North Sea system is interpreted. All in all, more metacognitive knowledge is necessary to recognise the context of policy concerning the North Sea. This demonstrates the need to jointly consider aspects of intellectual capacity.

Implications for intellectual capacity

Findings demonstrate that there is a lot of attention for system understanding and that knowledge development is happening at a high speed. This results in an increase of intellectual capacity. However, many critique the manner of knowledge development and indicate a need for more integrated, holistic, and fundamental research. This research should focus on species essential for the food chain, instead of species with a high 'cuddle factor'. Additionally, system understanding struggles with many barriers due to the dynamic nature of the North Sea, the dynamic nature of knowledge integration, and the large number of activities which makes it difficult to know which effects are caused by what intervention or activity. Additionally, while policy is developed to facilitate research, this policy could be a lot more extensive and inclusive to improve understanding and so intellectual capacity. Finally, to prevent misgivings which could threaten intellectual capacity, researchers have to be clear about the limitations of their research. This is more often realised with increased efforts to validate models based on monitoring observations.

6. DISCUSSION

This study sheds light on the development of knowledge and knowledge uptake in OWF placement and management for policy and decision-making in Dutch MSP. At the end of each result section a discussion on the implications for knowledge uptake is already provided in detail. However, some of the discussions provided, require some further consideration. Based on the structure of the results chapter, this chapter will discuss the results in the context of research questions, societal and academic debates on knowledge uptake in OWF development, literature, and theory. First, the results on OWF planning and knowledge uptake systems are discussed. Then the different aspects of institutional capacity are elaborated on.

6.1. DISCUSSING THE CURRENT OWF DEVELOPMENT AND KNOWLEDGE UPTAKE SYSTEMS

In line with the second sub-question asked in this study: *How is OWF development and knowledge uptake concerning OWF development organised in Dutch MSP policy and decision making?* An overview was provided of both systems in sections 5.1 and 5.2. Below, the implications for knowledge uptake and some possible adaptations of the processes to advance knowledge uptake are discussed.

6.1.1. The OWF development process

The OWF development system has been often revised to ensure the fast development of OWFs. Despite recent improvements, scientists and considerations of knowledge uptake are not sufficiently included in the OWF development process to include metacognitive knowledge. To increase the ability of organisations to set and achieve goals through knowledge and skills (intellectual capacity), policy makers should be aware of contexts, conditions and personal and organisational biases. To attain this inclusion of metacognitive knowledge, two more phases before the area selection phase have been mentioned. Both consider the early inclusion of knowledge to prevent the loss of opportunities and risks in policy considerations:

Step 0: The early inclusion of scientists to ensure realistic policy ambitions (discussed in FG2)
While developing policy ambitions, politicians are not always aware of the scientific implications of such ambitions. Socio-economic pressure from certain sectors and groups can lead to disruptive ideas being taken up in policy ambitions. To increase the understanding of biophysical contexts and conditions as well as counterweighting societal biases, scientists should be consulted during the development of policy ambitions. In this manner, certain opportunities not considered by politicians can be included, and unrealistic plans can be balanced in the context of scientific knowledge, adding metacognitive knowledge to the planning process and increasing intellectual capacity. The inclusions of a scientific committee in the NZO demonstrated that this could lead to important notices and solutions. It has to be mentioned that what counts as "*disruptive ideas"* would require further study, but in this instance, it is seen as opposed to scientific rationality.

Step 0.5: An early overview of necessary knowledge (discussed in FG2)
Currently, the need for certain knowledge is often communicated at too short a notice. As mentioned, knowledge development can take a long time and scientists and other knowledge developers should be informed as soon as possible to ensure that they have the maximum amount of time available for the development of relevant knowledge, this is important since conceptual and procedural knowledge often take longer to attain (Krathwohl, 2002; Nagel, 2014). Therefore, a step in OWF development should be included where politicians and policy makers lay out their plans, and indicate what

knowledge would be necessary for the development of policy. In this manner, knowledge developments would receive extra time to adapt to knowledge requirements and set up the necessary research, as well as a longer timeframe to discover and consider uncertainties.

6.1.2. The process of knowledge uptake in OWF development and policy and decision making in MSP

The structuration and continuity of knowledge processes proves important for knowledge uptake as indicated by participants. This structure is lacking in OWF development and MSP. As mentioned, the focus on knowledge by e.g., the NZO, and its function as an arena for discussion contributes significantly to the integration of knowledge providing more intellectual capacity to acquire and use diffuse information (Stange, 2017). To improve the capacity to acquire diffuse information, the NZO could take the role as a central knowledge authority, connecting developers, users, different sectors, and disciplines, which could lead to joint interpretations and learning (Keijser *et al.,* 2021). This would add a strong structural element to the system of knowledge uptake, furthering the institutions goals of structure, knowledge use, and continuity (OFL, 2020A, B).

A final point of discussion concerning the process of knowledge uptake, is when best to include knowledge. An identified barrier for knowledge uptake was the conflict between the precautionary principle, the uncertain and dynamic nature of OWF-related knowledge, and the long-term licenses for OWFs. The precautionary principle entails that policy decisions cannot be based on uncertain findings, making them difficult to include. The long-term licensing of OWFs complicate major adaptations when new knowledge arises. As such, including knowledge early is preferable, see section 6.1.1, but this is not always possible. Uncertainties are hard to include in the planning phase, since researchers have only had little time to draw conclusions at this stage. As mentioned by respondents, more adaptive policy could improve this situation (De Vrees, 2019, 2021). How this adaptiveness can best be attained is a subject for further study, but the quick and active inclusion of diffuse knowledge has been demonstrated to contribute.

6.2. DISCUSSING THE IMPLICATIONS OF INTELLECTUAL CAPACITY FOR KNOWLEDGE UPTAKE

This section further discusses the findings on the aspects of intellectual capacity considered in section 5.3. This discussion takes place in the context of the relevant theory on intellectual capacity and knowledge uptake. While discussing the aspects of intellectual capacity, the relations between the aspects as well as some opportunities and barriers will be considered. Finally, a discussion on the status of intellectual capacity in Dutch OWF development and MSP as a whole is provided.

6.2.1. System understanding

System understanding enjoys a strong focus in the current debate on OWF development and MSP in the North Sea. Participants critique the skewed research priorities and sectoral focus of studies. To set and achieve goals based on knowledge effectively, the knowledge in question has to be complete. As such, more conceptual, procedural and metacognitive knowledge is necessary about the governance system, and the development of joint understanding amongst different epistemic groups (Cars *et al.,* 2017). This necessity becomes particularly obvious when considering that facts are often interpreted differently in the current period of post-truth, increasing the need for understanding biases, and thus for meta-cognitive knowledge (Nagel, 2014). Examples are how policy makers are more likely to disregard uncertainty due to a pragmatist view of knowledge combined with the need to make

decisions on the short term. However, the degree and exact nature of such biases can't be described based on the current data and would require further research.

6.2.2. Knowledge integration.

Increased attention for the attainment of knowledge integration has been demonstrated in the results. Data demonstrates that interdisciplinary research programmes, like those of the NWO, and discussion platforms like the NZO contribute to the integral development of research agendas and mutual understanding (Stange, 2017). We can see that as indicated by Flyvbjerg (2003), Latour and Paris (2005), and Keijser *et al.,* (2021), the joint experience of stakeholders leads to improved and joint system understanding (Cars *et al*., 2017). Through cooperative governance, diffuse information from e.g., fishermen and ecologists are integrated, which allows for better joint interpretation and use. In this manner, a new hierarchical system of protection has been developed through joint learning, demonstrating the capacity to achieve goals based on existing knowledge (Keijser *et al.,* 2021; Van Ryneveld and McCutcheon, 1997). This confirms the notion by Keijser *et al.,* (2021), that learning from each other is necessary to find solutions. It also confirms findings by Stange (2017), who argues that knowledge integration can be facilitated through strategic arenas similar to the NZO. As such, increasing the shift in marine governance towards cooperative governance constitutes an opportunity for knowledge uptake through knowledge integration and double loop learning, since the comprehension, interpretation, and use of knowledge will be shared, leading to less conflict (Roe, 2013; Jentoft, 2007). The willingness of all parties to adapt their goals and understanding for common ground to be established is necessary. To improve this willingness, the creation of trust through strong personal and organisational relationships is needed (Gilek *et al.,* 2021). Such a shift from more transactional to relational ties between organisations can also prevent organisational lock in and conflicts of interest or interpretation (Mahapatra *et al.,* 2010).

Interesting for knowledge integration is how direct contact between policy makers and scientists is often considered positively. More findings on the communication between policy-makers and scientists demonstrates that lacking involvement and different expectations and epistemological views can lead to frustrations. As such, a better alignment of knowledge expectations could improve knowledge integration since organisations get the opportunity to learn together, improving intellectual capacity and knowledge uptake (Keijser *et al.,* 2021).

A final point of discussion is the severe lack of international coordination and cooperation when it comes to knowledge integration. The North Sea basin is one system and needs to be understood as such (Paramana *et al.,* 2021; Ehler, 2009). The need of increased authority and resources for overarching institutions like OSPAR can ensure cooperation, and regional knowledge development (van Tatenhove, 2013). All in all, we can see that knowledge integration significantly contributes to intellectual capacity in Dutch OWF development and MSP-related policy, but improvement, especially when it comes to the structuration of knowledge integration, is still desirable.

6.2.3. Single loop learning

Single loop learning seems to be well-developed in Dutch OWF development and MSP policy. However, according to Fabricius & Cundill, (2014), single loop learning on its own has limited use. If learning goals and frameworks are not properly adapted to current circumstances, the attainment of those goals does not always constitute solutions or improvements. As such, in line with the statements of Cars (2017), Popov (2011), and Healey (1998), double loop learning is necessary for single loop

learning to come to its full right. The sectoral and fact-based focus, and unbalanced scope of topics in current policy and learning goals receive ample critique, and their transition is still in its infancy. As such, the effectiveness of single loop learning cannot always be guaranteed, as demonstrated in section 5.3.3. However, some goals, like the goals of energy productivity and ecological protection and development are in line with the necessary energy and nature transition. Therefore, many instances of single loop learning presented have certainly contributed to intellectual capacity and effective knowledge uptake.

6.2.4. Discussion double-loop learning

The importance of double loop learning for single loop learning and knowledge integration has been discussed (Cars *et al.,* 2017; Popov, 2011). As such, the gradual adaptation of policy goals, frames and systems through the application of information contributes to the interpretation, comprehension, valuation and application of knowledge. Examples are the increased inclusion of uncertainty, marine-based planning, and a holistic view of the North Sea through cooperative governance and open discussions in the NZO. These changes lead to joint interpretation by organisations with different epistemological viewpoints, but to optimize joint interpretation by governmental pragmatists, scientific positivist and societally oriented interpretivist disciplines, more joint learning is needed (Nagel, 2014; Keijser *et al.,* 2021).

The expressed desire by the RVO to re-interpret the roles of governments and stakeholders, shows a desire for fundamental change, which requires double loop learning. As such, while gradual, there is certainly an intention to re-align policy goals, frameworks, and systems to changing contexts (Willems *et al.,* 2018, 2019). The specific inclusion of topics like uncertainty, or ecological values would be an interesting topic for future research.

The long time needed for double loop learning to adapt policy to evolving context may be the most important finding and resonates with Williamson (1998), and Willems *et al.*, (2018). This finding demonstrates that time is needed to properly adapt policy goals, frameworks and systems. As such requiring long-term visions for the proper adaptations of goals frameworks and systems as already mentioned in 6.1.

6.2.5. Intellectual capacity and knowledge uptake

The sections above demonstrate an array of implications for intellectual capacity in Dutch institutions dealing with OWF development and MSP. Most importantly, the theoretic notions that *the ability of organisations to set and achieve goals through knowledge, and skills* requires all four aspects together has been confirmed (Healey, 1998; Cars *et al.,* 2017). Knowledge uptake or t*he active acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy* can only happen when all four aspects are present. System understanding is required for the acquisition of knowledge, knowledge integration is needed to combine diffuse information, learning is necessary for the interpretation and valuation of knowledge and for its proper application into policy. While separate aspects of intellectual capacity are present in the debate, and are contributing to knowledge uptake, a holistic consideration of intellectual capacity is often missing.

This study has demonstrated that intellectual capacity is a useful framework for measuring knowledge uptake, and that knowledge uptake as a concept can be used to consider the general use of knowledge

in policy. It has to be kept in mind that the value of these concepts in practical terms can be seen as the completeness of knowledge, the willingness and ability to share viewpoints, the willingness and ability to adapt, and the optimisation of strategies, making these concepts useful in both theory and practice.

Furthermore, the definition of knowledge uptake used in this paper has proven useful for the consideration of how knowledge finds its way into policy including a conceptual generalisation of knowledge uptake in policy. Planning literature has often considered the impact and use of knowledge (Eliasson, 2000). However, this concept, developed from theory to include processes valued by participants, includes a deeper understanding of how knowledge finds its way into policy through individuals, organisations and processes. The definition taken from literature accounted for the acquisition, comprehension, and application of knowledge. But while this has been demonstrated to occur, particular problems arise with the valuation and interpretation of knowledge since this differs significantly among individuals and organisations. Especially when taking the division of power and authority in mind, valuation and interpretation can become problematic since powerful groups have the ability to influence what counts as knowledge (Flyvbjerg, 2003). However, with the increased transparency and possibility for reasoning in discussion bodies, power is less likely to influence knowledge. The influence of power can still be seen in e.g., the extremely rapid development of OWF's, and how power influences knowledge uptake in this case would require further research.

7. CONCLUSION

The goal of this thesis was to gain insight in, and consider possible improvements for knowledge uptake in Dutch OWF development and policy and decision making in MSP. Based on the data found and discussed in previous chapters, answers to the different research-questions are formulated in this chapter. Below, the separate sub-questions are answered before answering the main research questions and providing a final conclusion.

7.1. ANSWERING SUB QUESTION 1: THE DEFINITION AND USE OF KNOWLEDGE UPTAKE IN OWF AND MSP RELATED LITERATURE

To address the limited extent to which knowledge and knowledge uptake have been studied in OWF development and MSP related literature, this section aims to answer the sub-question: *How are knowledge and knowledge uptake currently defined and used in MSP and OWF-related literature?*
Knowledge gaps are often considered in MSP and OWF-related literature since knowledge about oceanic systems is incomplete (Dannheim *et al.,* 2021; Ehler and Douverre, 2009; Jay, 2010; Jay *et al.,* 2012). However, literature often implies factual or conceptual knowledge. Procedural and especially metacognitive considerations are present to a lesser extent. While scholars increasingly recognise the need for integral knowledge considerations, the focus is on the biophysical system, limitedly considering governance procedures and often neglecting knowledge uptake (Charnock *et al.,* 2021).

Additionally, different aspects of intellectual capacity are present to different degrees. The increase in research concerning the North Sea demonstrates that the need for *System understanding* is recognized by scholars and Dutch institutions. The understanding of marine systems and interventions is taken up in regulations like environmental impact assessments and strategic environmental assessments (Dannheim *et al.,* 2021; Klakegg *et al.,* 2016; Van Doren *et al.,* 2016; Brugnach *et al.*, 2008; Morisson-Saunders and Arts. 2004; Farooq, 2018). *Knowledge integration* on the other hand, is recognized by scholars like Janssen *et al.,* (2014), as being limited in Dutch planning practice. (Gusatu *et al.,* 2020; Spijkerboer *et al.,* 2020; Janssen *et al.,* 2014). As for *learning*, scholars demonstrate that while the *single loop* is commonly employed by Dutch policy makers to improve operations, the *double loop* adaptation of wider frames and common goals is not often emphasized (Willems *et al.,* 2018,2019; Keijser *et al.*, 2020).

Some studies like those of Keijser *et al* (2021), Van Tatenhove (2011), and Paramana *et al.,* (2021) include knowledge about governance and the uptake of knowledge through learning. These authors keep procedural and metacognitive considerations in mind by considering experience, joint interpretations, and differing conditions, contexts, and biases. Thus, knowledge and knowledge uptake usually are about factual and conceptual knowledge, this can lead to issues since procedural and meta-cognitive knowledge are required for the implementation of long-term solutions supported by all stakeholders involved. Knowledge uptake is much less considered in OWF and MSP-related literature. In some instances, it is mentioned as necessary but not elaborated on or defined. Even authors who specifically describe lacks in the capacity for knowledge uptake do not sketch an overarching image of what the uptake of knowledge entails. In recent years, authors consider the use of knowledge more explicitly, but knowledge uptake as a concept is still not specified (Gazzola *et al.,* 2015; Paramana *et al.,* 2021). As such, we can conclude that while capacities for knowledge use are increasingly considered in literature, it is limitedly researched. Additionally, knowledge uptake is hardly mentioned in OWF and MSP related literature.

7.2. Answering sub-question 2: The organisation of OWF development and knowledge uptake in OWF development and MSP

Before considering the possible improvements of knowledge uptake in OWF development and MSP, it was necessary to unravel the processes involved in OWF planning and knowledge uptake. A description of these processes is provided in chapter 5.1, and 5.2. Based on the findings, this section summarizes the processes of OWF development and knowledge uptake to answer the research question: *How are OWF development and knowledge uptake concerning OWF development organised in Dutch MSP policy and decision making?*

When keeping in mind the sustainable energy goals that need to be attained, the quick out roll of OWFs is facilitated by the Dutch process of OWF development. The process has been adapted for government control with the 2009 selection system, area passports help to optimize the use of space, and the process structurally ensures transparency and security for investors, who are encouraged to get involved in the process. In general, the process of OWF development is comprehensive and functions well for attaining the goal of quick and cost-efficient OWF development. Additionally, more ecological values are included in tendering rounds, and the organisation of user meetings and inclusion of the OWF sector in the NZO ensures the inclusion of investors, facilitating innovation and the use of conceptual and procedural knowledge. With the inclusion of now lacking parties and knowledge topics, the NZO could become an important structural factor for developing joint visions and knowledge uptake in Dutch OWF planning policy and MSP.

While especially factual, but also conceptual and procedural knowledge grow in importance, more time and resources are required to improve understanding. Knowledge programmes like WOZEP and MONS are addressing this by looking at the cumulative effects, and including many disciplines. Particularly MONS aims to structure the acquisition and use of knowledge and address more influences on the North Sea. As such, the programme aims to contribute to knowledge uptake through system understanding, knowledge integration and single loop learning, as well as including more conceptual and procedural knowledge. However, knowledge uptake is limitedly considered. Especially the interpretation, valuation and sometimes comprehension of knowledge are limited in policy, mostly due to the need for rapid development of OWFs.

7.3. Answering sub-question 3: How intellectual capacity changes OWF and MSP related policy

This section aims to answer the sub-question: *Which types of intellectual capacity are present in Dutch MSP, and OWF related policy processes to what extend and how does this influence knowledge uptake?* The section presents conclusions on the different aspects of intellectual capacity, summarising their status and influence in Dutch OWF development and policy and decision making in MSP. The section will end by answering the research question for intellectual capacity as a whole.

7.3.1. System understanding

System understanding concerns the comprehension of systems under study. The effect of these systems on policy formation and the subsequent effect of interventions on the biophysical system is essential for knowledge uptake. The realised need for better system understanding was one of the main motivations for this research, and the lack of knowledge about the North Sea system is universally agreed upon according to the results. Ample reasons exist for the persistence of knowledge

gaps: the dynamic nature of the ocean, limited timescale, and wide array of activities make it challenging to link causes and consequences. While efforts to develop more knowledge about the North Sea are increasing the intellectual capacity of institutions and stakeholders, the specific research questions and focusses imposed by the government receive ample critique. As such, if knowledge uptake is to occur in an efficient and effective manner, there is a need to re-consider the role of scientists, and other stakeholders, demonstrating the need for knowledge integration and double-loop learning. Despite the necessity to further adopt goals and frameworks, system understanding contributes significantly in issues with easy to adopt factual knowledge and increasingly in more complex issues due to the adaptation of goals and frameworks.

7.3.2. Knowledge integration

Knowledge integration concerns the inclusion of knowledge from different sectors and disciplines among different parties and into policy, or *the acquisition of diffuse knowledge*. The importance of joint knowledge bases and viewpoints is increasingly realised in sectors and disciplines involved in OWF and MSP. Through this discursive shift towards more holistic thinking, we see that it is taken up as explicit policy goal by the NZO, and increasingly facilitated in research programs.

Analysis according to the 4 conditions necessary for knowledge integration as indicated by Janssen *et al.,* (2014), demonstrated an increase in integration. The mentioned change in discourse, the development of integrative knowledge programs, and the establishment of policy arenas like the NZO increased the intensity, iterativity, structure, and integral assessment of interactions. Existing interactions between departments and knowledge development were regarded as structural, but sometimes insufficiently open. Multiple iterations were present in arenas and some knowledge programs and assignments, but not in all considered knowledge programs and knowledge assignments by departments. Structure and continuity were recognised as particular issues in MONS. However, integral assessment according to stakeholder interest and scientific knowledge was seldomly assured. The NZO was an exception, since policy documents regulating the internal workings of the NZO explicitly addressed all four of these conditions. The opportunity of developing intellectual capacity through learning together is evident. The body's capacity to solve issues between uncompromising parties through expert knowledge is promising.

Trust was discussed as important for knowledge integration, and conflict prevention. This can best be established through the cultivation of strong informal and personal relations. However, the establishment of formal knowledge contracts between departments and knowledge developers was found to facilitate such personal relations. As such, both formal, and informal relations should be established to develop intellectual capacity through knowledge integration and contribute to knowledge uptake by acquiring and comprehending diffuse information. All in all, knowledge integration is improving and receives more attention, but requires further structuration in OWF development processes and improved relations between departments and knowledge developers to improve knowledge uptake.

7.3.3. Single loop learning

Single loop learning is the adaptation of action strategies to existing goals. Results demonstrate that such adaptations occur on a regular basis. However, not all of these adaptations contribute to intellectual capacity since an action strategy for a goal that ends up being harmful due to a lack of double loop learning, leads to a bad result. As discussed, the adaptation of goals, systems, and

frameworks to existing context is therefore vital for single loop learning to be affective. Concludingly, policy goals have to be informed well through other aspects of intellectual capacity for single loop learning to be effective.

7.3.4. Double-loop learning

Double loop learning is the re-interpretation of existing policy goals, systems, and frameworks to match evolving contexts and knowledge bases. Results demonstrate that double-loop learning is often a long-term process. It is an iterative and discursive process of changing viewpoints, and slow adjustment of policy systems and frameworks. This becomes predominantly clear when we look at the gradual change towards an interpretation of the North Sea as a holistic system, and the slow adaptation of planning processes towards a more marine based system. As such, the intention to re-align policy to changing contexts is visible in the results but most MSP policy is still based on general laws with a predominantly terrestrial perspective and role division.

7.3.5. Does current intellectual capacity lead to better knowledge uptake in MSP, and OWF related policy processes?

Intellectual capacity is increasing in Dutch OWF development and policy and decision making in MSP. The most important finding was present in al conclusion and demonstrates that aspects of intellectual capacity require the development of other aspects in almost all circumstances to be truly affective.
Results indicate that double-loop learning depends on better system understanding, since the alignment of goals to environmental contexts requires the understanding of these contexts. Double-loop learning can also lead to better system understanding through the adaptation of research agendas, based on evolving contexts. Single loop learning, or the adaptation of action strategies is only effective when goals are properly aligned to the context, and this context often requires many institutions, organisations and disciplines to integrate knowledge. All in all, this joint development was demonstrated to be increasing in Dutch OWF development and MSP. However, especially the longer term-capacities like double loop learning need proper facilitation to be attained.

As such, current intellectual capacity in OWF development and MSP is increasing knowledge uptake. However, this happens at different speeds and extents, depending on the topic at hand. We see that factual knowledge is often adopted immediately. Conceptual and procedural knowledge is often more complex and implemented depending on the topic. Such knowledge is put into policy when it concerns protected species but not when it concerns fundamental species in the food chain. Finally, metacognitive knowledge appears to be largely ignored, but in some institutions, like the NZO, the different biases, contexts, and interests are included in policy making. Due to this inclusion, this thesis recommends the expansion of the NZO, and the imitation of its structure, goals, and procedures in the development of future discussing bodies, both for MSP and other societally relevant topics.

7.4. ANSWERING THE MAIN QUESTION

In this section, findings, discussions, and conclusions from previous sectors are combined to answer the main research question of this research: *What opportunities and barriers exist for the development of knowledge uptake in Dutch MSP, and how can the capacity for knowledge uptake concerning the placement and operation of Offshore Wind Farms in Dutch MSP be enhanced.*

Many barriers and opportunities to the development of knowledge uptake in OWF development and MSP have been mentioned. Particularly impactful barriers, ways of overcoming them, and opportunities are listed below. Most of the barriers and opportunities were explicitly mentioned in the previous sections, others were identified based on implicit findings. After considering the barriers, opportunities and how they can be dealt with, a final conclusion is given. Recommendations that were not explicitly linked to opportunities and barriers are presented in the next chapter on recommendations, due to the nature of the main research question, recommendations can be seen as an extension of the answer to the main question.

A lack of knowledge

A major barrier for the uptake of knowledge in OWF development and MSP is the lack of knowledge about the North Sea. During this research the underlying reasons for this lack have become apparent. The limited degree of past research and time-consuming nature of knowledge development about marine systems constitute a barrier. The complex circumstances in the North Sea and array of activities further complicate research. Additionally, the many parties and epistemological perspectives involved have to be aligned for universal agreements and actions, complicating knowledge uptake.
Just like the barrier itself, a solution would be complex and require fundamental, structural, and deep changes in current roles, approaches, goals, and frameworks.

One way to deal with the long periods of knowledge development is the increased use of modelling, which greatly speeds up the research process. The need for validation has to be kept in mind however if the quality of knowledge is to be guaranteed. Additionally, current limitations of computational power to model the North Sea, require technological innovation to solve. Apart from increases in skilled personnel and resources, other measures to deal with the long period of knowledge development is the early inclusion of scientists and comprehensive overview of necessary knowledge, mentioned in 6.1.1 to allow for better planning in knowledge development.

Supranational alignment

Policy goals indicated in EU directives are often interpreted differently by member states. As such, clear definitions can also help to align MSP and environmental protection approaches among North Sea countries. A way to attain such alignment however would be the development of a North Sea authority. Such an authority could come forth from OSPAR but would require more authority than the current unanimous voting system, where any country can decide to abstain. Currently, more integration between countries' Marine Spatial Plans would already contribute, this requires effort and mutual trust from all countries involved.

Uncertainty and adaptation

A major barrier to knowledge uptake is the uncertainties faced by scientists and policy-makers alike. The difficulty of including uncertainty into policy combined with the dynamic knowledge context of OWF development, make it difficult to develop adaptive policy, since knowledge bases change rapidly,

increasing uncertainty and the required speed of adaptation. Opportunities for adaptive policy to deal with this uncertainty have been indicated in chapter 5.3. For example, the adaptation of plot decisions during the construction phase, based on consultation with OWF owners. The adoption of such adaptive policy could improve the uptake of knowledge and help solve the dilemma between well-informed policy and quick development.

An issue with including uncertainties is that politics often decide on what is good and bad, and since uncertainties are hard to justify in politics, they are hard to include and even averted through the precautionary principle. While this is understandable the current situation demands a better inclusion of uncertainties, simply since so little is known. A good way for policy makers to stay aware of these, could be the discussed increase of relations between policy makers and scientists, align expectations, and the mentioned early inclusion of scientists.

To align expectation and increase knowledge integration, *knowledge contracts* between research agencies and policy organisations could be developed in greater detail. The contract could ensure the involvement of scientists in policy-making and vice-versa, regular updates on findings, presence at meetings or congresses, the inclusion of fundamental knowledge in policy, the inclusion of new findings on existing uncertainties, and generally align expectations between the organisations. Apart from official contracts, clear communication and admittance of limitations from both sides would improve this. This recommendation could be applied to MP and OWF development but also for other topics.

As mentioned, political interests can sometimes form a barrier for knowledge uptake, resulting in inconvenient truths being left out and preventing holistic views in policy. An institution to hold policy makers accountable was mentioned as a possible solution. Such an institution for knowledge accountability can structurally improve the transparency of political motivations for knowledge use in OWF policy and MSP. It could also prevent the misinterpretation of complex scientific results by policy makers. While such an institution could constitute a major improvement of knowledge uptake, developing such an institution is likely to be a difficult and controversial task.

7.5. Final conclusions

Based on the data found and discussed, this thesis demonstrates that while knowledge uptake is limitedly considered in academics and practice, evidence of intellectual capacity has been found to contribute to knowledge uptake in Dutch MSP and OWF planning. As mentioned in the discussion, the specific aspects of intellectual capacity: system understanding, knowledge integration and learning, contribute to the acquisition, comprehension, interpretation, valuation and application of diffuse knowledge. It was also found that, as indicated in the theory, intellectual capacity is most effectively and efficiently improved, if its aspects are developed in tandem. While system understanding and single loop learning are considered to a greater extent, they require knowledge integration and double loop learning for MSP to be able to deal with the complex and dynamic nature of the sea and the activities therein. However, current developments demonstrate that efforts are made to reconsider the goals, frameworks, and governance systems involved in MSP, and to integrate multisectoral and multidisciplinary knowledge into new policy. Since this positive trend is far from completed, opportunities and barriers should be acted upon to increase the intellectual capacity of Dutch OWF planning and MSP in institutions. Knowledge should be included into policy more structurally, policy makers and scientists should align expectations, and an overarching institution should be developed to deal with knowledge and the division of North Sea space. Knowledge should

be developed concerning the vital aspects of the North Sea system. This development would require organisations and institutions to cooperate in an intensive and trustworthy manner to integrate knowledge, and goals. Finally, goals, strategies, systems, and technologies should be constantly adapted if the context requires it.

8. RECOMMENDATIONS

This section provides an extension of the answer on the main research question, indicating how knowledge uptake in OWF development and policy and decision-making in MSP could be improved through both science and policy.

8.1. FOR POLICY

First, more adaptive policy is desirable to deal with the dynamic knowledge situation in OWF development and MSP. A way to facilitate adaptive policy, could be to allow for adaptations of plot decisions in later phases of OWF development. For example, OWF construction generally takes five years, if new knowledge leads to required adaptations in future OWF development, government agencies and OWF developers could jointly look at what can still be adapted in the project under construction. As such, the speed of knowledge uptake could increase. How the further development of the NZO and the inclusion of knowledge during the construction phase could best be realised, requires further study.

Second, most improvements in the approach of system understanding require a degree of improved knowledge integration and learning to increase the integral character and joint acceptance of knowledge goals and systems. An example is how currently, there is a skewed focus in OWF related research agendas. A better distinction between *fundamental knowledge* and *policy-oriented knowledge* may help to clarify the currently skewed distribution and contribute to the reservation of more resources for fundamental research.

third, the fulfilment of conditions of knowledge integration in a fundamental way by the NZO was considered to be extremely valuable by participants and policy documents alike. As such, the explicit establishment of such regulations, like those ensuring a continuous structure, ensuring long term existence, and ensuring close and iterative interactions, could greatly increase intellectual capacity. The structural implementation of similar regulations in knowledge programs, discussion bodies, departments, and approaches are therefore recommended.

Fourth, the initial discursive shift towards a more holistic view of the North Sea, system and more marine-based approaches is far from complete. To ensure that these adaptations continue, fundamental knowledge concerning the systems of the North Sea basin should be taken up into policy. When the fundamental qualities of the system are central in policy-making, holistic and marine-based policies are likely to follow since they are aimed at governing from this fundamental perspective.

Fifth, decommissioning should be taken up in licensing. However, we do not know enough about the effect of OWFs to develop concrete terms. An obligatory EIA before decommissioning could lead to better considerations of the ecological developments, informing policy on whether to remove artificial reefs.

Sixth, results demonstrated that political interests sometimes form a barrier for the holistic use of knowledge. An institution to hold governmental departments and other policy makers accountable was mentioned as a possible solution. Such an institution for knowledge accountability can structurally improve the transparency of political motivations for knowledge use. While such an institution could constitute a major improvement of knowledge uptake, developing such an institution is likely to be a difficult task. More research is needed to consider the development of such an institution.

8.2. FOR RESEARCH

First, trust is seen as an extremely important condition for both knowledge integration and the capacity to learn. Since trust is not explicitly mentioned as a condition for knowledge integration in theory, this thesis suggest the inclusion of trust in future frameworks of knowledge integration and intellectual capacity. Managerial sciences have often demonstrated the positive effect of trust on cooperation. As such, further research should be performed in the possibility to increase trust in MSP and OWF development, specifically between scientists and policy makers.

Second, based on the answer on the first sub-question, it becomes clear that knowledge uptake is insufficiently considered in both literature and practice. A conscious and transparent consideration of how knowledge finds its way into policy, and how policy is informed, could contribute to the development of knowledge uptake in the long run. As such, this thesis recommends further research into systems of knowledge uptake in MSP and OWF development. Additionally, discussions or strategies concerning knowledge uptake would contribute to its development in policy and decision-making. This thesis recommends the use of the following definition for knowledge uptake for its clear and transparent consideration: *the acquisition and comprehension of diffuse information and its subsequent interpretation, valuation, and application into policy.* Finally, this thesis employed a framework of intellectual capacity to analyse the aspects and processes that jointly form knowledge uptake. This thesis recommends the further use of this framework as well as the exploration of different frameworks for the analysis of knowledge uptake.

Lastly, this thesis provides an overview of the systems of knowledge uptake, it does not consider how specific knowledge is taken up into specific policy. In some occasions the thesis refers to influences through discourse, actors, or rules of the game, as influencing policy. However, the scope of the thesis did not allow for extremely detailed analysis of such influences. Such research would require more detailed knowledge on certain policies and how they are specifically influenced by knowledge. Specific insight on how knowledge can for example influence plot decisions, area selection, or national water programs would be extremely valuable for the understanding of knowledge uptake in OWF development and MSP policy and decision-making. See the reflection on theory for a possible theoretical framework which facilitates such more detailed research concerning knowledge uptake in specific policies.

9. REFLECTION

Various comments can be made regarding the limitations of this thesis in relation to the theories employed, the validity of the results, and the usage of methods. This chapter will discuss the strengths, weaknesses and limitations of this study. This chapter will first discuss the theoretical choices in this thesis, afterwards it reflects on the limitations of results and ends methods used.

THEORY

The choice of theory in this thesis came about by combining several theories under consideration. Literature research into knowledge uptake provided several theories. Theories on learning and knowledge integration seemed to be the most suitable to consider knowledge uptake in OWF development and MSP since they were well structured and included transparent conditions. Most other theoretical statements on knowledge uptake considered tools for the analysis of research impact, or the use of innovative technologies. These theories were not considered suitable for the uptake of knowledge concerning the biophysical, socio-economic, and governance systems relevant for the North Sea basin (Bharwa and Skinner, 2020; Rose and Manley, 2012).

While considering the choice between knowledge integration and learning theory, theories concerning intellectual capacity were discovered. In intellectual capacity theory, the combination of the two theories under consideration and the addition of system understanding as a fundamental aspect provided for a more complete consideration of knowledge uptake, and was therefore selected for this thesis.

In answering the sub-question on how intellectual capacity changes specific policy and decision-making in MSP, the conclusion shows that the theory did not to consider the specific ways in which knowledge can lead to policy change. While changes in policy were identified, and could be attributed to aspects of intellectual capacity, the specific way in which they changed policy-and decision making was not considered. Future research could fill this gap by considering how aspects of intellectual capacity influences policy arrangements. This possible addition to the conceptual framework is elaborated below, and visualized in figure 15 and 16

In future study, changes in the marine policy domain can be conceived in terms of the necessary renewal of policy arrangements. Policy arrangements are defined as: “A temporary stabilisation of the substance and organisation of policy domains in terms of policy discourses, actor coalitions, rules of the game and resources” (Arts, *et al.,* 2006; Van Tatenhove *et al.,* 2000). Arrangements are expected to stabilize as a result of daily interaction, and can be analysed or changed from four dimensions, see figure 3 (Liefferink, 2006). These dimensions embody a useful framework of how policy arrangements can be influenced through knowledge, and how they can support its development and use. Additionally, these dimensions have already been mentioned implicitly as important for the features of intellectual capacity:

- *Actors* and *coalitions* in the policy domain. It was mentioned already that learning happens through individuals, and that knowledge integration is simplified through close cooperation (Keijser *et al.,* 2020; Janssen *et al.,* 2014).
- The *resources* available to different actors, which leads to differences in power. Knowledge use depends a lot on the goals and epistemology of those in power. Knowledge itself can be seen as a resource depending on the goals of certain actors (Flyvbjerg, 2003; Faludi, 2000).

- *Rules of the game* or both formal and informal procedures of implementation and decision making. These can be improved and influenced through learning. Especially double-loop learning is explicitly mentioned to aspire change in this dimension (Willems *et al.,* 2018).
- Existing policy *discourses*, referring to different views, narratives, norms, values, epistemological lenses, and conceptions of goals and problems of actors involved. The discourses within an organisation can have great influence on their learning capacity and how they regard and use certain knowledge (Liefferink, 2006; Keijser *et al.,* 2020).

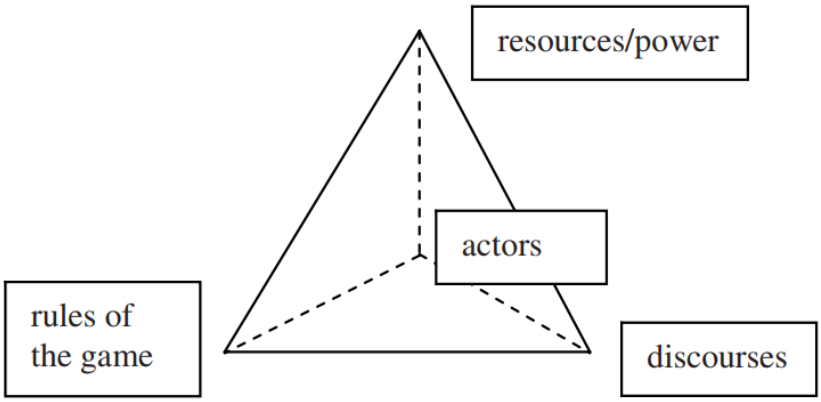


Figure 15: The tetrahedron of policy arrangements demonstrates the four interconnected dimensions of a policy arrangement (Liefferink, 2006).

The assessments, interactions, and monitoring programmes which lead to intellectual capacity building in practice can be analysed based on which intellectual capacities they build upon, and how they influence policy arrangements based on the four dimensions discussed. In figure four, the conceptual framework of this thesis, policy formation does not specify how knowledge uptake can change policy, and is thus a black box. Figure 17 demonstrates how policy arrangement theory can be used to fill this black box with specific insight.

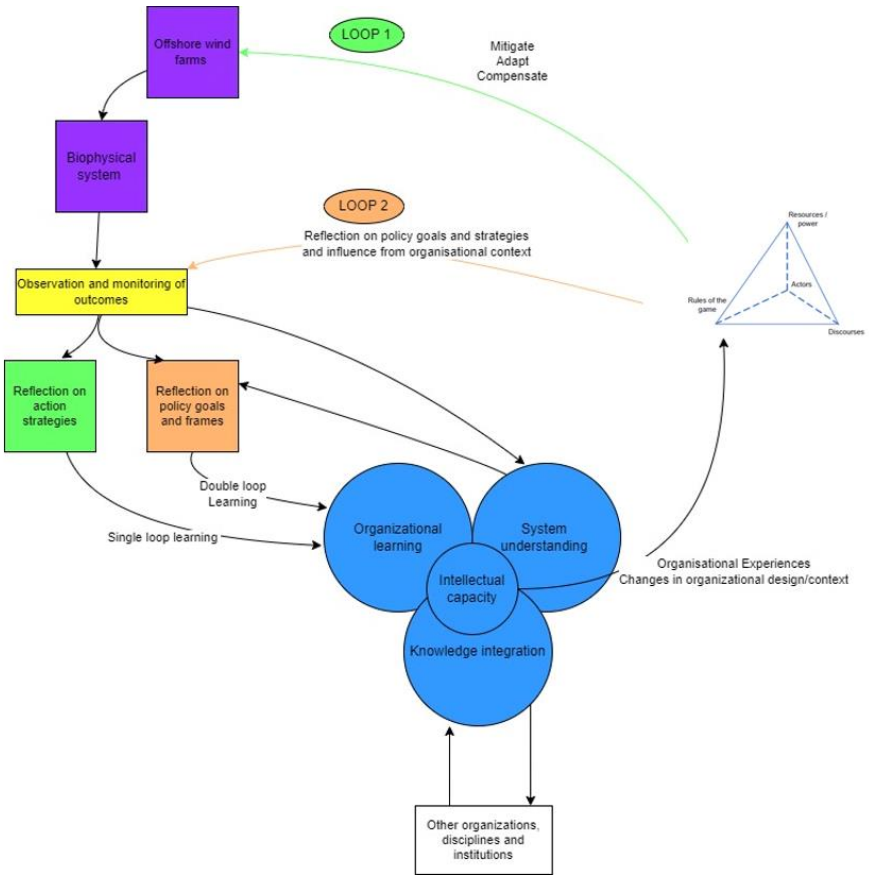


Figure 16: A re-draft of the conceptual framework presented in figure four, including policy arrangements to allow for the analysis of how knowledge uptake can change specific policies, depending on their arrangements.

THE VALIDITY OF RESULTS AND METHODS, LIMITATIONS

Concerning the validity of results and methods in this thesis, several things have to be kept in mind. To reflect on the quality of these results, criteria for the quality of qualitative research are used. The elements of credibility, transferability, dependability, confirmability, and saturation are reflected upon in the section below (Shenton, 2004).

First, saturation entails that no additional data can be found that may shed an additional light on the study at hand (Shenton, 2004). Concerning the time and resources of the researcher and the extensive number of possible sources, data saturation was attained. Interviews and documents later in the research process did not provide much novel information. It has to be mentioned however, that this research was not exhaustive in which groups it considered. The conscious choice of focussing on the interaction between researchers and policy makers was a result of this limited timeframe. However, inquiry in the position of the OWF industry would have made a strong contribution to this study's representation of the real situation of knowledge uptake in OWF development and MSP.

Second, credibility concerns the conformity between the research and reality (Shenton, 2004).
As mentioned, the limited timeframe meant that not all relevant stakeholder groups could be considered, which can reduce the conformity to reality in this thesis. Another issue for the credibility of this thesis is the dynamic context of OWF development and MSP, as well as environmental laws in the Netherlands. It has to be kept on mind that since the Dutch kabinet's decision to further increase the 2030 OWF goals with 10.7GW in March 2022. Since this decision, no new plot decisions or area

selection documents have been released that consider these new goals. Future research would have to consider the effect of this increased ambition on knowledge uptake. Additionally, the Netherlands is currently in transition to a new legal framework of environmental law, which will be bundled in the law on the environment. This new legal context has not been taken into consideration and should be addressed in future research.

As mentioned in the reflection on the method, the selection of participants may have influenced the findings. Due to the possibilities of working for Deltares during the thesis, a large number of researchers were selected from Deltares and the research consortium in which the author assisted. However, since this consortium was specifically developed to be multi-disciplinary, and researchers from many different backgrounds were selected from Deltares, no particular obstructions for credibility are expected.

However, one possible issue is the selection of participants among policy-makers. Many policy-makers declined the request for interviews. Most policy-makers interviewed were positive about the inclusion of knowledge but indicated that many of their colleagues were less inclined towards academic research. As such, it is possible that our selection of policy-makers does not represent the employees at the average government department. However, participants were asked about the specifics of colleagues who are less inclined towards research to mediate this possible lack.

A final consideration on credibility is that the spatial scales at which the the biophysical systems of the North-Sea function, do not relate to the levels of government at which it is planned. Additionally, the coordination of many of the North-Sea's uses on a regional scale could massively increase their productivity. In order to protect the North-Sea ecology and make optimal use of ecosystem services, and other uses, planning should happen at the appropriate scale. While the EU, and several international treaties and organisations attempt to ensure uniform rules for integrated uses, the protection of important species, and the management of transport routes, OWF planning mostly happens based on national plans, and according the borders of national waters. However, due to the complexity of OWF development and the interests of different actors involved, this study focussed at the Dutch national level, to keep the task comprehensive and clear. We highly recommend future research on the different views on knowledge of OWF planning in all countries bordering the North-Sea. However, this would require a comprehensive understanding of the different policy arrangements and their relations with intellectual capacity in all countries involved.

Third, transferability provides insight on whether findings can be used to interpret other cases (Shenton, 2004). The application of the framework of intellectual capacity to analyse the extent of knowledge uptake is explained and developed to such a degree that it is possible to apply the findings to other cases. While the context of knowledge uptake is specific for this research, the formulation of a definition for knowledge uptake is universal and can be used for analysis in other cases. Thus, it is held that transferability was attained in this research.

Fourth, dependability concerns whether this research is reproduceable (Shenton, 2004).
The theoretical notions, conceptual framework, methods, and context of this research are extensively and transparently explained. The use of both deductive and inductive codes, and the semi-structured interviews allowed for different structures and lines of questioning in interviews, slightly reducing the ability for re-production. However, since every interview set out according to the same structure and

each respondent was asked the same questions, no serious impediments are expected to arise in the reproduction of this research.

Fifth, confirmability considers the objectivity of research and whether findings are not based on the preferences and characteristics of the researcher. As mentioned in the reflection on methods, my position of a researcher may cause an unconscious bias towards the position of researchers as opposed to that of policy-makers. However, triangulation and feedback from coordinators at Deltares concerning the objectivity of findings were strenuously adhered to. As such, no serious obstructions to the objectivity of research are expected and objectivity can be considered to be attained in this thesis.

Additionally, conscious decisions were made about the use of results. In some cases the improvement of technologies led to a change in goals, systems or frameworks. These results were ultimately not taken up in considerations of double loop learning since it would be hard to infer wether these changes were caused by knowledge uptake, by lobbying, or other pressures.

Finally, while this study focusses on aspects of intellectual capacity, future research is needed to consider the position of legal, technical, and socio-political capacity in the institutions governing OWF development (Fransz *et al.*, 1991; Clarke and Flannery, 2020; European Commission, 2020a; European Commission, 2020b; Spijkerboer *et al.*, 2020; Gușatu *et al.*, 2021, 2020; NWO, 2020; Rijksoverheid, 2021A,B).

REFERENCES

Ansong, J., Calado, H. and Gilliland, P. M. (2021). 'A multifaceted approach to building capacity for marine/maritime spatial planning based on European experience', *Marine Policy*. Elsevier Ltd, 132. pp. 103422.

Argote, L. (2011). 'Organizational learning research: Past , present and future'. *Management learning,* 42(4), pp. 439-446.

Armitage, B., Marschke, M. and Plummer, R. (2008). 'Adaptive co-management and the paradox of learning'. *Global Environmental Change* 18, pp. 86–98.

Arts, B., Leroy, P. and Van Tatenhove, J., (2006). 'Political modernisation and policy arrangements: a framework for understanding environmental policy change'. *Public organizational review.* 6.2. Springer, pp. 93-107.

Babbie, E. (2013). '*The practice of social research'.* Wadsworth, NY.

Basco-Carrera, L. (2017). 'Collaborative Modelling for Informed Decision Making and Inclusive Water Development'. *Water Resources Management*. 31(9), pp. 2611–2625. doi: 10.1007/s11269-017-1647-0.

Bakır, C. (2017). 'Policy learning and policy change: learning from research citations'. *Policy Science,* 50, pp. 585–597. doi: 10.1007/s11077-017-9299-8

Baxter, P. and Jack, S. (2008). 'Qualitative case study methodology: Study design and implementation for novice researchers'. *The qualitative report*, 13(4), pp.544-559.

Berkhout, F., Hertin, J. and Gann, D.M., (2006). 'Learning to adapt: Organisational adaptation to climate change impacts'. *Climatic Change,* 78(1), pp. 135–156.

Bhaskar, R. (1975). 'A realist theory of science'. York, Books.

Bhawra, J. and Skinner, K. (2020). 'Examination of tools associated with the evaluation of knowledge uptake and utilization: A scoping review'. *Evaluation and Program Planning*, 83, pp. 101875.

Blaak, M. (2021). 'The normative practitioner: adding value to organisational learning in education NGOs in Uganda'. University of Groningen. doi: 10.33612/diss.192062455

Brown, C., Boltz, F., Freeman, F., Tront, l. and Rodriguez, D. (2020). 'Resilience by design: A deep uncertainty approach for water systems in a changing world'. *Water Security*. Elsevier, 9, pp. 100051. doi: 10.1016/j.wasec.2019.100051.

Brugnach, M. Dewulf, A., Pahl-Wostl, C. and Taillieu, T. (2008). 'Toward a relational concept of uncertainty: About knowing too little, knowing too differently, and accepting not to know', *Ecology and Society*, 13(2). doi: 10.5751/ES-02616-130230.

Böcher, M. and Krott, M. (2016). '*Science makes the world go round: Successful scientific knowledge transfer for the environment*'. Cham: Springer International Publishing

Bourblanc, M., Crabbé, A., Liefferink, D. and Wiering, M., (2013). 'The marathon of the hare and the tortoise: implementing the EU Water Framework Directive'. *Journal of Environmental Planning and Management*, 56(10), pp. 1449-1467.

BZ (Dutch ministry of foreign affairs). (1993). 'Verdrag inzake de bescherming van het mariene milieu in het noordoostelijk deel van de Atlantische Oceaan, met Bijlagen en Aanhangsels'. *Tractatenblad van het koninkrijk der Nederlanden*, 51, Nr. 2. Paris.

BZK (Dutch ministry of internal affairs and kingdom relations). (2020). 'Handreiking gebiedspaspoort Borssele'. Ministerie van binnenlandse zaken en koningsrelaties.

Cash, D. W., Clark, W. C., Alcock, F., Dickson, N., Eckley, N. and Jäger, J. (2002). 'Salience, credibility, legitimacy and boundaries: Linking research, assessment and decision making'. John F. Kennedy School of Government, Harvard University.

Campbell, D. and Bleiker, R. (2016). 'Post-structuralism'. In: *International relations theories: Discipline and diversity.* eds: Dunne, t., Kurki, M. and Steve Smith, S. Oxford University Press, pp. 196-219.

Clarke, J. and Flannery, W. (2020). 'The post-political nature of marine spatial planning and modalities for its re-politicisation'. *Journal of Environmental Policy and Planning*. Taylor & Francis, 22(2), pp. 170–183. doi: 10.1080/1523908X.2019.1680276.

Cars, G. Healey, P. Madanipour, A. and, De Magalhaes, C. (2017). '*Urban. Governance, Institutional Capacity and Social Milieux*'. Routledge: Abingdon, UK,

Charnock, H., Dyer, K. R., Huthnance, J. M., Liss, P., and, Simpson, B. H. (2012). '*Understanding the North Sea System'*. Springer Science & Business Media.

Danermark, B. (2002). 'Interdisciplinary research and critical realism: The example of disability research'. *Journal of Critical Realism*, 5(1), pp. 56-64.

Dannheim, taim, J., Bergström, L., Birchenough, S. N., Brzana, R., Boon, A. R., Coolen, J. W., Degraer, S. (2020). 'Benthic effects of offshore renewables: identification of knowledge gaps and urgently needed research'. *ICES Journal of Marine Science*, *77*(3), pp.1092-1108.

Danish ministry of climate, energy, and utilities. (2018). 'Energy agreement 2018'. Copenhagen.

Dassenakis, M., Poulos, S., Megalofonou, P., Paramana, T., Karditsa, A., Petrakis, S. and, Milatou, N. (2019). 'Environmental status of Lakonikos Gulf in connection to MSP'. *Proceedings of the 14th MEDCOAST Congress on Coastal and Marine Sciences, Engineering, Management and Conservation*, Marmaris, 1, pp. 361–372.

Dembski, S. and Salet, W. (2010). 'The transformative potential of institutions: How symbolic markers can institute new social meaning in changing cities'. *Environment and Planning A*, *42*(3), pp. 611-625.

de Roo, G. (2018). 'Spatial Planning and the Complexity of Turbulent, Open Environments: About purposeful interventions in a world of non-linear change'. In M. Gunder, A. Madanipour, & V. Watson (Eds.), Routledge, *The Routledge Handbook on Planning Theory.* pp. 314-325.

Devetak, R., Linklater, A., Donnelly, J., Paterson, M., Reus-Smit, C., and. True, J. (2005). '*Theories of international relations'*. Palgrave Macmillan.

Dunne, Tim, Milja Kurki, and Steve Smith, eds. (2016). '*International relations theories: Discipline and diversity'*. Oxford University Press.

van Doren, D. Runhaar, H. Driessen, P. and, Schijf, B., (2013). 'Evaluating the substantive effectiveness of SEA: Towards a better understanding', *Environmental Impact Assessment Review*. Elsevier B.V., 38, pp. 120–130. doi: 10.1016/j.eiar.2012.07.002.

Edelenbos, J., van Buuren, M.W., and. van Schie, N. (2011). 'Co-producing knowledge: joint knowledge production between experts, bureaucrats and stakeholders in Dutch water management projects'. *Environment science, and policy* 14, pp. 675-684.

Edelenbos, J. and Teisman, G. (2013). 'Water governance capacity'. *International Journal of Water Governance*, 1(1), pp. 89–108. doi: 10.7564/12-ijwg5.

EMMFEU. (2020). 'Strategic Environmental Assessment On North Sea Energy'. European Maritime and Fisheries Fund, Brussels.

Entman, R., (1993). 'Framing: Toward clarification of a fractured paradigm'. *Journal of Communication*. 43(4). pp. 51–58.

Ehler, C. (2008). 'Conclusions: benefits, lessons learned, and future challenges of marine spatial planning'. *Marine Policy*, *32*(5), pp. 840-843.

Ehler, C. N. (2018). 'Marine spatial planning: an idea whose time has come'. *Offshore energy and marine spatial planning*, pp. 6-17.

Ehler, C., Douverre, F., (2009). 'Marine Spatial Planning: A step by step approach to ecosystem-based management'. intergovernmental Oceanographic Commission and Man and the Biosphere Programme. iOC Manual and Guides. 53(6). Paris.

Eliasson, I. (2000). 'The use of climate knowledge in urban planning'. *Landscape and urban planning*, *48*(1-2), pp.31-44.

European Commission. (2008). 'Directive of the European Parliament and of the Council Establishing a Framework for Community Action in the Field of Marine Environmental Policy, Marine Strategy Framework Directive'. European Commission Directive 2008/56/EC, OJ L 164.

European Commission., (2014). 'Directive of the European parliament and council establishing a framework for marine spatial planning (Marine spatial planning directive)'. European Commission. Directive 2014/89/EU, OJ L 257/135

European Commission. (2017). 'Report on the Blue Growth Strategy Towards more sustainable growth and jobs in the blue economy'. Brussels.

Ion., (2019). 'Key stages and progress up to 2019.' Available at: https://ec.europa.eu/info/files/report-implementation-marine-strategy-framework-directive-key-stages-and-progress-2019_en. (Accessed: 03/04/2022).

European Commission. (2020) '*Report on the implementation of the Marine Strategy Framework Directive'. 259*

European Commission. (2022) 'REPowerEU: Joint European action for more affordable, secure and sustainable energy.' Available at: https://ec.europa.eu/commission/presscorner/detail/en/ip_22_1511 (Accessed: 22/03/2022).

European MSP Platform. (2022). 'The Netherlands'. Available at: https://www.msp-platform.eu/countries/netherlands. (Accessed: 22/03/2022).

EZK., (2015). 'Uitvoeringsregeling Wet windenergie op zee. nr. WJZ/15083277'. Available at: https://wetten.overheid.nl/BWBR0036786/2017-04-01#SlotformulierEnOndertekening (accessed: 19/05/2022).

EZK. (2021A).'Ontwikkelkader windenergie op zee'. Ministerie van Economische Zaken en Klimaat: Den Haag.

EZK. (2021B). 'Wijzigingsbesluit kavelbesluiten I, II, III, IV en V (innovatiekavel). windenergiegebied Borssele, I, II, III en IV. windenergiegebied Hollandse Kust (zuid) en V windenergiegebied Hollandse Kust (noord)'. Den Haag.

Fabricius, C. and. Cundill, G. (2014). 'Learning in adaptive management: insights from published practice'. *Ecology and Society*, *19*(1).

Faludi, A. (2000). 'The performance of spatial planning'. *Planning practice and Research*, *15*(4), pp. 299-318.

Farooq, R. (2018). 'A conceptual model of knowledge sharing', *International Journal of Innovation Science*, 10(2), pp. 238–260. doi: 10.1108/IJIS-09-2017-0087.

Fazey, I., Fazey, J. A. and. Fazey, D. M. (2005). 'Learning more effectively from experience'. *Ecology and Society*, *10*(2).

Flyvbjerg, B. (2003). 'Rationality and Power', *Readings in planning Theory, 3.* pp. 318–329.

FOD., WMU., (2021). 'Transnational marine spatial planning in Europe' FOD Mobiliteit en Vervoer, Available at: https://maritime-spatial-planning.ec.europa.eu/practices/transnational-maritime-spatial-planning-north-sea-shipping-context (Accessed: 06/01/2021).

Foster, N. (2014).'EU Law' *oxford press.,* Oxford, United Kingdom.

Foucault, M., (1980). '*Power-Knowledge'*. 1. Random house USA, New York.

Fransz, H. G., Mommaerts, J. P. and. Radach, G. (1991). 'Ecological modelling of the North Sea', *Netherlands Journal of Sea Research*, 28(1–2), pp. 67–140. doi: 10.1016/0077-7579(91)90005-L.

Gazzola , P., Roe, M. and Cowie, P. (2015). 'Marine spatial planning and terrestrial spatial planning: reflecting on new agendas', *Environment and Planning C: Government and Policy*, 33(5), pp. 1156–1172. doi: 10.1177/0263774X15612317.

Grossoni, P. and Bussotti, F. (no date). 'Recent research projects of Plant Biology Department on Vallombrosa.' *L'Italia Forestale e Montana (Italy)*.

Gusatu, L., Zuidema, C., Yamu, C. and Faaij, A., (2020). 'A spatial analysis of the potentials for offshore wind farm locations in the North Sea region: Challenges and opportunities', *ISPRS International Journal of Geo-Information*, 9(2).

Gusatu, L. F., Zuidema, C., Yamu, C., Faaij, A. (2021). 'Spatial and temporal analysis of cumulative environmental effects of offshore wind farms in the North Sea basin', *Scientific Reports*, 11(1), pp. 1–18.

Gilek, M. (2016). '*Governing Europe's Marine Environment: Europeanization of Regional Seas Or Regionalization of EU Policies'*. Routledge.

Gilek, M., Armoskaite, A., Gee, K., Saunders, F., Tafon, R., and Zaucha, J. (2021). 'In search of social sustainability in marine spatial planning: A review of scientific literature published 2005–2020'. *Ocean & Coastal Management*, *208*, pp.105618.

Hanlon, O. and Cummins, V. (2020). 'A comparative insight of Irish and Scottish regulatory frameworks for offshore wind energy – An expert perspective', 117.

Hallowell, M. R. (2009). 'Techniques to minimize bias when using the Delphi method to quantify construction safety and health risks. Building a Sustainable Future'. Construction Research Congress, Seattle, Washington, pp. 1489–1498.

Haque, A., Dodman, D. and Hossain, M. (2014). 'Individual, communal and institutional responses to climate change by low-income households in Khulna, Bangladesh'. *Environment and Urbanization*, 26(1), pp. 112–129. doi: 10.1177/0956247813518681.

Healey, P. (1998). 'Building institutional capacity through collaborative approaches to urban planning'. *Environment and planning, 30*, pp.1531–1546.

Hennink, M., Hutter, I., & Bailey, A. (2020). 'Qualitative research methods'. Sage.

Hovmand, P. and Richardson, G. (2011). 'Scriptapedia : A Handbook of Scripts for Developing Structured Group Model Building'. PDF hosted at the Radboud Repository of the Radboud University.

Hovmand, P. S. (2014) 'Community based system dynamics', *Community Based System Dynamics*, 9781461487630, pp. 1–104. doi: 10.1007/978-1-4614-8763-0.

Hsieh, H., and Shannon, S. (2005). 'Three approaches to qualitative content analysis'. *Qualitative health research*. 15(9). pp. 1277-1288. doi: 10.1177/1049732305276687. PMID: 16204405.

IDON. (2015). 'Integrated Management Plan for the North Sea'. Available at: https://www.noordzeeloket.nl/en/policy/noordzee-natura-2000/downloads/noordzeebeleid/@166927/integrated-0/ (Accessed 20 December 2018).

Informatiehuis marien., (2022) . 'De digitale Noordzee'. Available at: https://www.informatiehuismarien.nl/nieuws/nieuwsberichten-artikelen/2021/iv-zee-informatievoorziening-diepte/ (Accessed: 06/05/2022).

Isaza, C., Herrera Kit, P. and Lozano Herrera, J. (2016). 'Capacity: A Literature Review and a Research Agenda', *SSRN Electronic Journal*.

IWR., (2021). 'Windparks in Deutschland geplande tenders en algemene info industrie.' *Offshore wind industrie de* Available at: https://www.offshore-windindustrie.de/windparks/deutschland: (Accessed, 21/05/2021).

I&W & EZK. (2014). 'Rijksstructuurvisie windenergie op zee 2016-2021'. Den Haag.

I&W, EZK. (2015). 'Policy document on the North Sea 2016-2021'. Den Haag.

I&W. (2020A). 'Appreciatie van de adviezen over de governance van het Noordzeeoverleg en deelname van de visserijsector. 'Kamerbrief IENW/BSK-2020/231757: Den Haag.

I&W. (2020B). 'Klimaatbeleid. Klimaatverandering' *Rijksoverheid.* Available at: https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatbeleid (Accessed 12/05/2021).

I&W, EZK, BZK, and. LNV. (2020). 'Klimaatbeleid'. Available at: https://www.rijksoverheid.nl/onderwerpen/klimaatverandering/klimaatbeleid (Accessed: 17/03/2022).

I&W, EZK, LNV. and. BZK. (2021). 'Marien strategie voor het Nederlandse deel van de Noordzee 2022-2027'. In: Programma Noordzee: 2022-2027. The Hague.

Janssen, S., Mol, A., Van Tatenhove, J., and Otter, H. (2014). 'The role of knowledge in greening flood protection. Lessons from the Dutch case study future Afsluitdijk'. *Ocean & Coastal Management*, *95*, pp. 219-232.

Jay, S. (2010). 'Built at sea: Marine management and the construction of marine spatial planning'. *Town Planning Review*, *81*(2), pp. 173-193.

Jay, S., Ellis, G., and Kidd, S. (2012). 'Marine spatial planning: a new frontier?' *Journal of Environmental Policy & Planning,* 14(1), pp. 1-5.

Jones, P., Lieberknecht, L., and Qiu, W. (2016). 'Marine spatial planning in reality: Introduction to case studies and discussion of findings.' *Marine Policy*, *71*, pp. 256-264.

Jick, T. D. (1979) 'Mixing Qualitative and Quantitative Methods: Triangulation in Action.' *Administrative Science Quarterly*, 24(4), pp. 602–611.

Kannen, A. (2014). 'Challenges for marine spatial planning in the context of multiple sea uses, policy arenas and actors based on experiences from the German North Sea.' *Regional Environmental Change,* 14 pp. 2139–2150. doi: /10.1007/s10113-012-0349-7.

Keijser, X., Toonen, H. and van Tatenhove, J. (2020) 'A "learning paradox" in maritime spatial planning', *Maritime Studies*, 19(3), pp. 333–346. doi: 10.1007/s40152-020-00169-z.

Kidd, S., and Ellis., G., (2012). 'From the land to sea and back again? Using terrestrial planning to understand the process of marine spatial planning'. *J. Environ. Pol. Plann.* 14 (2012) pp.49–66.

Kirkeby, I. M. and Flyvbjerg, B. (2016) 'Transferable Knowledge: An Interview with Bent Flyvbjerg', *SSRN Electronic Journal*, doi: 10.2139/ssrn.2711749.

Klakegg, O. J., Williams, T. and Shiferaw, A. T. (2016) 'Taming the "trolls": Major public projects in the making', *International Journal of Project Management*. Elsevier Ltd, 34(2), pp. 282–296. doi: 10.1016/j.ijproman.2015.03.008.

Krathwohl, D. R. (2002). 'A revision of Bloom's taxonomy: An overview'. *Theory into practice*, *41*(4), pp. 212-218.

Kwakkel, J. H., Haasnoot, M. and Walker, W. E. (2015) 'Developing dynamic adaptive policy pathways: a computer-assisted approach for developing adaptive strategies for a deeply uncertain world', *Climatic Change*, 132(3), pp. 373–386. doi: 10.1007/s10584-014-1210-4.

Laeni, N., Brink, M. V. D., Busscher, T., Ovink, H., & Arts, J. (2020). 'Building local institutional capacities for urban flood adaptation: Lessons from the water as leverage program in Semarang, Indonesia.' *Sustainability*, *12*(23), pp.10104.

Latour, B. and Paris, S. (2005) 'A Textbook Case Revisited – Knowledge as a Mode of Existence', *Nature*, pp. 381–382.

Levers, M. (2013) 'Philosophical paradigms, grounded theory, and perspectives on emergence', *SAGE Open*, 3(4). doi: 10.1177/2158244013517243.

Liefferink, D. (2006). 'The dynamics of policy arrangements: turning round the tetrahedron'. In: Arts, B., Leroy, P. (Eds.), Institutional Dynamics in Environmental Governance. Springer, Dordrecht, pp. 45-68.

Lindeboom, H., (2008). 'The North Sea, past and present: shifting baselines and human uses'. *in*: Mees, J. (Ed.) *VLIZ Young Scientists' Day, Brugge, Belgium,* 40: pp. 24.

Loos, A. Van Der. (2021) 'The co-evolution of innovation systems and context : Offshore wind in Norway and the Netherlands'. *Renewable and Sustainable Energy Reviews*. Elsevier Ltd, 138 p. 110513. doi: 10.1016/j.rser.2020.110513.

Mahapatra, Santosh K., Ram Narasimhan, and Paolo Barbieri. (2010). 'Strategic interdependence, governance effectiveness

and supplier performance: A dyadic case study investigation and theory development'. *Journal of Operations Management* 28.6 (2010): 537-552.

Matthijssen, J., Dammers, E. and Elzenga, H. (2018). 'De toekomst van de Noord Zee: de Noord Zee in 2030 en 2050, een scenariostudie'. Planbureau voor de leefomgeving.

Mccormick, J., (2014). 'Understanding the European Union'. Palgrave McMillian, Basingstoke UK.

McCreary, S., Gamman, J. and Brooks, B. (2001). 'Refining and testing joint fact-finding for environmental dispute resolution: Ten years of success'. *Mediation Quarterly*, 18(4), pp. 329–348. doi: 10.1002/crq.3890180403.

Ministry of VROM, ministry V&W, ministry of LNV, and ministry of EZ. (2004). 'Nota Ruimte.' available at: https://zoek.officielebekendmakingen.nl/kst-29435-2.html. (Accessed: 20/04/2022).

Ministry of V&W, Ministry of VROM, and Ministry of LNV, (2009). 'Nationaal Waterplan 2009-2015.' Available at: https://www.rijksoverheid.nl/documenten/rapporten/2009/12/01/nationaal-waterplan-2009-2015. (Accessed: 23/04/2022).

Ministry of I&E, and Ministry of EZ. (2015). 'Nationaal Waterplan 2016-2021.' available at: https://www.rijksoverheid.nl/documenten/beleidsnota-s/2015/12/14/nationaal-waterplan-2016-2021. (Accessed 25/04/2022).

Ministry of I&E, and Ministry of EZ. (2015). 'Rijksstructuurvisie Windenergie Op Zee - Aanvulling Gebied Hollandse Kust, 2016.' available at: https://www.rijksoverheid.nl/documenten/rapporten/2016/12/08/bijlage-1-rijksstructuurvisie. (Accessed 27/04/2022).

Ministry of I&E, and Ministry of EZ. (2015). 'Beleidsnota Noordzee 2016-2021.' available at: https://www.rijksoverheid.nl/documenten/beleidsnota-s/2015/12/14/beleidsnota-noordzee-2016-2021 (Accessed 27/04/2022).

Ministry of I&E, and Ministry of EZ. (2015).'Nationaal Waterplan 2016-2021.' available at: https://www.rijksoverheid.nl/documenten/beleidsnota-s/2015/12/14/nationaal-waterplan-2016-2021 (Accessed 27/04/2022).

Ministry of LNV, and ministry of I&W., (2022). 'Marine strategie voor het Nederlandse deel van de Noordzee'. Den Haag.

Morisson-Saunders, A., and Arts, J., (2012). 'Assessing Impact: Handbook of EIA and SEA Follow-up.' Taylor and Francis, London.

Müller, N., Haesen, E., Ramaekers, L. and Verkaik, N., (2017). 'Outlook and Implications for Offshore Wind in the North Seas.' Available at: https://northseawindpowerhub.eu/wp-content/uploads/2017/10/Translate-COP21-Public-report-July2017-final.pdf (Accessed: 05/04/22).

Nagel, J., (2014) 'A very short introduction to Knowledge' Oxford university press, Oxford.

Noordzeeloket., (2021). 'Kader Ecologie en Cumulatie'. Available at: https://www.noordzeeloket.nl/functies-gebruik/windenergie/ecologie/cumulatie/kader-ecologie/ (Accessed; 23/06/2022).

Noordzeeloket., (2016). 'Wind Op Zee Ecologisch Programma.' Available at: https://www.noordzeeloket.nl/functies-gebruik/windenergie/ecologie/wind-zee-ecologisch-programma-wozep/ (Accessed: 01/06/2022).

NWO., (2020). 'Effects of windfarms on the marine ecosystem, and implications for governance'. available at: https://www.nwo.nl/en/projects/nwa123618001 (Accessed: 01/11/2021).

NWO., (2022). 'Acoustic ecology of pelagic fish communities (APELAFICO): a study into the effects of construction and operation of wind farms'. Available at: https://www.nwo.nl/projecten/nwa123618004 (Accessed: 01/07/2022).

Ostrom E. (2005). 'Doing Institutional Analysis Digging Deeper Than Markets and Hierarchies'. In: Menard C., Shirley M. (eds) *Handbook of New Institutional Economics.* Springer, Boston, MA.

Okasha, S., (2016). 'A very short introduction to philosophy of science. ' Oxford university press, Oxford.

OFL., (2020).'Het akkoord voor de Noordzee'. OFL: Den Haag. Available at: https://www.overlegorgaanfysiekeleefomgeving.nl/actuele+projecten/actuele+projecten+overzicht/noordzeeoverleg/documenten+noordzeeakkoord/handlerdownloadfiles.ashx?idnv=1901025 (Accessed: 03/03/2022).

OFL., (2020A). 'Onderhandelaarsakkoord voor de Noord-zee'. *Rijksoverheid*. (Accessed 14/06/2021). Available at: https://www.rijksoverheid.nl/documenten/rapporten/2020/02/10/bilage-1-onderhandelaarsakkoord-nzo (Accessed: 04/03/2022).

OFL., (2020B). 'Advies afspraken governance Noordzeeoverleg (NZO)'. Overlegorgaan Fysieke leefomgeving. available at: https://www.rijksoverheid.nl/documenten/rapporten/2020/11/27/advies-afspraken-governance-noordzeeoverleg (accessed: 06/03/2022).

OFL., (2021). 'Monitoring en Onderzoek Natuurversterking en Soortenbescherming (MONS)'. OFL: Den Haag. Available at: https://www.informatiehuismarien.nl/projecten/monitoring-onderzoek-natuurversterking/ (Accessed: 09/03/2022).

Paramana, T., Karditsa, A., Milatou, N., Petrakis, S., Megalofonou, P., Poulos, P. and Dassenakis, M., (2021). 'Msfd in-depth knowledge of the marine environment as the stepping stone to perform marine spatial planning in Greece.', *Water Switzerland*, 13(15), pp. 1–25.

Popov, V. (2011). 'Developing New Measurements of State Institutional Capacity', *SSRN Electronic Journal*, (54), pp. 1–8.

Renewables UK., (2020). 'Statistics renewable energy'. Renewable UK. Available at: https://assets.publishing.service.gov.uk/government/uploads/system/uploads/attachment_data/file/747218/2019-20-renewables-obligation-level.pdf (Accessed, 04/01/2022).

Rijksoverheid. (2015). 'Regels omtrent windenergie op zee (Wet windenergie op zee)'. Staatsblad, 264. Available at: https://wetten.overheid.nl/BWBR0036752/2021-11-11 (accessed: 21/05/2022).

Rijksoverheid. (2018). 'Kavelbesluit IV Windenergiegebied Hollandse Kust zuid.' Staatscourant, 2497, Available at: https://zoek.officielebekendmakingen.nl/stcrt-2018-2497.html. (Accessed 20/05/2022).

Rijksoverheid. (2019). 'Ondersteunende opgave wet wind op zee (Wijziging wet wind op zee).' wetsvoorstel 35092, Den Haag.

Rijksoverheid., (2020). 'Windenergie op zee. Duurzame energie'. *Rijksoverheid* (Accessed 05/05/2021) Available at: https://www.rijksoverheid.nl/onderwerpen/duurzame-energie/windenergie-op-zee

Rijksoverheid., (2021a). 'Wind op zee na 2030.' Available at https://windopzee.nl/onderwerpen/wind-zee/wanneer-hoeveel/wind-zee-2030-0/ (Accessed: 04/01/2022).

Rijksoverheid., (2021b). 'Wind op zee; hoeveel ruimte' Available at: https://windopzee.nl/onderwerpen/wind-zee/hoeveel-ruimte/ (Accessed: 06/01/2022)

Rijksoverheid. (2022A). 'Kabinet verdubbelt productie windenergie op zee'. Available at: https://www.rijksoverheid.nl/actueel/nieuws/2022/03/18/kabinet-verdubbelt-productie-windenergie-op-zee. (Accessed: 24/03/2022).

Rijksoverheid. (2022B). 'Totstandkoming wind op zee.' Available at: https://windopzee.nl/onderwerpen/wind-zee/landingspagina-0/totstandkoming/ (Accessed: 24/03/2022).

Ripken, M., Keijser, X., Klenke, T., and Mayer, I. (2018). 'The 'living q'—an interactive method for actor engagement in transnational marine spatial planning'. *Environments*, *5*(8), pp.87.

Rose, T. M., and Manley, K. (2012). 'Adoption of innovative products on Australian road infrastructure projects'. *Construction Management and Economics*, *30*(4), pp. 277-298.

RVO., (2021). 'Offshore wind energy 2040: developing approach and routemap'. RVO. available at: https://offshorewind.rvo.nl/file/download/57655be3-22f0-49cc-a01c-

aed5021ac826/162321802920210603%20presentation%20webinar%20offshore%20wind%20energy%202040.pdf (Accessed: 12/05/2022).

RVO, and ministry of BZ., (2022).'Dutch Offshore wind Guide'. *Wind and water works*. RVO: Den Haag.

RVO. (2022). 'routekaart wind op zee.' available at: https://www.rvo.nl/onderwerpen/windenergie-op-zee/routekaart (Accessed: 20/03/2022).

RWS., (2016). 'Kavelbesluit 1 Windenergiegebied Borssele'. *Staatscourant.,* nr 14428.

RWS., (2019). 'Kavelbesluit 5 windenergiegebied Hollandse kust Noord' *Staatscourant.,* nr 24545.

RWS., (2022A). 'Kavelbesluit 7 Windenergiegebied Hollandse kust west'. *Staatscourant.,* nr 4381.

RWS., (2022B). 'Framework for Assessing Ecological and Cumulative Effects (KEC) 4.0 for the roll-out of offshore wind energy and wind farm zones (Éxtra Task 2030+)'. *Ministerie van Infrastructuur en Waterstaat.* Den Haag.

Slonim, R., Wang, C., Garbarino, E., and Merrett, D. (2013). 'Opting-in: Participation bias in economic experiments'. *Journal of Economic Behavior & Organization*, *90*, pp.43-70.

van Splunder, I., Graafland, M., (2022).'WOZEP'. Keynote presentation at the CWW congress, 3. Egmond aan Zee.

Rosenberg, A. (2016). 'Philosophy of social science.' Westview Press, Boulder Colorado.

Salet, W. (2018). 'Five Paradigms of Institutional Planning'. *Public Norms and Aspirations*, pp. 93–132. doi: 10.4324/9781315111599-5.

Senge, P., (1990). 'The Fifth Discipline: The Art and Practice of the Learning Organization'. New York: Currency Doubleday.

Spijkerboer, R. Zuidema, C., Buscher. and Arts, J., (2020). 'The performance of marine spatial planning in coordinating offshore wind energy with other sea-uses: The case of the Dutch North Sea'. *Marine Policy*. Elsevier Ltd, 115, pp. 103860.

Spijkerboer, R. Zuidema, C., Buscher, T. and Arts, J. (2021). 'Unravelling institutional work patterns: Planning offshore wind farms in contested space'. *Environmental Innovation and Societal Transitions*. Elsevier B.V., 40. pp. 249–261.

Stange, K., (2017). 'Knowledge production management plans for European fisheries', PhD thesis, University of Wageningen, Wageningen.

Taljaard, S., Slinger, J. and Merwe, J. (2013). 'Ocean & Coastal Management Dual adaptive cycles in implementing integrated coastal management'. *Ocean and Coastal Management*. Elsevier Ltd, 84, pp. 23–30.

Topsector energie., (2019). 'Meerjarig Missiegedreven programma hernieuwbare electriciteit op zee' Available at: https://www.topsectorenergie.nl/sites/default/files/uploads/Urban%20energy/Innovatieprogramma/MMIP%202%20Hernieuwbare%20elektriciteitsopwekking%20op%20land%20en%20in%20de%20gebouwde%20omgeving%20-%20versie%2029%20juni%202021.pdf (Accessed: 01/07/2022).

Topsector energie., (2020). 'Topconsortium voor Kennis en Innovatie, Wind Op Zee'. Available at: https://www.topsectorenergie.nl/tki-wind-op-zee (Accessed: 01/07/2022).

UK government. (2021). 'Offshore wind farms'. Available at: https://www.renewableuk.com. (Accessed: 18/01/2022).

UNDP. (2009). 'Capacity Development: A UNDP Primer.' *Undp*, p. 64. Available at: http://www.undp.org/capacity.(Accessed: 12/03/2022).

van den Brink, M., Edelenbos, J., van den Brink, A., Verweij, S., van Etteger, R. and Busscher, T. (2019). 'To draw or to cross the line? The landscape architect as boundary spanner in Dutch river management'. *Landscape and Urban Planning*, *186*, pp. 13-23.

Van Ryneveld, M., and McCutcheon. R. (1997) 'Teaching of development engineering at undergraduate level in the civil engineering degree at the University of the Witwatersrand, Johannesburg'. Proc. 8th Annual Congress of the South African

Institution of Civil Engineering.

Van Ryneveld, M., and Sproule, S. (2009). 'Knowledge uptake by technical professionals and decision-makers for developmental water services Part 1: Methodology, knowledge and context'. *Water SA*, *35*(4).

Hajer, M., Van Tatenhove, J., and Laurent, C. (2004). 'Nieuwe vormen van governance, een essay over nieuwe vormen van bestuur met een empirische uitwerking naar de domeinen van voedselveiligheid en gebiedsgericht beleid'. *RIVM rapport 500013004, Duurzaamheidsverkenning*.

Van Tatenhove, J. (2011). 'Integrated marine governance: questions of legitimacy'. *Mast*, *10*(1), pp. 87-113.

van Tatenhove, J. P. (2017). 'Transboundary marine spatial planning: a reflexive marine governance experiment?' *Journal of Environmental Policy & Planning*, *19*(6), pp. 783-794.

van Tatenhove, J., Arts, B., and Leroy, P. (Eds.). (2013). '*Political modernisation and the environment: the renewal of environmental policy arrangements*.' 24. Springer Science & Business Media.
Veitayaki, J. and South, G. (2001). 'Capacity building in the marine sector in the Pacific Islands: the role of the University of the South Pacific ' s Marine Studies Programme.' 25, pp. 437–444.

de Vrees, L. (2019). 'Adaptive marine spatial planning in the Netherlands sector of the North Sea.' Marine Policy. Elsevier Ltd. pp. 1–10. doi:/10.1016/j.marpol.2019.01.007.

Vrees, L. (2021). 'Adaptive marine spatial planning in the Netherlands sector of the North Sea.' *Marine Policy*. Elsevier Ltd, pp. 132.

Vreugdenhil, H., (No date). 'Dual adaptive systems'. Deltares.

Water wet, (WTW). (2021). Available at:
https://wetten.overheid.nl/BWBR0025458/2021-07-01 (Consulted: 19/05/2022)

Weick, K. (1995). 'Sensemaking in Organizations'. 3,Thousand Oaks, CA Sage.

Weick, K. E., and Westley, F., (1996). 'Organizational learning: Affirming an oxymoron'. In: Clegg S, Hardy. C. and Nord W. (eds) Managing Organizations. London: SAGE.

Wet Milieubeheer., (2017). 'Wet milieubeheer'. Den Haag WBR0003245. Available at: https://wetten.overheid.nl/BWBR0003245/2017-08-30 (Accessed: 10.05/2022).

Willems, J., Busscher, T., van den Brink, M., and Arts, J. (2018). 'Anticipating water infrastructure renewal: A framing perspective on organizational learning in public agencies'. *Environment and Planning C: Politics and Space*, *36*(6), pp. 1088-1108.

Willems, J., and Busscher, T. (2019). 'Institutional Barriers and Bridges for Climate Proofing Waterway Infrastructures', *Public Works Management and Policy*, 24(1), pp. 63–70. doi: 10.1177/1087724X18798383.

Williamson, O. E. (1998). 'The institutions of governance'. *The American Economic Review*, *88*(2), pp.75-79.

WindEurope. (2021). '2050 vision.' Available at: https://windeurope.org/about-wind/reports/our-energy-our-future/ (Accessed: 04/01/2022).

WindEurope. (2022). 'Ministers meet to discuss North Sea offshore developments' Available at: https://windeurope.org/newsroom/news/ministers-meet-to-discuss-north-sea-offshore-developments/ (Accessed: 27/04/2022).

Zeigermann, U. (2021). 'Scientific knowledge integration and the Implementation of the SDGs: Comparing strategies of sustainable networks'. *Politics and governance,* 9.(1). pp. 164-175.

APPENDICES

APPENDIX 1. DOCUMENTS USED

Document analysed	Author/organisation	General Aim	Role in analysing knowledge uptake	Reference
LEGAL				
The water law	Dutch national government	Laying out the new legal framework for the usage and management of Dutch waters	Determining the inclusion of newfound knowledge in legal goals and considerations. Are the rules of the game adapted to include new knowledge goals.	*Water wet,* (WTW)., (2009). Available at: https://wetten.overheid.nl/BWBR0025458/2021-07-01 (accessed: 19/05/2022).
Execution procedure law wind at sea	Dutch ministry of economic affairs.	Determining technical, financial, and economic conditions for the exploitation of new wind farms.	Determining the inclusion of newfound knowledge in operational practice.	EZK., (2015). 'Uitvoeringsregeling Wet windenergie op zee'. nr. WJZ/15083277. Available at: https://wetten.overheid.nl/BWBR0036786/2017-04-01#SlotformulierEnOndertekening (accessed: 19/05/2022).
Law wind energy at sea	Dutch national government.	Regulating the development and management of windenergie at sea.	Determining the inclusion of newfound knowledge in legal goals and considerations. Are the rules of the game adapted to include new knowledge goals?	Regels omtrent windenergie op zee (Wet windenergie op zee)., (2015). Available at: https://wetten.overheid.nl/BWBR0036752/2021-11-11 (accessed: 21/05/2022).
Amendment Law wind energy at sea.	Dutch national government.	Improving upon the wind at sea act.	Determining the inclusion of new found knowledge in the amendment.	Ondersteunende opgave wet wind op zee (Wijziging wet wind op zee)., (2019). Den Haag.
Environmental management act.	Dutch national government	Managing environmental threats and opportuntities	Getting insight in the legal bases for many North Sea related legislation and policy	Wet Milieubeheer., (2017).'Wet milieubeheer'. Den Haag WBR0003245. Available at: https://wetten.overheid.nl/BWBR0003245/2017-08-30 (Accessed: 10.05/2022).
OSPAR	OSPAR/ BZK.	Establishing regional cooperation for the governance of the North-Sea.	Acquiring more detailed knowledge about regional governance and international knowledge goals and views.	BZ., (1993). 'Verdrag inzake de bescherming van het mariene milieu in het noordoostelijk deel van de Atlantische Oceaan, met Bijlagen en Aanhangsels'. *Tractatenblad van het koninkrijk der* Nederlanden, 51, Nr. 2. Paris.
MSFD	The European Commission	Ensuring the integrated, nature inclusive	Acquiring more detailed knowledge about the Marine governance	European Commission., (2008). 'Directive of the European Parliament and of the Council Establishing a Framework for

		and sustainable planning of European seas.	system, as well as analysing what knowledge goals are included in supra-national legislation.	Community Action in the Field of Marine Environmental Policy (Marine Strategy Framework Directive)'. European Commission. Directive 2008/56/EC, OJ L 164.
MSP directive	The European Commission	Ensuring the integrated, nature inclusive and sustainable planning of European seas.	Acquiring more detailed knowledge about the MSP system, as well as analysing what knowledge goals are included in supra-national legislation.	European Commission., (2014). 'Directive of the european parliament and council establishing a framework for marine spatial planning (Marine spatial planning directive)'. European Commission. Directive 2014/89/EU, OJ L 257/135
POLICY and Advice				
MONS	RWS	Setting the rules and procedures for the MONS programme.	Gaining insight in a major knowledge programme and how/which knowledge is taken up.	OFL., (2021).' Monitoring en Onderzoek Natuurversterking en Soortenbescherming (MONS)'. Den Haag.
North-sea accord	OFL	Determining agreements between the government and stakeholders concerning the use and management of the Dutch part of the North Sea.	Analysing the inclusion of knowledge and how/if this is taken up in the Ground rules.	OFL., (2020A). 'Het akkoord voor de Noordzee'. OFL: Den Haag.
Parliament letter appreciation advice North Sea talks.	House of representatives	Indicating appreciation for the NZO	Analysing the reaction on the use of knowledge in the NZO by the dutch parliament.	I&W., (2020).' Appreciatie van de adviezen over de governance van het Noordzeeoverleg en deelname van de visserijsector.' Kamerbrief IENW/BSK-2020/231757: Den Haag.
Policy document in the North Sea 2016-2021	Marine spatial plan	Determining the Dutch North sea policy for the indicated period	Increasing the Understanding of Dutch spatial planning and analysing the uptake of knowledge.	I&W, EZK., (2015).' Policy document on the North Sea 2016-2021'. The Hague.
National water programme North Sea 2022-2027	I&W, EZK, LNV, BZK.	Updating the spatial planning of the Dutch part of the North Sea.	Increasing the Understanding of Dutch spatial planning and analysing the uptake of knowledge.	I&W, EZK, LNV, BZK., (2021).' Marien strategie voor het Nederlandse deel van de Noordzee 2022-2027'. In: Programma Noordzee: 2022-2027. The Hague.
Rijksstructuurvisie windenergy op zee 2016-2021	I&W, EZK	amendment on national water plan 9-15 and policy document on the North Sea due to more included OWF	Analysing changes in the uptake of knowledge	I&W & EZK., (2014).' Rijksstructuurvisie windenergie op zee 2016-2021'. Den Haag.

		areas (borssele and Ijmuiden ver).		
Routemap wind energy at sea 2040	RVO	Demonstrating how OWF development occurs in the Netherlands	Familiarising with Dutch OWF development policy and looking for opportunities/ barriers of knowledge uptake	RVO., (2021). 'Offshore wind energy 2040: developing approach and routemap'. RVO.
Dutch offshore wind guide	RVO	Demonstrating the Dutch approach of OWF development abroad	Analysing what role knowledge plays in the Dutch presentation of its OWF policy.	RVO, BZ., (2022).'Dutch Offshore wind Guide'. *Wind and water works*. RVO: Den Haag.
Development framework wind energy at sea	EZK	Policy briefing	Analysing the role of knowledge, familiarizing with Dutch OWF development	EZK., (2021A).'Ontwikkelkader windenergie op zee'. Ministerie van Economische Zaken en Klimaat: Den Haag.
Marine strategy Dutch part of the North Sea	LNV, I&W	The second cycle of implementing the European MSFD for the Dutch part of the North Sea, into national law.	Analysing which goals exist for the Dutch marine strategy. Understanding strategic maritime planning in the Netherlands. Analysing which newfound knowledge is taken up in the policy document.	LNV, I&W., (2022). 'Marine strategie voor het Nederlandse deel van de Noordzee'. Den Haag.,
The future of the North Sea 2030-2050	PBL	Scenario study	Analysing the expected role of knowledge	Matthijssen, J., Dammers, E., Elzenga, H., (2018).' De toekomst van de Noord Zee: de Noord Zee in 2030 en 2050, een scenariostudie'. Planbureau voor de leefomgeving,
OFL advice governance North Sea	OFL	Advising the government and stakeholders on the management of the North Sea	Analysing the role of knowledge and the decision making framework concerning MSP.	OFL., (2020B). 'Advies afspraken governance Noordzeeoverleg (NZO)'. Overlegorgaan Fysieke leefomgeving.
Plot decisions				
Borssele				RWS., (2016). 'Kavelbesluit 1 Windenergiegebied Borssele'. *Staatscourant.,* nr 14428.
Hollandse kust Noord				RWS., (2019). 'Kavelbesluit 5 windenergiegebied Hollandse kust Noord' *Staatscourant.,* nr 24545.
Hollandse kust west				RWS., (2022). 'Kavelbesluit 7 Windenergiegebied Hollandse kust west'. *Staatscourant.,* nr 4381.
Wijziging kavelbesluit hollandse kust.				EZK., (2021B). 'Wijzigingsbesluit kavelbesluiten I, II, III, IV en V (innovatiekavel). windenergiegebied Borssele, I, II, III en IV. windenergiegebied Hollandse Kust (zuid) en V windenergiegebied Hollandse Kust (noord)'. Den Haag.

APPENDIX 2. CODING TREE FOR DESK RESEARCH AND INTERVIEW ANALYSIS: KNOWLEDGE IN OWF

This coding framework consists of a combination of deductive and inductive codes.

The framework is partly based on the testing of pre-existing conceptions, these theory-driven, deductive codes are chosen to fit the theoretical framework of the research.

Due to the discursive character of part of the study design, the results of early rounds of interviews will be used to inform inductive codes in order to get a better image of the difference knowledge views and practices of participants and the organisations they are involved in.

In practice this means that the initial codes will mostly focus on the theoretical frameworks described in the thesis. If data driven patterns or significant results emerge from desk research or interviews, they will be included inductively. If results emerge regarding unexpected but relevant matters or concepts, inductive coding will be to include these as well.

General

-knowledge type.

1. Factual knowledge concerns empirically observed details,
2. Conceptual knowledge concerns categories, functions, and theories, or how facts can be organized,
3. Procedural knowledge is derived from experience, and often considers how to perform subject-specific tasks,
4. Metacognitive knowledge can be seen as recognising contextual and conditional differences, understanding (personal) biases, realizing the complexities in a system, and being able to strategically deal with them

-spatial scale
-temporal scale
-concerning placement
-concerning management
-concerning mitigation/compensation
-concerning decommissioning

Intellectual capacity

System understanding

-Is going well but simply needs more time
-More effort is needed to understand
-More modelling is needed/ is better at this point than monitoring
-More monitoring needed/ limited trust for modelling
-international political/ policy considerations
-considerations on the north-sea basin as a whole

-considerations of the Dutch EEZ
-turbine level considerations
-OWF level considerations
-needs to be studied

Knowledge integration
Within the organisation
With other organisations of a similar type
With different organisations
Considering the MSP/OWF institutions as a whole
Effective
Barrier
Formal
Informal
Idea of improvement
intensive interaction,
multiple iterations
structural embedding
tools for an integrated assessment

Organisational learning

-single loop/ actions change

-Practice changes due to knowledge
-what is the experienced timeframe of changing practice
-what knowledge is taken up in changes of practice
-barriers in policy to changing practices
-overcoming barriers to changes in practice
-freedom/appreciation to discuss and stimulation of change of practice in orgs

-double loop/ goals change

- change in goals through knowledge
- change in goals through political causes
- change in goals through financial causes
- change in goals through discursive causes
-barriers in policy to changing goals
-how to overcome barriers in policy to changing goals
-freedom/appreciation to discuss and stimulation of change in goals

-triple loop

Policy arrangements influence through:

Power/ Resources

discourse

Rules of the game

Actors/coalitions

APPENDIX 3. INTERVIEW GUIDES

Interview Vragen voor beleidsmakers in het Nederlandse Offshore wind beleid

-Ik wil het interview graag opnemen
-In het eindproduct wordt expertise en organisatie genoemd, gebruikte en andere inzichten uit het interview worden opgestuurd ter verificatie
-Ik wil u graag uitnodigen voor het invullen van een survey bestaande uit 20-30 vragen. Deze vragen worden gebaseerd op de interviews, desk onderzoek, en een group model building sessie. De vragen staan in het format van een Likert schaal en zijn makkelijk en snel te beantwoorden.

-**Introductie onderzoek**
Wij doen onderzoek naar de rol van kennis in het informeren van nieuwe bestuurlijke kaders voor het plaatsen, managen, en weghalen van windparken in de Noordzee. Het is belangrijk om bij het samenstellen van deze kaders de mogelijke effecten (zowel positief als negatief) op de ecologie en andere gebruiken van de Noordzee in de gaten te houden. Wij hopen hierom de interactie tussen de fysische systemen in de Noordzee, en de beleidssystemen duidelijk te maken. Dit willen we doen doormiddel van een combinatie van kennis gerelateerde capaciteiten en beleidsarrangementen zie fig 1, en tabel 1 en 2. Wij willen hiermee inzicht bieden in hoe kennis over fysische systemen beleid kan informeren, en hoe beleid op zijn beurt de fysische systemen kan beïnvloeden.

Om dit te kunnen doen, willen we onderzoeken wat beleidsmakers, wetenschappelijke experts en andere stakeholders hopen te bereiken in de context van het Offshore wind beleid. Wij hopen beter inzicht te krijgen in de belangen van verschillende sectoren, en op welk deel van het beheer- en beleidsproces door verschillende autoriteiten en sectoren de nadruk wordt gelegd, alsmede hoe deze kennis inzet of de inzet van kennis graag zou zien. Ook hopen we erachter te komen welke effecten van windturbines op het biofysische systeem worden overwogen, wat voor effect dit heeft op het beheer en beleid, en hoe kennis wordt benut in dit proces.

Doelen van het interview
-Begrijpen naar welke invloeden op het bio-fysisch systeem wordt gekeken, en op welke schaal dit gebeurt.
-Inzicht vergaren in hoe kennis gebruikt wordt in het beheer en beleidsproces en hoe onderzoek bij kan dragen bij het vormen van bestuurlijke arrangementen.
-Inzicht krijgen in het beheer- en beleidsproces en dit visueel representeren met een causaal cirkeldiagram, zie fig. 2.
-Inzicht in het delen van kennis met andere instituties/organisaties.
-Inzicht in het aanpassen van doelen en werkwijzen op basis van kennis.
-Begrijpen wat voor blik u heeft op het gebruik van kennis.

De rol van dit interview

De kennis verkregen in dit interview zal gebruikt worden bij het schetsen van een beeld over het gebruik van kennis, en om de focus van verdere interviews te informeren.

1 Algemene vragen

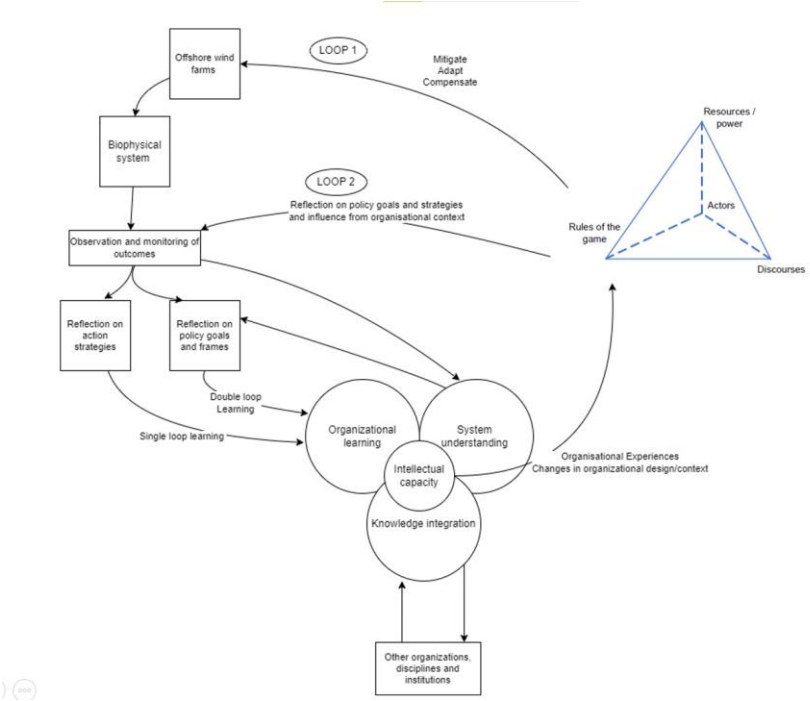
1. Kunt u zichzelf kort voorstellen?
2. Kunt u kort de positie van uw organisatie binnen het ontwikkelingsproces van kennis en beleid voor wind op zee uitleggen?
3. Kunt u uw rol in het beheer- en beleidsproces van offshore wind uitleggen? Welk deel van dit proces houdt u zich voornamelijk mee bezig.
4. Hoe neemt u kennis van onderzoekers tot u, en hoe gebruikt u hun bevindingen? (Is dit in het geval van windmolens op zee anders)? Met welke onderzoekers of instituten werkt u samen?
   Hoe zit dit binnen uw organisatie, is er een protocol, is er veel vrijheid? Verschilt het veel per persoon?
5. Hoe ziet u het proces van het gebruik van kennis in beheer en beleid?

De rol van kennis

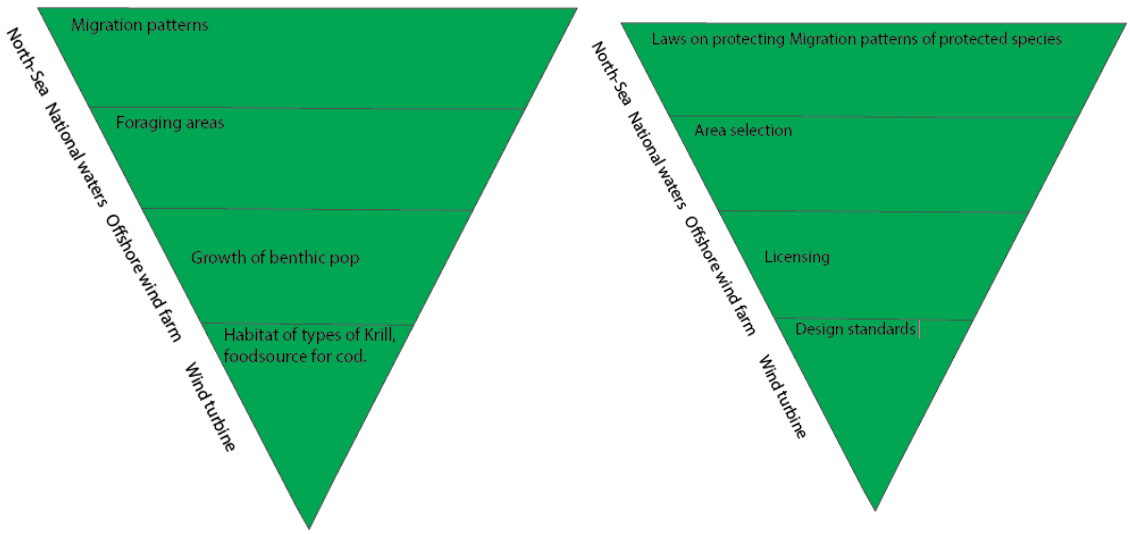
6. Wat voor kennis werkt u mee (Technisch, theoretisch, praktisch, niveau van onzekerheid).
7. Is er binnen uw organisatie en tussen de uwe en anderen, veel overleg over de betekenis of toepasbaarheid van kennis, hoe gaat dit, en wordt dit aangepast.
8. Wat stimuleert verandering m.b.t. de omgang met kennis. (policy arrangementen in doelen en aanpak)

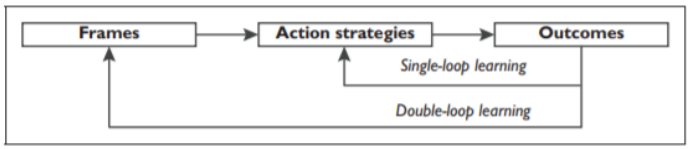
9. Wat zijn de grenzen van het wind-op-zee beleid - welke sectoren en thema's zijn onderdeel van de beleidsfocus en welke niet. Hoe uit zich dat in individuele projecten, gebieden, ontwerp aspecten, de hele EEZ.
10. Op welke ruimtelijke en temporale schaal werkt u voornamelijk?
11. Wat voor zwaktes zitten er in het huidige beleid?
12. Hoe zorgen deze zwaktes voor problemen gerelateerd aan het plaatsen en onderhouden van windmolens op zee?
13. (Wat zijn de specifieke oorzaken hiervan?)
14. Wat zijn de specifieke gevolgen hiervan?
15. Wat voor actie zou u graag zien om deze problemen op te lossen, wie zou er actie moeten nemen?
16. Wat voor impact heeft nieuwverworven kennis (bijv. over het ecologische systeem van de Noordzee) op het beleidsproces en het beheer, in welk deel van het proces wordt dit betrokken?
17. Wat zijn de beste mogelijkheden die u ziet voor actie op korte termijn als nieuwe kennis wordt ontdekt? Productie innovatie, ecologische mogelijkheden, regelgeving. Tot wat voor type besluiten (adapt, mitigate, compensate) leidt dat? En wat zou er gebeuren als de ecologie daadwerkelijk zwaar zou blijken te lijden onder grootschalige windmolenparken?
18. En op de lange termijn? Welke tijdsschaal denkt u dat het handigst is voor het nemen van actie? Wordt er bijvoorbeeld al aan het verwijderen van windmolens of de volgende tenderronde gedacht?

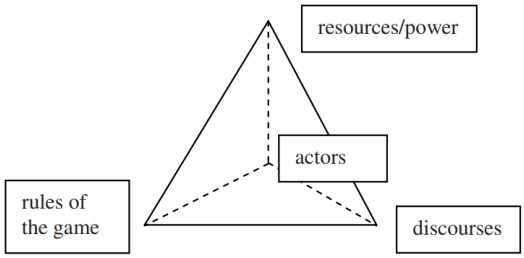
19. Hoe kan onderzoek bijdragen bij het maken van beleid, voornamelijk bij het oplossen van de door u beschreven zwaktes en problemen? Wat voor kennis zou het meest waardevol zijn? En wie bepaalt welke kennis er wordt meegenomen?
20. Zijn er bepaalde manieren waarop u graag zou samenwerken of in contact zou staan met onderzoekers/beleidsmakers?
21. Wat vindt u het belangrijkste om in de toekomst mee rekening te houden omtrent kennis.



22. Fig 1. Model for features of intellectual capacity and policy arrangements.







Interview Vragen voor experts in het Nederlandse Offshore wind beleid

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3. Kunt u uw rol in het kennis ontwikkelingsproces van offshore wind uitleggen? Welk deel van dit proces houdt u zich voornamelijk mee bezig.
4. Hoe staat u in verbinding met beleidsmakers? en hoe ziet u dat uw bevindingen gebruikt worden? (Is dit in het geval van windmolens op zee anders)? Met welke onderzoekers of instituten werkt u samen?
   Hoe zit dit binnen uw organisatie, is er een protocol, is er veel vrijheid? Verschilt het veel per persoon?
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