UNIVERSITY OF TROMSØ UIT

Faculty of Biosciences, Fisheries and Economics

Marine Ecosystem Governance in the Making

Planning for petroleum activity in the Barents Sea-Lofoten area

Maaike Knol

A Dissertation for the Degree of Philosophiae Doctor

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Summary

Expanding petroleum activity in the Barents Sea-Lofoten area has worked as a catalyst for the development and introduction of the first integrated, ecosystem-based management plan in Norway. This plan sets the framework, in particular, for further petroleum activities. Building on Science and Technology Studies (STS) this thesis provides an analysis of the practices and instrumentation of *marine ecosystem governance,* which encompasses the broader dynamics around the introduction of integrated, ecosystem-based management. It follows processes of co-production at the science-policy interface and analyzes how scientific knowledge is mobilized and translated into governance practices and policy instrumentation for the regulation of oil and gas activities and their related risks and uncertainties.

While the thorough expert processes are characterized by a focus on integrated natural scientific knowledge production, the political implementation of marine ecosystem governance is characterized by the introduction of rather general, rigid policy measures. This comes to light when studying the two main instruments for the regulation of petroleum activity in the Barents Sea-Lofoten area: a zoning arrangement and a zero discharge regulation. These instruments function as the obligatory passage points for the expansion of petroleum activity into the Barents Sea area. Apart from designing durable and mobile instruments, the design processes for ecosystem governance are directed at building in responsiveness to environmental change. This, however, does not necessarily provide guidance to governance intervention when the critical limits of the ecosystem are within reach.

Since risk is a central organizing concept in the governance of oil and gas activities, this thesis looks into the governance of risk related to normal petroleum operations, as well as to events of acute pollution. It demonstrates the relevance to study risk assessment and management as a part of a complex process that includes politics as much as science. This thesis emphasizes the centrality of uncertainties and knowledge gaps in marine governance practices, and develops the argument that the focus on knowledge gaps illuminates the dominant framings of risk. Although the production of more knowledge can lead to a refinement of the very notion of risk, this thesis emphasizes that scientific and social indeterminacy are constant challenges to be dealt with.

List of papers

Paper 1	Knol, M (2010). Scientific advice in integrated ocean management: The process towards the Barents Sea plan. *Marine Policy* 34 (2): 252-260.
Paper 2	Knol, M. Mapping ocean governance: From ecological values to policy instrumentation *(Accepted December 2010; Journal of Environmental Planning and Management)*.
Paper 3	Knol, M (2010). Constructing knowledge gaps in Barents Sea management: How uncertainties become objects of risk. *MAST* 9(1): 61-79.
Paper 4	Knol, M. The uncertainties of precaution: Zero discharges in the Barents Sea *(in press; Marine Policy)*.

Introduction

Globally, it has been recognized that an increase in human activities in and on the sea through shipping, fisheries, tourism or energy production demands a rethinking of marine management approaches (Pauly and Maclean 2003, Young et al. 2007). This awareness has grown since the concept of sustainability entered the international environmental agendas in the late 1980s (Brundtland 1987), which was a strong incentive for initial developments of approaches and ideas for ecosystem-based management. During the World Summit on Sustainable Development in 2002, Norway signed an agreement to implement ecosystem-based management by 2010.[1]

The planning of petroleum activity in the Norwegian north has been integrated into a broader ecosystem governance framework. This framework is materialized in a comprehensive ecosystem-based management plan for the Barents Sea and the areas outside the islands of Lofoten and Vesterålen (Ministry of the Environment 2005-2006). The management area (after this: Barents Sea-Lofoten area) is largely located in the circumpolar Arctic (figure 1). The plan sets the environmental framework for the regulation of the most important human activities in this region, and includes also the fishery and shipping sectors. This thesis studies the turn towards marine ecosystem governance and looks closely into the practices and processes at the interface of science and policy.

As the central theme in this study concerns the dynamics between science and politics in a controversial context of marine environmental governance, this thesis draws much of its inspiration from science and technology studies (STS) and actor-network theory (ANT). Furthermore, I draw on Beck's risk society thesis (1992) in several places. Whereas ANT puts its focus on local processes of translation, Beck's ideas provide a worldview that is less-empirically grounded, and which might at first sight seem difficult to combine with ANT. However, as Beck's 'world risk society' is simultaneously a knowledge society built around techno-science and its controversies, it acts as the 'panorama view' for this thesis (Latour 2005, see also Blok 2010).

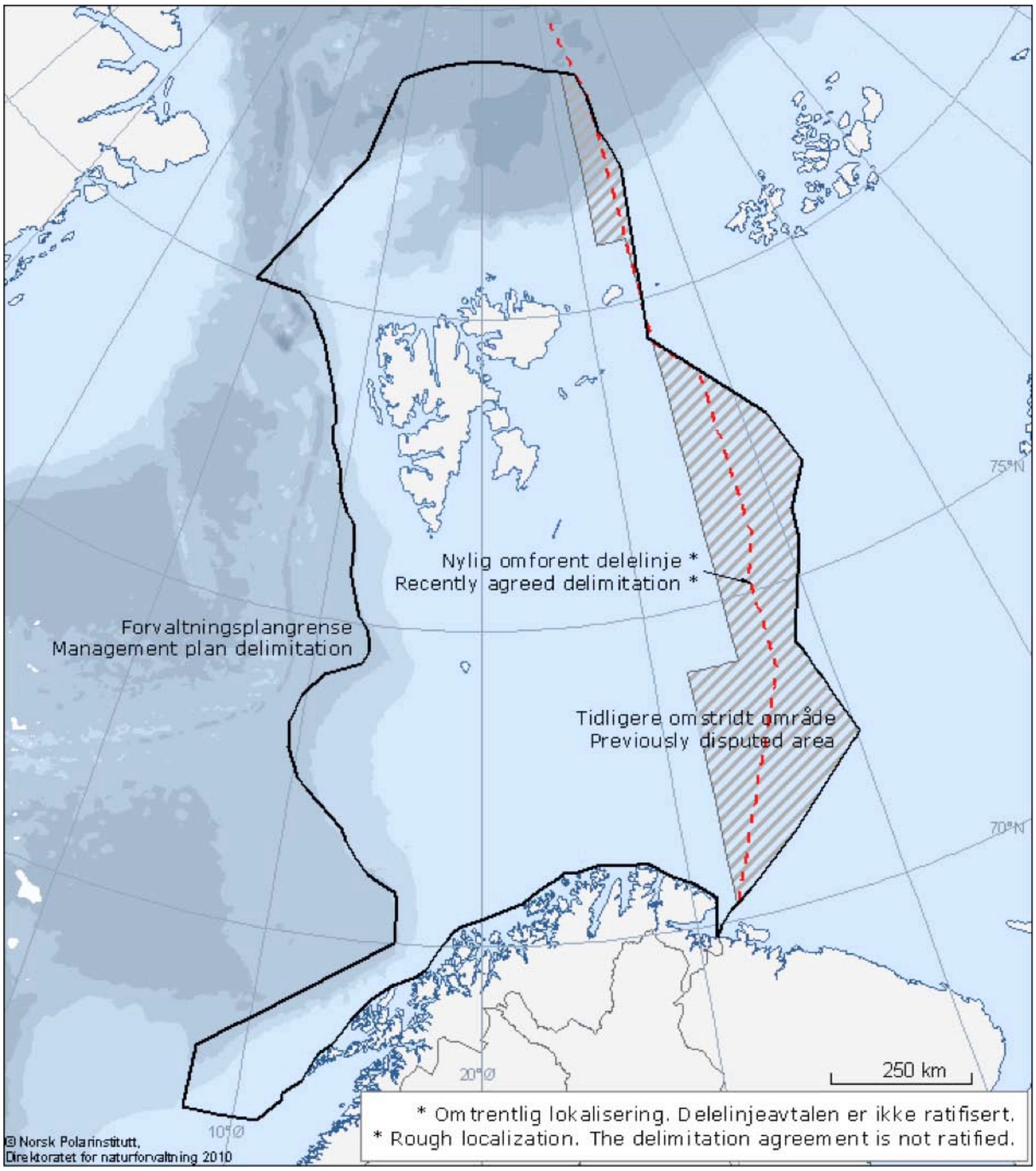
This introduction provides the relevant empirical and theoretical background material that binds this thesis together. With a collection of articles, the individual papers can be read on their own. Each of them provides insight into aspects of marine ecosystem governance in the making, with particular reference to the planning and management of petroleum activity in

[1] This commitment was part of the Millennium Goals.

the Barents Sea-Lofoten area. Taken together, however, this project has been an attempt to produce something greater than the sum of the individual papers' parts. It is hoped that – together with this introduction and the epilogue at the end of this thesis – the papers provide insight into the practices, dilemmas and controversies in marine ecosystem governance.

The next sections set out the objectives and research questions, and provide methodological reflections and justifications for how this work was carried out. Subsequently, I introduce the concept of 'marine ecosystem governance', which covers the larger processes at the science-policy interface that surround the introduction of integrated, ecosystem-based management. Following from there, this thesis presents a history of the debates about petroleum activity in the Barents Sea, and sets that history in relation to developments of oil and gas activities on the rest of the Norwegian Continental Shelf. It touches upon the central elements in the Norwegian management system of petroleum activity, which are essential to understanding the planning for offshore activities within an integrated, ecosystem-based management framework. Then, the thesis zooms into the Barents Sea and the increasing environmental concerns that have been central in discussions about opening the area from the 1970s onward.

As science is central within marine ecosystem governance, the introduction devotes a section on the role of science in society, including its role in the governance of risk and uncertainty. Subsequently, I leave these abstract notions and follow an ANT-inspired approach that looks more closely into how scientific practices co-construct political realities. Hence, I suggest and outline an approach for the study of ecosystem governance *in the making*. It shows why and how it is useful to focus on practices and instruments in order to understand marine ecosystem governance, and how it can be analyzed and understood. Then, the individual papers will be briefly introduced, as well as their mutual connections. After the presentation of the four papers, a final epilogue provides an update of the situation surrounding marine governance of the Barents Sea-Lofoten area, and outlines directions for further research.



Source: Norwegian Polar Institute and Norwegian Directorate for Nature Management

Figure 1: Geographical delimitation of the management plan for the Barents Sea-Lofoten area. *The islands of Lofoten and Vesterålen are located in the southernmost part of the management area. This updated map includes the rough localization of the new border in the area with previous overlapping claims between Russia and Norway.*

Research questions and objectives

This thesis connects ecosystem-based management and the planning and management of petroleum activity in an explicit and direct way. The overall theme is marine ecosystem governance in a context of expanding petroleum activity in a controversial, Arctic, area. The central focus is on the science-policy interface, where instruments are designed and practices established for the comprehensive governance of oil and gas activities and their related risks and uncertainties. The three central and interrelated research questions are the following:

a. What characterizes the role of science in the process towards marine ecosystem governance? (Paper 1, 2, 3)
b. How does the translation from scientific knowledge to the policy instrumentation for marine ecosystem governance take place? (Paper 1, 2, 4)
c. How are knowledge, uncertainty and risk related in planning for petroleum activity within a marine ecosystem governance framework? (Paper 2, 3, 4)

Through analyzing the case material in depth, it is my objective to create a thorough understanding of the practices of marine ecosystem governance at the science-policy interface. This, I hope, offers a contribution to the fields of environmental sociology and science and technology studies (STS), as well as to the interdisciplinary scholarly discussions on marine ecosystem-based management.

Different from other approaches for the study of marine ecosystem-based management, this approach does not start from an analysis of the *principles and objectives* (e.g. Slocombe 1998). The objectives of ecosystem-based management plans are often formulated in general terms, reflecting ideal situations. The real world is more messy and complicated, and can only be governed and measured through simplification. A study of the objectives of ecosystem-based management, and the extent to which they are followed up, would have a strong tendency to describe what ecosystem-based management *should be*, and to explain why the studied context *is not,* or does not (yet) meet the set requirements. This would become a story about shortcomings.

I consider it a challenge to study the *making of* marine ecosystem governance through its practices and instruments, and through the mobilization and enrolment of actors and information. The design of policy instrumentation and the establishment of new practices are considered to be part of a transformation to a new governance approach in the marine realm, which builds upon existing practices. In the chapter *Outlines of a post-constructivist approach* I will demonstrate that it is central to this study of marine ecosystem governance to follow the ways in which scientific methods and practices are mobilized in processes of classification and categorization, through which ecosystem realities are enacted. They build the material infrastructures that serve as the foundations for marine ecosystem governance.

The central focus on practices and instruments does not only provide insight into ecosystem governance in the making. At the same time, one is better enabled to analyze the governance implications that follow the choice of certain instruments. Policy instruments create their own effects, and the choice for certain policy instruments signifies the larger choices and directions in marine governance (Lascoumes and Le Gales 2007).

Although this thesis is inspired by actor-network theory, it should not be positioned as an ANT thesis, as that would have required a more detailed focus on local translation processes throughout the entire thesis. It would also have demanded a different set-up of this introduction. The inspiration drawn from ANT is mostly present in the last chapter of this introduction, as well as in paper 2, and to a smaller extent in paper 3.

I became increasingly familiar with the ANT literature during the second half of this PhD research period. For that reason, ANT is either more or less present in the individual papers. Paper 2, for example, was thoroughly rewritten in the last phase of this PhD and follows, in a way, the outlines of a post-constructivist approach most closely. The writing of this introduction has clarified my own position. At the same time, it has reinforced my ideas about the usefulness of a post-constructivist approach. In addition, I find it of complementary value to theorize the larger dilemmas at the science-policy interface in environmental governance in more general STS concepts. Finally, I hope that this thesis demonstrates that it is possible to combine a panoramic view over the *risk society* with a study of the co-construction of ecological and political realities.

Methodological considerations

This research can be identified as case study research. Case study research, as Yin puts it, offers an "empirical inquiry that investigates a contemporary phenomenon within its real life context especially when the boundaries between phenomenon and contexts are not clearly evident" (Yin 2009: 13). Within sociology, and not least within science and technology studies, case study research has been increasing in importance. While some would argue that single case-study research is not fit for generalizing, I rather support the idea that case study research delivers important insights into a particular field of interest (Flyvbjerg 2006, Yin 2009). The case study method has the possibility to offer a thick narrative in which the complexities and contradictions of real life can be captured (Flyvbjerg 2006). As such, it is fit for contributing to social theory building, which can be related to other fields. Methods for empirical inquiry in this case study research were all qualitative. Most important sources of 'data' generation consisted of document analysis as well as semi-structured, in-depth interviews. Furthermore, the attendance of several meetings provided me with richer insights of a larger variety of perspectives on oil and gas activities, particularly in the areas outside the islands of Lofoten, Vesterålen and Senja in northern Norway.

Document analysis

The initial central object of study in this PhD research is a policy document; the White Paper that sets the framework for integrated, ecosystem-based management in the Barents Sea-Lofoten area (Ministry of the Environment 2005-2006). Indeed, the mere existence of this White Paper initiated my PhD research; it was my task to study how integrated, ecosystem-based management was introduced in this particular area. More specific research questions followed during the first months. It has, from the start off, been important to view this White Paper as something larger than a 'receptable' (of instructions, regulations, needs, etc), but also to view it as an object that is open to interpretation, manipulation and reconstruction, and as a resource to be mobilized for further action (see Prior 2004).

In order to be able to understand these potential mobilizations for further action, I had to go into the history of the White Paper; how it was made and what prior texts had served as background material. This implied that I had to study other policy documents, and most importantly in this research, mandated scientific reports that had informative and constructive input functions into the White Paper. In such a study it is important to realize that documents (both policy and scientific documents) are never fixed or static, but always situated and exercising effect (Prior 2004).

I had access to a large number of documents. The scientific reports that I studied apart from the White Paper were often prepared within expert fora, where a variety of experts from several institutions took part. These reports included environmental impact assessments; assessments of vulnerable areas; total impact assessments; and various other, often rather specific, studies. All these documents were publicly available from the websites of the responsible institutions. Furthermore, the Norwegian Polar Institute and the Ministry of the Environment had (and still have) a special page on their websites where a large number of assessment reports were made available.[2] Throughout the research, I selected the material that was relevant to the papers that I worked on. Hence, this selection process took place in a rather *ad hoc* fashion.

Interviews

Ecosystem governance is characterized by cooperation of people, among whom scientists, policy- and decision-makers have an essential task. Talking to those people who took part in 'making' ecosystem-based management (EBM) is therefore a vital activity for those who want to understand what EBM implies, what practices it consists of, and how its instruments are designed. Interviews were an important source for gathering information, knowledge and perspectives. They were not so much a source of 'data collection', since that would presuppose the role of the interviewee as a 'vessel-of-answers'; it was rather the interviewee's accounts on reality that was interesting. As a process of meaning making, interviewing is an active form of reality assembling and construction (see Baker 2004, Holstein and Gubrium 2004, Miller and Glasner 2004).

In total, I carried out eighteen interviews for this research, all of which can be characterized as semi-structured, in-depth interviews that covered a selection of themes relevant to the project. The interviews took place in the working place of the interviewee, except for one interview, which was carried out over the telephone. All interviews lasted between 45 and 90 minutes. The interviewees consisted of key persons who were central in the processes towards the integrated management plan for the Barents Sea. Interviews were

[2] http://npweb.npolar.no/tema/forvaltningsplanbarentshavet ; http://www.regjeringen.no/nb/dep/md/tema/hav--og-vannforvaltning/forvaltningsplan-barentshavet.html?id=87148

carried out with one or more informants of the following institutions: The Ministry of the Environment; The Ministry of Fisheries and Coastal Affairs; The Ministry of Petroleum and Energy; The Climate and Pollution Agency; The Institute of Marine Research; The Norwegian Polar Institute; Statoil ASA; and Acona WellPRO AS. A number of persons were interviewed twice in order to cover specific topics in depth. I initiated my research with a series of interviews in order to orientate in the field, which I followed up when more specific ideas for articles got shape.

Although I am generally satisfied with the results and information that I achieved from doing interviews, there are many challenges with qualitative in-depth interviewing. The difference in roles between the interviewer and the interviewee can provide obstacles, in various ways, to achieving the kind of information that one is looking for. Whereas my objective has always been to understand relations in the co-production of marine ecosystem governance, I sometimes observed a slightly defensive position among the interviewees (defending the position of their institution). At the start of an interview I was told that my interviewees could not talk about political issues and standpoints. There were, however, more instances wherein interviewees seemed not to feel fully comfortable to talk about 'more than facts'. This latter point appeared not to be very problematic, as many 'facts' turned out to be the sources of a controversy, and hence we talked politics after all, albeit in a different way.

The other interviewing challenges are of a more practical nature. I carried out part of the interviews in Norwegian, but most of them were held in English. While my Norwegian skills are good in reading (including scientific and policy documents) and satisfactory when spoken in daily situations, my language skills require improvement when it comes to being able to respond abruptly and in detail during professional interviews. As such, the quality of my interviewing techniques is related to the language in which my interviews are carried out. Differences in gender and age might also lead to interviewing challenges (most interviewees were males, older than I am), but it is difficult to trace how this was directly influential to the results. Throughout this PhD research my interviewing techniques improved, resulting from increased interviewing experience, clearer research directions, and larger knowledge of the topic. However, I find it a lasting challenge to structure the interview after my research interests and not to let myself get overwhelmed by talkative counterparts.

The interview material (of which the majority was transcribed in detail) is represented only meagerly in the articles in a direct sense. Where I found it of analytical importance, I used interview quotes to strengthen the empirical story *and* the central arguments in the papers (specifically in paper 3). However, where the use of interview quotes was not of added value for analytical purposes, I left these out in order not to become anecdotal. Much of the knowledge and inspiration upon which the articles are built, however, is directly linked to the interviews that were carried out. Interviews have thus been crucial in carrying out the research of this project. Moreover, the combination of interviews and analysis of documents proved relevant, as many of the interviewees played an active role in carrying out the assessments and studies that were documented in the reports.

Observations

In addition to the interviews and analysis of documentation, I attended several meetings between 2007 and 2010 that were open for all interested parties and where topics of concern in the management plan were discussed with a broader audience. This audience included regional stakeholders (such as fishermen's organizations and lobby groups for or against petroleum activity in the areas outside the Lofoten-Vesterålen islands), regional authorities, and industrial groups. Two of these meetings were so-called reference groups meetings. These were annual meetings, which took place in Tromsø in the spring of 2008 and 2009. Here, updated scientific material for the Barents Sea management plan was presented and discussed. Each of these meetings attracted around 50 participants.

In addition to these reference group meetings, I attended a large public hearing conference (well over 200 participants) in Svolvær (main centre of the Lofoten islands) about the overall revision of the management plan. This conference took place in June 2010. The revision of the management plan was initially scheduled to take place in the second half of 2010, but is rescheduled to the spring of 2011 as a direct consequence of the oil spill in the Mexican Gulf in the spring of 2010. I will return to this topic in the epilogue of this thesis.

These meetings were important to get a broader societal view over the governance of petroleum activity in the Barents Sea-Lofoten area. It was during one of the reference group meetings (spring 2009) that I got more insight into the different knowledge claims about the environmental risk of acute pollution. This meeting largely inspired me to write paper 3.

Notes on quality

The combination of document analysis, interviews, and observations has been fruitful in carrying out this project. However, the very combination of these methods (triangulation) should not considered to be of central relevance to the *quality* of this thesis. Quality in qualitative research has been a contested area. Rather than discussing quality through the application of criteria of reliability and validity, I would like to make some notes on *trustworthiness* and *relevance*, which can be considered important elements determining the quality of qualitative case study research.

Sandelowski (1986) has argued that issues of validity of qualitative studies should be linked to trustworthiness. Trustworthiness can be achieved by the rigor through which the scientist has presented her or his material, making visible the practices of research, hence making it 'auditable'. The process of auditability implies that the scientist leaves a 'decision trail', so that the reader is able to track and verify the research process (Sandelowski 1986, see also Rolfe 2006). ANT uses a similar argument, and emphasizes *empiricism.* According to Latour (2005), a good description requires no explanation: if there is no explanation in the description, it is not a good description.

It is important to add that empirical material can be misrepresented or drawn out of its context. Trustworthiness is therefore also related to the extent to which the researcher is able to give good accounts of her/his subjects' realities, when for example interview material is extensively used in the research report. I have tried, in each article, to follow that principle of empiricism. However, in judging trustworthiness it should be acknowledged that it is inevitable for a researcher to make certain choices in the way she/he writes down her/his textual account. In that sense, through the choices made and research methods used, the researcher takes part in creating a reality, in performing a certain social world.[3]

This is directly related to relevance. Choices and directions in the research process are to some extent based on the world that the researcher wants to help to make (Law and Urry 2004). Research should be convincing and relevant, and relevance, I argue, codetermines its quality. For the first, this thesis aims to be relevant to the practices of marine ecosystem governance in Norway through the conclusions and implications drawn throughout this thesis. But case study research is directed at drawing conclusions about wider phenomena (Yin 2009), and its relevance should not be limited to the case itself. This case aims to provide insight into the turn to marine ecosystem governance at a broader level, and contributes to the scholarly literature on the subject. Novel about this thesis is that it links ecosystem-based management and the planning of petroleum activity in an explicit and direct way. On yet a higher level, it intends to contribute to the STS and environmental sociology literature. With regard to the STS field this thesis mainly contributes empirically. Cases of marine

[3] See also Law and Urry (2004) for an account on the performativity of method in the social sciences.

governance, to my knowledge, are only sparsely present in the large body of STS literature. Finally, this thesis aims to contribute to environmental sociology through its use of STS and ANT concepts and approaches, leading to descriptions, analyses and conclusions that might offer new insights into issues at the science-policy interface in environmental sociology. The quality of this thesis depends on its relevance on all of these three levels.

Introducing marine ecosystem governance

The marine ecosystem governance theme builds upon scholarly and policy discussions about marine *ecosystem-based management*. As this section will demonstrate, the concept of marine ecosystem governance that I use is broader for two main reason: 1) it includes integrated management and, consequently, cross-sectoral planning; 2) it involves the wider processes (including science-policy dynamics) through which influence is exerted on the making of ecosystem-based policy instrumentation.

Ecosystem-based management

The turn towards ecosystem-based management of the marine environment seems to result from several causes. As I have mentioned earlier, the very notion of sustainability has entered the global environmental agenda, and has been influential in the development of ecosystem-based management plans for the marine environment. The development towards marine ecosystem-based management is also driven by the conceived growing pressure of a larger variety of activities on the marine area, and the need to manage their cumulative impact. The idea of *vulnerable* ecosystems is central in this development. Furthermore, and I will come back to this point later in this introduction, there is an ongoing paradigm shift in ecology, which no longer takes for granted the idea that ecosystems exist in equilibrium. The turn towards ecosystem-based management can be considered as a response to this paradigm shift (Kuhn 1970) in science.

The concept of ecosystem-based management entered the international agenda during the 1992 Conference on Environment and Development in Rio de Janeiro, when countries were asked to develop new approaches for the protection and sustainable development of marine environments and resources (Barange 2003). Ten years later, during the Johannesburg World Summit on Sustainable Development, an agreement was made that countries should implement plans for ecosystem-based management by 2010.

Having its origins in terrestrial management (Slocombe 1998) the concept of ecosystem-based management first became related to marine management as a way to deal with the crisis in the world's fisheries (Botsford et al. 1997, Myers and Worm 2003). Multi-species management and the establishment of marine protected areas are the most popular methods towards more sustainable fisheries management. Implementation of these tools is still in a very early stage. While there is currently a parallel move towards integrated, ecosystem-based management, the scholarly literature on ecosystem-based management is still very much explicitly concerned with fisheries (see for example Hall and Mainprize 2004, Jennings 2004, Bianchi and Skjoldal 2008, Morishita 2008).

The concept of ecosystem-based management uses a powerful combination of 'ecosystem' and 'sustainability', which combines "understanding the defining characteristics of complex adaptive systems with the objective of identifying and sustaining healthy relationships within and between the interconnected spheres of ecosystem, economy and society" (Gaichas 2008: 393). Ecosystem-based management recognizes that the value of the whole ecosystem is greater than the sum of its parts (Browman and Stergiou 2004) and emphasizes that management systems should start from an understanding of ecosystems as complex, adaptive systems (Levin 1998, Gaichas 2008). The approach takes into account the interconnectedness and interdependent nature of ecosystem components and emphasizes the importance of maintaining the ecosystem's structure, functioning and productivity. Ecosystem-based management is expert driven, but its aim should not be to understand the entire structure and functioning of an ecosystem, before management instruments can be designed and implemented (see also Jennings 2004).

Towards integrated, ecosystem-based management

It could be argued that there is an important difference between ecosystem-based management on the one hand, and integrated management on the other (Curtin and Prellezo 2010). I do not consider such a distinction to be necessary, but I do differentiate between sectoral and cross-sectoral (or integrated) approaches. Hoel (2005) distinguishes between type I and type II ecosystem-based management. Type I offers sector-based approaches to ecosystem-based management (in reality this means ecosystem-based *fishery* management), while type II contains integrated cross-sectoral approaches to ocean management. Commercial activities are then considered against other commercial activities as well as against environmental aspects. Type II covers the various human activities in a marine area within a single policy framework. Implementation of type I remains largely a responsibility of the sector agencies and authorities. In integrated ecosystem-based management (type II), such as in the Barents Sea-Lofoten area, the implementation of new policy instruments happens both at the sector level *as well as* in a 'new layer' of ocean governance (which, in Norway, is governed at the level of environmental authorities).

Such new methods for integrated, ecosystem-based management include marine spatial planning, which is becoming a popular tool not least as a result of experiences with marine spatial planning in the Great Barrier Reef Park (Day 2008, Day et al. 2008). Marine spatial planning is typically an activity that is shared among various sector agencies and their advisory institutions. It is aimed at governing the cumulative environmental impacts of human activities, as well as to govern multiple spatial claims among different sector interests (Norse 2005, Crowder and Norse 2008, Douvere 2008, Gilliland and Laffoley 2008, Halpern et al. 2008).

One of the points of departures in designing plans for integrated ecosystem-based management is that the multiple uses of the sea need to be streamlined so that they can be compatible without disturbing the ecosystem's functions and productivity and biodiversity. The *total environmental impact* should not increase as a result of an increased level of activity. This is in particular a challenging objective in areas where industrial activities are expanding. For that reason, another central element in integrated, ecosystem-based management is the development of environmental monitoring systems (Day 2008), as well as the development of methods to assess total environmental impact.

Underlining that ecosystem-based management is a wide-ranging area-based approach, one of the broader global initiatives comprises a network that aims to advance the assessment and management of Large Marine Ecosystems (LME) (Sherman 1995, Fanning et al. 2007). The framework is proposed as a possible practical structure upon which ecosystem-based management could be implemented internationally. The boundaries of LMEs are drawn based on a combination of ecological, biophysical, geological and administrative arguments. The focus of LME management should comprise fisheries, pollution and ecosystem health, socioeconomics, and governance (Sherman et al. 2005).

Embedding the governance concept

As the title of this thesis is marine ecosystem *governance* in the making, it is necessary to make a step from the management concept, to the concept of governance. Governance is more multi-layered than management, and involves the enrolment of a diversity of actors at multiple levels. Governance is more reflective and deliberative, and less means-oriented and instrumental than management (Kooiman 2005). The turn towards marine ecosystem governance implies transformations at various levels. Van Kersbergen and van Waarden (2004) argue that new governance arrangements include changes in the forms and *mechanisms* of governance, the *location* of governance, governing *capabilities* and *styles* of governance. With particular reference to marine governance van Leeuwen and van Tatenhove talk about a shift in *locus* and *focus* of governance (2010). The shift in locus of governance refers to the emergence of new actors that either strongly influence, or are official partners in governance processes. The shift in focus of policy and politics refers to a shift in the rules of the game and the steering mechanisms developed (van Leeuwen and van Tatenhove 2010).

The concept of marine ecosystem governance involves the wider dynamics around the introduction of integrated, ecosystem-based management in a given area. Simultaneously, the very concept denotes certain directions; it has a guiding function and directs attention to certain issues (I will come back to this in the section "outlines of a post-constructivist approach"). In the broad conceptualization of marine ecosystem governance that I use in this thesis, I include all processes related to the establishment of routinized practices and the design of instruments for integrated, ecosystem-based management. This involves the reorganization, mobilization, and translation of scientific knowledge for ecosystem-based management.

Public hearing processes and stakeholder conferences are also a central part of marine ecosystem governance. In addition, I would argue that activities that take place outside the 'formalized' process should also be included in an analysis of marine ecosystem governance *if* these activities exert influence on the design of ecosystem-based policy instrumentation. Here, one could think of (lobby) activities of industrial organizations or environmental NGOs. I have, however, not been able to explicitly focus on these processes and activities in the work for this thesis.

I have chosen not to use the concept of 'integrated marine governance', which becomes more widely used in the ocean governance debates (for example van Tatenhove 2010). This concept puts relatively much emphasis on organizational and institutional challenges, which is not the main focus of this thesis. As I will demonstrate in the last chapter of this introduction ("outlines of a post-constructivist approach") the *ecosystem* is at the core of marine governance practices. I outline the relevance of looking into the scientific practices of constructing the ecosystem's normal situation and critical limits, upon which governance designs are built. By choosing the wording 'marine ecosystem governance' then, the expert-driven processes as well as the challenges to translate natural scientific information into policy instrumentation receive central analytical attention.

Towards comprehensive planning of petroleum activity

The management plan for the Barents Sea-Lofoten area was the first experiment towards ecosystem governance in Norway. Since the development of oil and gas activities has worked as the central catalyst for the production of an ecosystem-based management plan – which is idiosyncratic to this Norwegian case study – I find it relevant to sketch a historical overview of the development of the sector that is most important to the Norwegian economy.

This rather detailed and descriptive chapter first describes the organization of petroleum management, but its broader objective is to provide insight into the historical controversy over the expansion of the oil economy into the Norwegian north. The chapter offers a more comprehensive context for the articles in this thesis. After a brief introduction it describes the development of a sector policy from the start of the Norwegian petroleum era. Subsequently, it looks into the division of tasks and responsibilities in the Norwegian model of petroleum management. Then, this chapter describes the history of the opening of the northern areas for petroleum activity, which has finally led to an environmental turn and the development of a more comprehensive approach to the management of marine areas.

Introduction

Norwegian petroleum activity started in the North Sea, and has increasingly developed northwards into the other petroleum provinces: the Norwegian Sea and the Barents Sea (see figure 2). Throughout the past decades the oil and gas industry has become of central importance to the Norwegian economy. In 2008, Norway produced 2,5 million barrels of oil and 99,3 billion standard cubic meters of gas daily, and the petroleum sector contributed to 34 per cent of the state's income and 50 per cent of its export value (Ministry of Petroleum and Energy 2010).

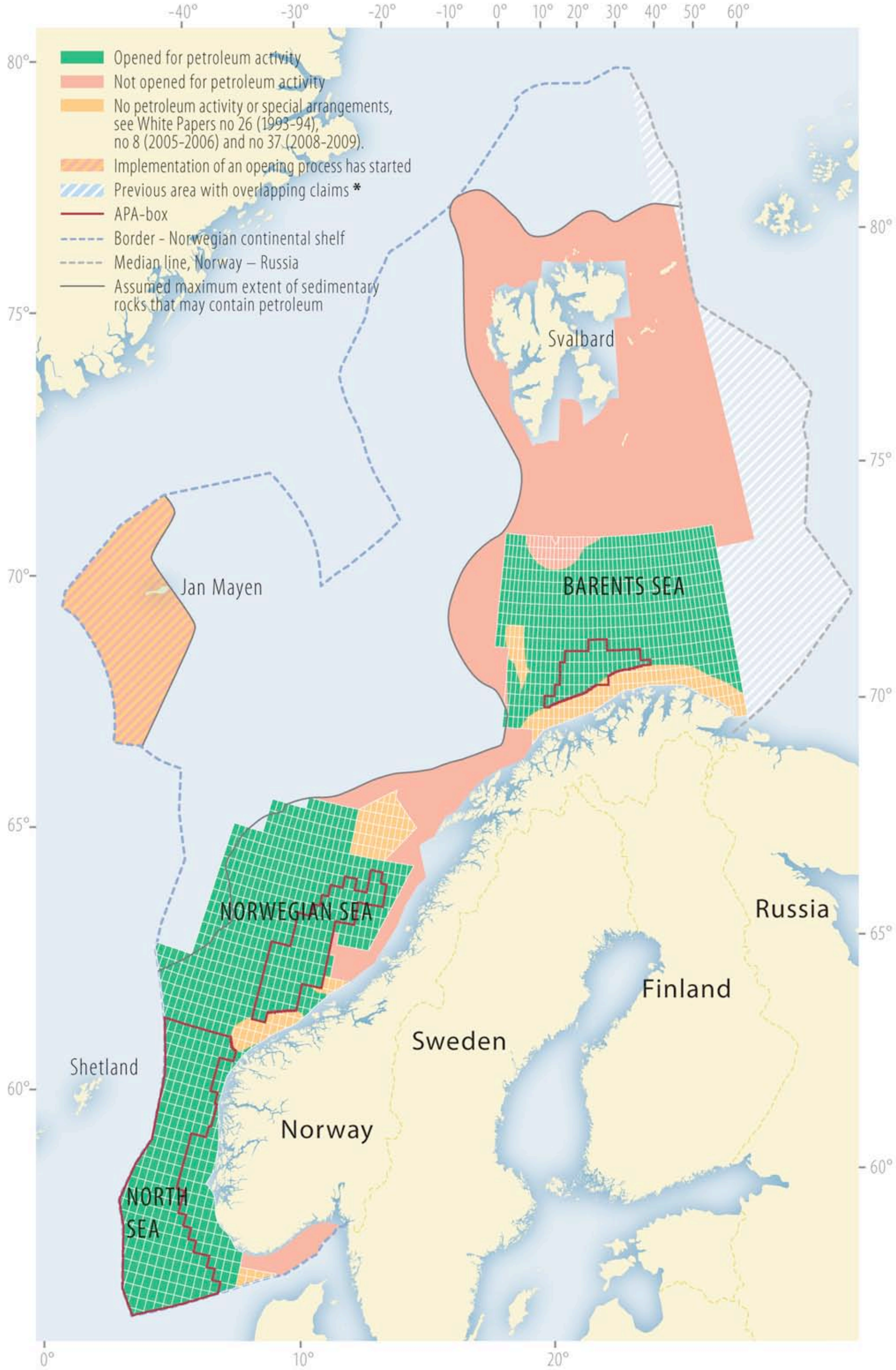
While the total production of oil and gas in Norway will decline in the years ahead, the focus of the Norwegian petroleum sector is expected to shift northwards. Of 65 fields in production on the Norwegian Continental Shelf today, only one is located in the Barents Sea.[4] The shifting focus towards the circumpolar region is not a mere Norwegian phenomenon. The US Geological Survey has estimated that 30 per cent of the world's undiscovered gas, and 13 per cent of the world's undiscovered oil is located in the circumpolar north (Gautier et al.

[4] 52 fields are located in the North Sea, and 12 fields in the Norwegian Sea.

2009). Of total undiscovered resources in Norway, the petroleum authorities expect around 28 per cent to be located in the Barents Sea (Ministry of Petroleum and Energy 2010). The expected amount of petroleum resources in the Barents Sea is nevertheless rather uncertain, due to the largely immature status of the area. The only field in production in the Barents Sea is Snøhvit, where Statoil has been producing Liquefied Natural Gas (LNG) since 2007. The Goliat field, close to Snøhvit, will be the first oil field to be in production in the Norwegian part of the Barents Sea. The Russian side of the Barents Sea is also attracting growing interest, following the large Shtokman field discovery in 1988.

Northern Norway has been presented as the area of opportunities within the government's Strategy of the High North (Ministry of Foreign Affairs 2006), which includes great optimism regarding future oil and gas developments. While the petroleum industry is shifting its focus from south to north, there is a simultaneous shift in focus from oil to gas. It is expected that discoveries in the Barents Sea will consist of more scattered fields. This brings along technological challenges for the industry with respect to the most efficient forms of production.

The area outside the islands of Lofoten and Vesterålen – in the southern part of the Barents Sea management area - receives special attention in the planning and management of future petroleum activity. This area has a number of unique features. Important ecological processes center in this very narrow part of the Continental Shelf outside these islands, enabling seasonal fisheries that have been relevant to the region for centuries. The area attracts many tourists and has been proposed to be included on the UNESCO world heritage list for its natural and cultural values. Simultaneously, the petroleum industry is keen on entering this area. The Petroleum Directorate's mapping of 'prospective areas' (Norwegian Petroleum Directorate 2010), resulting from the seismic surveys that were carried out in 2007-2009, has reinforced this desire for rapid expansion.



Source: Norwegian Petroleum Directorate

Figure 2: Area status Norwegian Continental Shelf.

Development of a sector-policy

The history of petroleum activity in Norway started in 1963 when Phillips Petroleum decided to pursue an exploration program in the North Sea. While in the 1950s there were very few who believed that the North Sea contained large petroleum potential, this changed when Shell and Esso discovered the vast gas field at Slochteren, near Groningen in the Netherlands, in 1959. This had been the largest gas field that was known outside the USSR until then. The discovery of Slochteren changed the prospects for the North Sea, including the Norwegian part of it. While exploration drilling in the North Sea took off, Norway started to develop a national framework for the management of oil and gas activities in its ocean areas. After over 30 wells had been drilled on the Norwegian side, of which none proved to be commercial, Phillips discovered the Ekofisk field in November 1969 (Yergin 1991). This vast discovery was followed by another series of productive new discoveries on the British, Dutch and Norwegian sides of the North Sea. The North Sea was one of the greatest investment projects in the world and a “technological marvel of the first order” (Yergin 1991: 651); it was a province of the sort that the industry had never operated in before, because of the water depths, weather conditions and viciousness of the sea.

These emerging activities in offshore petroleum development accelerated the tempo of bilateral negotiations for the fixation of boundaries of the Norwegian Continental Shelf (Ryggvik 2009). In 1965 Norway formally agreed with Britain and Denmark on how to divide the North Sea. The establishment of a 200-mile exclusive economic zone in 1977 further defined Norway’s rights to its continental shelf. While there is no uniform manner in which boundaries between countries’ ocean areas are drawn, the fixation of boundaries with Denmark and Britain was rather unproblematic, as all countries accepted the median-line principle. In the northeastern part of Norway’s ocean areas however, Norway and Russia only came to an agreement on the former area with overlapping claims in the spring of 2010 (for a history of this dispute, see Tamnes 2010).

Throughout the 1960s a rights-based regime was established to manage petroleum activity through a licensing system, where the government had a steering position to determine the tempo of the developments (Al-Kasim 2006). This concession system, still in place today, implies that the state grants awards to an oil company, or groups of oil companies, in specific blocks. Each block on the Norwegian Continental Shelf represents a geographically defined area measuring 15 minutes of latitude and 20 minutes of longitude. In an ordinary licensing round the Ministry of Petroleum and Energy invites oil companies to nominate blocks, which the companies believe contain high potential and should hence be integrated into the announcement. After review, and with input from the Petroleum Directorate, as well as after negotiations with fisheries and environmental authorities, the Ministry announces blocks that the companies can apply for. These announcements include special environmental and fishery conditions. A production license is normally granted for one block or part of a block, and is granted to one company or to a group of companies. Licenses give the licensee a monopoly to perform exploration drilling and recovery of petroleum resources within that particular area, for up to thirty years. A license follows with a work programme that the company should follow up in the first years. When production starts, the licensee becomes the owner of the petroleum that is produced, however, the producing company pays a resource rent to Norway as the hosting country.[5]

Licensing rounds usually take place every second year. In 2003 Norway implemented an additional licensing system to speed up exploration activities in so-called mature areas. These APA[6]-licensing rounds take place yearly. Partly as a result of this system, 2009 has been a record year in exploration activities as well as in the amount of discoveries that have taken place (Ministry of Petroleum and Energy 2010). It can be expected that the 21st licensing round (June 2010) will be followed by increased exploration in the north, as it had a special focus on the northern areas and 51 blocks were announced in the Barents Sea. Awards will be made in the spring of 2011. The licensing system has become a central element in the management of petroleum activity.

In addition to the licensing system, a taxation and legislation framework form the basic and interrelated elements of petroleum management in Norway. The taxation system is set up in such a way that the state receives a large share of the value created through oil and gas activities. It is based on regulations for ordinary corporation tax, which is 28 per cent. Due to the extraordinary profitability related to the production of petroleum resources, a special tax is also charged on the income of these activities, which is 50 per cent. Furthermore, the state's revenues from oil and gas activities derive from direct ownership in fields and infrastructure, from charges and fees, and dividends from ownership in Statoil (the state owns 67 per cent of the shares in Statoil) (Ministry of Petroleum and Energy 2010).

The legislation system includes work, health, safety and environmental regulations. This framework was developed from 1965 onwards and includes regulations during seismic surveys, exploration drilling, as well as regulations for the production phase (Al-Kasim 2006).

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[5] Yergin (1991: 414) and Ryggvik (2009) provide interesting accounts on the theoretical origins of this resource rent.

[6] APA: Awards in Predefined Areas

The internal control principle has been strong throughout the Norwegian petroleum history, which means that the licensees are responsible for compliance with these regulations. Legislation was formalized with the comprehensive Petroleum Law in 1985, after almost 20 years of experience with petroleum activities on the Norwegian Continental Shelf. The Petroleum Law contributed to clarifying the divisions of tasks and responsibilities in the Norwegian petroleum administration (Al-Kasim 2006). Importantly, the law required a consequence assessment before an area was opened, or before a field development could start. A revision of the Petroleum Law was carried out in 1996.

Division of tasks and responsibilities

The development of a management system for petroleum activity took place parallel to the establishment of management institutions. In the early years the Ministry of Industry held main responsibility for developing the licensing, taxation and legislation system for oil and gas exploration and production, which was later taken over by the Ministry of Petroleum and Energy; established in 1978.[7]

In 1970 the government established a committee to draft the organization of Norway's petroleum administration. This led to establishment of the Norwegian Petroleum Directorate in 1972, which initiated a division of the power and management responsibilities between the Ministry and the Directorate.[8] While the Ministry held the overall political responsibility and assigned licenses, the Directorate worked as the competence base and professional advisory institution under the auspices of the Ministry. The overall objective of the Directorate was to recommend assignment- and development solutions which over time should maximize the level of exploitation. The Directorate was in a good position to build up strong competence on the resource aspects, since the applications for concessions that the companies delivered contained lots of geological information. The reasons for this is that the companies were obliged to pass on their results from the many drillings they had to carry through when they received a concession (Ryggvik 2009).

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[7] Before this, the Norwegian Petroleum Council worked on issues concerning petroleum activity, which was established on behalf of the Ministry of Industry (Al-Kasim 2006)

[8] In 2004 the Norwegian Petroleum Directorate was split up into two bodies: The NPD itself, and the Petroleum Agency (Petroleumtilsynet), which is responsible for technical and operational safety and works under the auspices of the Ministry of Labor and Social Inclusion.

Statoil was also established in 1972, which was then a fully state-owned company with the objective to take care of the business function of the Norwegian petroleum administration. The Labor Party argued that this state-owned enterprise should receive monopoly power to explore and exploit the areas north of 62° North. Statoil never got that monopoly position, but the company received an important role in defining the petroleum politics in the north (Tamnes 2010).

With respect to the environmental effects of oil and gas activities, the Ministry of the Environment has overall responsibility. Environmental regulations for offshore petroleum activities were formalized in 1981 with the implementation of the Pollution Control Act. The Pollution Control Act is an enabling act, which implies that the details in each case are outlined through discharge permits and regulations issued by the pollution control authorities. The responsibility for follow-up lies with the Climate and Pollution Agency[9], which is the advisory organ of the Ministry of the Environment. The Climate and Pollution Agency plays an important role in establishing environmental regulations for petroleum activities.

In accordance with the Pollution Control Act, the Norwegian preparedness system to deal with acute pollution is threefold. Oil companies have the primary responsibility to dealing with acute pollution from their own activities. Offshore activity as well as larger industrial facilities on land need to have oil spill preparedness systems in place. The operator companies on the Norwegian Continental Shelf have organized themselves into the Norwegian Clean Seas Association for Operating Companies (NOFO), which manages emergency response systems, develops contingency plans and supports research and development of oil spill response equipment. Secondly, the municipalities are obliged to take care of the necessary equipment to deal with smaller, acute spills. The local authorities are obliged to have response plans in place to deal with acute pollution, and should be able to provide crews and equipment. Norway is divided into 34 emergency-regions, each with an inter-municipal committee for acute pollution. Lastly, the state is responsible for emergency response in case of major incidents of acute pollution, when spill response is not covered by private and municipal preparedness. The state shall prevent acute pollution, and ensure that the responsible polluter or municipality takes appropriate measures when acute pollution occurs. The overal responsibility for oil spill preparedness in Norway lies with the Ministry of Fisheries and Coastal Affairs, with the Coastal Adminstration as adivisory, planning, controlling, and executive body. Apart from the Coastal Adminstration, other governmental

[9] The Climate and Pollution Agency was formerly knows as the Norwegian Pollution Control Authority (Statens Forurensningstilsyn – SFT). It changed its name early 2010.

agencies have important roles, among which the Petroleum Safety Authority (subject to the Ministry of Labor) and the Climate and Pollution Agency (subject to the Ministry of the Environment). The latter sets the environmental requirements for preparedness systems and monitors compliance with the environmental regulations.

Focus north

While the North Sea saw a rapid expansion of petroleum activities throughout the 1970s and 1980s, the area north of 62° north knows a long history of assessments, White Papers, proposals for (partial) openings of the area, and subsequent moratoria and closings. The history of the opening of the area north of 62° north can be told from diverse perspectives (for example Tamnes 2010, Thesen and Leknes 2010). Here I concentrate on elements in this history that are relevant to understanding the later turn towards ecosystem-based management and the simultaneous reinforcement of the Ministry of the Environment in exerting influence on petroleum politics.

As mentioned above, the area that is delimited today as 'the Barents Sea-Lofoten area' initially belonged to a larger geographical area, which was discussed in relation to the development of oil and gas activities in 'the north'. Arbo (2010) explains how the boundary at 62° north transformed from an administrative necessity to a symbolic boundary in the history of petroleum developments. This area remained closed for exploration drilling until 1980.[10] There were several reasons for this, which included that the area was economically unattractive because of its geographically remote location with large distances to the markets. Moreover, the majority of the potential resources consisted of gas, which demanded more technologically challenging solutions than oil. For a long time, when there was no infrastructure available, gas was considered to be an inconvenient by-product of oil production, and was therefore burned off. There were other technological limitations as well, which had their origin in the geologically challenging structures of the Barents Sea. These limitations slowed down the process of exploration and potential discovery after the area was opened in 1980 (Doré 1995). Another reason for the late start is that the northern areas have always been controversial, in particular as a result of a concern for conflict-potentials with fisheries. These related to issues of reduced space, increased debris and pollution, as well as

[10] Seismic surveys, however, were carried out prior to that. In 1969 a special committee was appointed to prepare a plan for the exploration of the Norwegian Continental Shelf and its natural resources, and recommended extensive national surveys in the areas north of 62 north prior to opening the areas for licensing (Al-Kasim, 2006: 26)

competition of employment opportunities (Andresen and Underdal 1983, House 1986, Hersoug 2010). The concerns were related to all phases in petroleum activity: from seismic surveys, to exploration drilling, to the production of petroleum resources. From the 1970s to today, the development of new technology significantly reduced these negative effects in all phases of petroleum activity (see Hersoug 2010). There is nevertheless an ongoing discussion and conflict over the effects of seismic surveys on fish. The Institute of Marine Research (2010) has recently reported that these activities scare away fish, but uncertainty remains over the scope of these effects.

The first White Paper that dealt with the potentials for opening the areas north of 62˚ north was presented in 1976, which dealt specifically with the Tromsøflaket and Haltenbanken areas (Ministry of Petroleum and Energy 1975-1976). The White Paper presented considerable scepticism to oil and gas developments due to fisheries and environmental concerns. It was argued that oil spill response systems were underdeveloped. The Bravo accident in 1977 led yet to another postponement of exploration activities in the north. However, in 1979, the majority of the Parliament gave green light to start exploration activities in a few selected areas that the authorities considered both appropriate and mature for commercial exploration (Al-Kasim 2006: 64). As a result, in January 1980 the first blocks north of 62˚ north were allocated; one on Haltenbanken and two on the Tromsøflaket bank area. It was the government's long-term intention for the northern areas to provide the resource basis for continued activity beyond what the North Sea alone could sustain (Al-Kasim 2006: 65). With these first allocations in the north, not only Statoil, but also Norsk Hydro and Saga Petroleum received operator responsibilities (Tamnes 2010).

The adoption of the Petroleum Law in 1985 initiated a large consequence assessment for the southern Barents Sea, which was carried out between 1985 and 1989 and included the involvement of fisheries and environmental institutions. This assessment looked particularly into the effects of exploration activities. In the subsequent White Paper (Nr. 40 1988-1989) it was pointed out that there was a gap in knowledge about the effects of exploration activities on vulnerable resources in the marine environment. In addition, attention was directed, once again, to the lack of oil spill response systems in the Barents Sea area. Despite these shortcomings, the government opened the southern part of the Barents Sea (south of Bjørnøya) for exploration activities in 1989, with the only exception of Troms II (Ministry of

Petroleum and Energy 1988-1989).[11] From a national perspective, it was now considered important to uphold the Norwegian sovereignty rights in the northern regions (Al-Kasim 2006, Tamnes 2010). Furthermore, exploration activity was initiated with the incentive to vitalize the economy of northern Norway (Al-Kasim 2006). Environmental concerns remained high and strict seasonal limitations to drilling were implemented. It was emphasized that the risk of exploration activity in the Barents Sea should not be higher than on other parts of the Norwegian Continental Shelf (Ministry of Petroleum and Energy 1988-1989).

The government allocated blocks in the Barents Sea during three consecutive licensing rounds. In the twelfth round in 1989 six blocks were allocated in the Barents Sea; followed by 25 blocks in the thirteenth round (1990) and only two blocks in the fourteenth round (1993) (Al-Kasim 2006). As a result, between 1980 and 1992, 54 exploratory wells were drilled in the Norwegian part of the Barents Sea, with an average of 85 days of drilling per well (Klungsøyr et al. 1995). There were no allocations in the subsequent rounds, as there were very few discoveries, and the areas were not considered interesting enough to the oil companies. The years between 1994 and 2000 saw a stop on all exploration drilling in the Barents Sea.

The environmental turn

The turn towards marine ecosystem governance took place with the installation of the Bondevik government in 2001. The Sem-declaration committed the government to a proactive environmental and resources policy based on the principle of sustainable development. It was decided that an integrated management plan for this area had to be produced. This announced a leading role for the Ministry of the Environment, which headed the process towards integrated management of the Barents Sea. A full moratorium was imposed on all oil and gas activity in the Barents Sea in 2002. Before explorations could resume, a consequence assessment of year-round petroleum activity in the Barents Sea had to be carried out.

After it was decided that a management plan was needed before the Barents Sea-Lofoten area could be reopened for petroleum activity, a steering committee was established to coordinate the process towards the plan. The Ministry of the Environment headed the steering committee, and thereby received a position through which it could exert more

[11] The areas outside the Lofoten and Vesterålen islands (Nordland VI and Nordland VII) were not taken into consideration as part of the Barents Sea, and remained closed.

influence on petroleum politics in the north. Paper 1 describes the process towards this plan in detail. In 2006 the management plan for the Barents Sea was adopted, and soon after that a similar process started to design a plan for the Norwegian Sea. The ecosystem-based management plan for the Norwegian Sea was finished and implemented in 2009 (see Ottersen et al. in press). Currently, an ecosystem-based management plan for the North Sea is in preparation.

While a strong sector policy for petroleum activities was developed from the 1960s onwards, the 21st century marks a shift towards more comprehensive, cross-sectoral plans with a simultaneous reinforcement of the position of the Ministry of the Environment. The steering committee that the Ministry of the Environment headed designed the process, formulated tasks, and mandated exercises to scientific institutions and governmental directorates. The environmental turn in petroleum management, and the simultaneous development of marine ecosystem governance, has been characterized by an increasing role for science.

Science in society

Central in this thesis is the role of science in marine ecosystem governance. In order to understand the complexities of these dynamics it is relevant to look into the changing meaning of science as it has become more central in addressing societal issues. How can we look at science and its role in society? The following sections discuss Merton's ethos of science, and describe how new relations between science and society gradually called for an updated ethos of science *in society* throughout the last decades. I will present a number of 'reform proposals' for, and updated diagnoses of, the contemporary role of science in society that have been developed within science studies. To conclude, I demonstrate how this broad topic of 'science in society' can be more specifically connected to the governance of environmental risk and uncertainty.

The traditional principles of science

In 1942 Merton developed his principles for an ethos of science, which became an important reference in (social) studies of science ([1942] republished in Merton 1968). For Merton science was an autonomous institution, in which the goals were the extension of certified knowledge. The ethos of science contained the values and norms that were held to be binding for the scientist. Merton called these the 'institutional imperatives' of science. They are often referred to as the CUDOS norms in science:

Communism: the findings of science are owned by society and scientific knowledge is thus a common property.

Universalism: claims to truth must be subjected to pre-established impersonal criteria.

Disinterestedness: scientists should be unbiased, and their only and overriding interest is to achieve truth.

Organized Skepticism: scientists are required to scrutinize all findings before they can be accepted as true.

An early account on the role of scientists in politics was offered in the US government policy report of 1945 prepared by Vannevar Bush: *Science: the endless frontier*. In this report, the role for scientific research in achieving economic, technological and practical benefits for society as a whole was underlined. Basic research would lead to new knowledge, and for that reason the report called for strong support for research while respecting the autonomy of scientists and their ability to determine the most important areas for research. Nearly three decades later Bell (1974) argued that information and knowledge were the major structural forces of post-industrial society. Bush' and Bell's accounts represent the Mertonian idea(l) of an autonomous science. With respect to the use of science for innovation and policymaking they suggest linearity; good science following the Mertonian ethos is a prerequisite for innovation and policy making in the post-war, post-industrial society. Important in these accounts is the call for a clear division of tasks: scientists are responsible for knowledge production, while politicians are responsible to implement that knowledge in policy.

The social contract of science with society was due to change during the post-war period as scientists became increasingly attached to governments and industries.[12] Within university settings, the Mertonian norms remained relevant, varying however across disciplines. But in general, knowledge production for the sake of knowledge production found decreasing societal support and there was a call for an updated ethos of science in post-academic settings (see for example Ziman 2000). In outside-university science, the objectives of knowledge production became more specific and emphasized usefulness and relevance of results.

New relations between science and society

While the Mertonian principles demarcated science from non-science, one can witness a trend that demands a new discussion on the contemporary ethos of science. Old principles have become replaced by new ones, or co-exist with new principles; in each context in a new configuration. The developments described above have resulted in a shifting of the boundaries of science, which have been discussed and contested throughout the last decades. Gieryn (1983) made important contributions with his notion on boundary work, to discuss and analyze the demarcation problem between science and 'non-science' empirically. An important turning point for the relationship between scientists and policy-makers was the publication of Weinberg's article on "science and trans-science" (Weinberg 1972, see also Jasanoff 1987). Weinberg warned scientists and policymakers for the grey zone between science and policy. He suggested the establishment of a new branch of science – regulatory science –, which is subjected to different norms for proof than ordinary science. In the *Fifth*

[12] It should be noted that scientists became attached to industries already from the 1860s onwards, starting in the German chemical industry and the American electro-technical industry.

Branch Jasanoff (1990) argues for procedural reforms in regulatory science. It is, however, her notion of co-production (2004) that I find of particular relevance here, which provides a framework for understanding the relationship between science and society and the role of the scientists in that relationship. The co-production idiom gives room to look at science and politics as two separate things; two basically different activities that follow their own principles. They are, however, intertwined and mutually dependent. The case study of marine governance in Norway is an example of the co-production of science, society and nature.

One of the most popular diagnoses of the new relation between science and society is offered by Gibbons, Nowotny and their colleagues, who offer an analytical distinction between Mode I and Mode II science (Gibbons et al. 1994, Nowotny et al. 2001). In Mode I 'problems are set and solved in a context governed by the largely academic interests of a specific community'. This characterizes 'conventional' research, which originates from the scientist's curiosity to new facts. In Mode II, on the other hand, knowledge is produced in a 'context of application', which involves a wide range of perspectives. It is characterized by heterogeneity of skills, transdisciplinarity, flatter hierarchies, and transient organizational structures (Gibbons, Limoges et al. 1994). In Mode I, the academic communities 'spoke' to society. In Mode II, society speaks back to the expert communities. Knowledge production takes place as a result of specific questions concerning specific thematic fields or geographical places. Such context-sensitive knowledge is produced in more open systems of knowledge production (Gibbons 2000: 162). Instead of seeking for *reliable* knowledge, the focus in mode II knowledge production should be to produce *socially robust knowledge* (Gibbons 1999, Nowotny 2003). Socially robust knowledge, it is argued, can be achieved through more 'open' systems of knowledge production. Quality is thus to a larger extent defined by characteristics of the science process, rather than by its outcomes.

It must be noted that the description of Mode II should be acknowledged with care, as it offers a somewhat dramatized picture of the transformation of science as a whole. Furthermore, the notion of transdisciplinarity in knowledge production is a tricky one as well. While the problems in Mode II *society* (Gibbons 2000), for example in environmental governance, are of a transdisciplinary nature, it is difficult to find empirical material that proves the transformation of science into transdisciplinary knowledge production. Expert fora might be organized in interdisciplinary research projects, but their parts can be traced back to disciplinary knowledge (Weingart 1997). This, too, is to large extent the case in knowledge production for ecosystem-based management.

Finally, Funtowicz and Ravetz suggest a 'post-normal science' framework for dealing with complex contemporary societal problems (Funtowicz and Ravetz 1993, Ravetz 2006). This is a proposal for further reform, more than a diagnosis of the new relations between science and society. 'Post-normal' refers back to Kuhn (1970), who developed the notion of scientific paradigms, by which he reconsidered the idea that science develops first and foremost through individual discoveries and inventions. Paradigms result from scientific revolutions that break the established rules and taken-for-grantedness in a particular discipline. With a paradigm, a scientific community acquires a criterion for choosing problems that can be assumed to have solutions. Normal science, then, is puzzle solving within a paradigm. In Kuhns words "normal-scientific research is directed to the articulation of those phenomena and theories that the paradigm already supplies" (1970: 24). Post-normal science is brought outside this normal, university context of puzzle solving within a paradigm. It describes contemporary science-politics situations according to four characteristics: (1) high uncertainty, (2) disputed values, (3) high stakes and (4) high urgency (Funtowicz and Ravetz 1993).

In post-normal problems of environmental governance, the new dominant problematique is no longer technological risk, but the contradiction between sustainable development and nurturing economic growth. While governments strive to guarantee safety on the one hand, they violate it on the other because of objectives of economic innovation and growth. In such post-normal problems, various sorts of uncertainty and value-commitments enter into any decision on risk. Because of that, within post-normal science it is argued that the scientific side of the work must be complemented by other considerations. For this reason, Funtowicz and Ravetz (1993) suggested that 'extended-peer communities' should have an important role in quality assurance. They argue that only through a dialogue between all sides, where scientific expertise is discussed in relation to local and environmental concerns, can creative solutions be achieved. If such a dialogue is not a central part of the process, counterproductive forces will dominate.

The establishment of extended peer communities is thus not merely a political or ethical act, but can enrich the process of scientific investigation (Funtowicz and Ravetz 1993). Extended peer communities are particularly seen as facilitating decision-making when the traditional dichotomy of fact and value is eroded, as they mediate technical and lay interests for the production of a knowledge base that integrates technical and contextual matters (Healy 1999). It remains a difficult question *how to extend* the peer community, and in what ways a dialogue leads to wider legitimacy of policy outputs. Furthermore, it should be critically questioned if it is possible and desirable to reach agreement on uncertainties, as the post-normal science framework proposes (Funtowicz and Ravetz 1993, Healy 1999).

The works of Jasanoff, Gibbons, Nowotny and colleagues, and Funtowicz and Ravetz have provided important theoretical foundations and empirical understanding of the changing role of science in environmental governance. This literature has been helpful in thinking about the new kinds of challenges that science and society are faced with, and the responses in terms of updated contracts between science and society. This has been a prerequisite to pose questions about practices and instruments of marine ecosystem governance, and in particular about the governance of risk and uncertainty in such post-normal settings, which I turn to now.

Governing risk and uncertainty

In the words of Jasanoff "in industrial nations 'risk' has become *the* organizing concept that gives meaning and direction to environmental regulation" (1999: 135). Risk, indeed, has become a central concept in environmental and marine governance. This thesis has been partly inspired by Beck's *Risk Society*, which he published first in 1986 as *Risikogesellschaft: Auf dem Weg in eine andere Moderne* and was translated to English first in 1992. Beck argues that our concern is no longer merely with how to make nature useful, but the concerns increasingly center on the problems that result from the techno-economic development of society. Beck diagnosed a society in which risks resulting of technological progress would become even more central in defining the essential elements of late-modernity. Beck's thesis was that while science and technology play an increasingly important part in producing risks, society at the same time depends on science and technology in managing these negative side effects. There are two important interrelated themes in *Risk Society*: risk and reflexive modernization. Through the production of late-modern risks as a by-product of industrialization, and as a result from the focus on the identification and management of those risks, modernization is becoming its own theme and has as such become reflexive (Beck 1992). The reflexive modernization thesis will however not be further explored in this thesis.

According to Beck, "in risk positions consciousness determines being" (1992: 24). He makes a distinction between risk and catastrophe, where risk implies the anticipation of a catastrophe, and not the catastrophe itself. As a result, "risks exist in a permanent state of virtuality, and become 'topical' only to the extent that they are anticipated" (2006: 332). A major concern in *Risk Society* is the incalculability of modernization risks. The argument is that sciences' monopoly on rationality has been broken when it comes to definitions of risk. There is, indeed, no expert on risk (Beck 1992: 28). The relevance of this point is illustrated in decision-making on risk, especially when it concerns those decisions that relate to acceptable levels of risk exposure. In such dilemmas, Beck explains, social movements start raising questions that cannot be answered by risk technicians, while these risk technicians answer questions that miss the point of what is really asked (1992: 30).

In environmental risk assessment and management risk is often understood as the combination of probability of an event, and its consequences. Risk assessment and risk management are very often directed at reducing the uncertainties in the knowledge base. Paper 3 argues that uncertainties will never be fully covered by new knowledge, and hence, the very notion of uncertainty needs to be a more important part of risk discussions. Therefore, to understand the concept of risk, it is useful to have a better notion of the role of uncertainties in risk discussions. While Beck treats uncertainties as principal building blocks of the 'non-knowledge society' (Beck 2009) - wherein he argues that more and better science has led to an increased level of non-knowledge that obstructs environmental governance processes – it is more constructive to look into the framework that Wynne (1992) proposes for the identification of various types of uncertainties.

Wynne's framework is also different from, for example, the way in which post-normal science treats uncertainty. While Funtowicz and Ravetz (1993) propose to measure uncertainty on a scale from small to large, Wynne argues that we have to take into account different *types* of uncertainties, and introduces the concepts of ignorance and indeterminacy. Ignorance refers to the unknown unknowns; it escapes recognition by definition, partly as a result of the institutional exaggeration of science as provider of all answers (Wynne 1992). Environmental policy is designed based on *existing* knowledge, which, of course, does not clarify how that knowledge will proceed, apart from following up the defined uncertainties. As an example, when the oil industry started up in the 1960s and produced water was discharged without any regulations, there was no awareness yet of the potential harmful effects of produced water. There was an undefined and unrecognized ignorance about the pollutant properties of produced water and, as such, there was no question about whether or not it could safely be discharged (see paper 4).

Indeterminacy is the other component of Wynne's framework of uncertainty, and introduces a social element into what is usually seen as purely scientific. Following Wynne, uncertainties in the scientific knowledge for environmental management cannot be properly described as objective shortfalls of knowledge, as most treatments suppose. "The extent of uncertainty seen in the scientific knowledge base is itself a subjective function of social and cultural factors" (Wynne 1992). Paper 3 demonstrates how identified uncertainties relate to social and cultural positions of those supporting and pursuing them, and how these scientific uncertainties similarly transform with changing social conditions. It shows how, indeed, "the urgency and existence of risks fluctuate with the variety of values and interests" (Beck 1992: 31).

To discuss risk, it is not only important to identify the types of uncertainties that are constructed and translated. It is just as important to understand the processes that take place beyond the boundaries of 'scientific' risk assessment. To theorize beyond the boundaries of risk assessment and risk management, and to capture the dynamics between the two, I suggest to talk about *risk governance*. Thereby I intend to perceive risk assessment and management in line with Jasanoff:

> The older linear model of risk assessment/risk management has not been abandoned, but it is now part of an entirely more complex process, one that is cyclical and grounded in, not separate from, the rhythms of deliberative politics. [ ] Trying to assess risk is [ ] necessarily a social and political exercise, even when the methods employed are the seemingly technical routines of quantitative risk assessment (Jasanoff 1999: 150).

This thesis traces the different notions of risk that are used in Barents Sea governance, in particular in the discussions about acute pollution in the areas outside the Lofoten and Vesterålen islands. Rather than starting out with a predefined conception of risk, I follow the practices and instruments that are assembled in order to make risk calculable. The epilogue of this thesis follows up the discussion of risk in the process towards the revision of the Barents Sea management plan, and comments on the potential for a settlement of the risk controversy in this area.

Outlines of a post-constructivist approach

I have now discussed the turn towards marine ecosystem governance in planning for petroleum activity in the Barents Sea. The former section presented ideas and concepts for a rethinking of the contemporary role of science in society – in particular in relation to 'post-normal' problems such as the planning of petroleum activity in the Arctic marine environment. While the former chapter theorized the transforming role of science in society, actor-network theory proposes to leave these abstract notions and to look more closely into how scientific practices co-construct political outcomes. What thus remains for this introduction is to explain in more detail the meaning of *in the making* in the title of this thesis. This does not merely refer to the status of the development of marine ecosystem governance in the Barents Sea-Lofoten area, but contains some deeper theoretical meanings and consequences for the ways in which this research has been carried out.

Beyond realism and social construction

In what follows I will present a 'post-constructivist' approach to the study of marine ecosystem governance. It must first be acknowledged that there is a whole body of literature that could be labeled as 'post-constructivist' that I will not discuss or mention (but see Wehling 2006). The approach that I will present is largely inspired by actor-network theory. The most important objective of these sections is to position this approach – and hence this thesis – between, or rather beyond the *social construction* versus *realism* dichotomy and to outline the usefulness of that position for the study of marine ecosystem governance.

A large extent of social science research is drawn to social constructivist explanations, which stand in sharp contrast to the realist approaches of the natural sciences that suggest that there is a single reality out-there waiting to be discovered. One of the most prominent works in the social construction literature is Berger and Luckman's *The social construction of reality* (1967), in which social construction was introduced into the social sciences. Their argument was that reality is constructed through institutionalized social roles and reciprocal interactions and that all knowledge was the result of social interaction. Different versions of social constructionism/constructivism have followed since Berger and Luckmann (see Burr 1995).

An impressive list of social construction literature can be found in Hacking's *The social construction of what?* (1999). Hacking provides a critical account of this body of literature, and argues that social construction works often have a political agenda against that what is claimed to be socially constructed. He mentions examples as gender, racism and child abuse. Hacking's first argument is that what is mostly meant to be socially constructed is not, say, X, but the idea of X. Social constructionist literature often neglects this first important point and does not pose itself the question *what* it is that is argued to be socially constructed. As a result of that, X can be real and socially constructed at the same time (Hacking 1999).

For Hacking and other post-constructivists[13], but in particular also for Latour (2004), the problem of social construction is that it is traditionally put in opposition to naturalized facts. Latour calls on scholars to adopt new approaches to social construction/criticism that develop, rather than debunk, things and ideas. He argues that social construction's traditional argument is that there is no sure ground anywhere and that its goal has always been to show that there are no unbiased natural facts and truths in society. Following Latour, one of the problems in the field of social construction/criticism is that it has led to artificially maintained controversies, which has often led to a confusion of the argument. The intentions of social construction were however never to create confusion to the certainty of a closed argument (Latour 2004). Social construction has nevertheless become void of meaning.

For the critical mind to become relevant again, Latour calls for a new realist attitude, which does not fight empiricism, but *renews* it. Latour calls it a task for the critically minded to return to the realist attitude, to make a turn to the *second empiricism*. This realism should not be concerned with matters of *fact*, but rather with matters of concern (2004), in which fact and value are no longer treated as dichotomies.

This empiricism is central in actor-network theory (ANT), which is, in the words of Law (1992), "a relational and process-oriented sociology that treats agents, organizations and devices as interactive effects". Early actor-network theory is in particular a call to 'follow the actor' in order to understand how material-semiotic networks are formed and performed. Central were laboratory studies in which scientists were followed in their construction of facts (Latour and Woolgar 1986) and technologies (e.g. Callon 1986a). These were strong empirical accounts that demonstrated how heterogeneous processes involving both human, non-human and material actors co-produce and co-construct objects and facts.

An important principle in ANT is that of generalized symmetry, which means that agency should be assigned equally to human and non-human actors. Callon (1986b) developed this into an ontological argument of free association, which implies that researchers should offer the same kinds of explanations in the natural and in the social worlds,

[13] The notion of post-constructivism was introduced by Joseph Rouse in: Rouse, J. 2002. Review: Vampires: social constructivism, realism, and other philosophical undead. *History and Theory* 41(1): 60-78.

since nature and culture are produced together. The notion of translation is of particular importance here, which emphasizes the continuity of displacements and transformations. Studying the process of translation provides one with a "symmetrical and tolerant description of a complex process which constantly mixes together a variety of social and natural entities", but also provides insight into "how a few obtain the right to express and to represent the many silent actors of the social and natural worlds they have mobilized" (Callon 1986b: 19).

The co-constructed ecosystem

ANT concepts are particularly useful in 'new' situations. It provides helpful tools to look at ecosystem-based management as the latter reflects and enacts innovative forms of governance with novel instruments and processes. Ecosystem governance takes place at the interface between nature and culture, where humans and their objects are engineering nature for the sake of economic progress and the coexistence of commercial actors. It involves a complex network of knowledges, artifacts, technologies, scientists, policymakers, industrial actors, and environmental and regional organizations.

When talking about *ecosystem*-based management or ecosystem governance, it is relevant to first look into the origins of this particular concept. In 1935 the term ecosystem was first mentioned by Tansley who was looking for a concept that would be better able to grasp the various relations of the organisms in a given region, including the dynamics of physical factors influencing this complex of relations (Tansley 1935). Interestingly, the ecosystem concept did not come into play before the modern use of computers and modeling, and the term thus captures mechanical engineering to nature (Asdal 2003, Gaichas 2008).

The ecosystem concept illustrates a search for *order* in science. Tansley claimed that ecosystems were the basic units of nature on earth, and argued that they develop towards a state of equilibrium. Natural resource management models were built upon this equilibrium idea[14]. In the past decades, however, ecology experienced a paradigm shift from 'ecosystems in balance' to 'ecosystems in flux' (Ladle and Gillson 2008), which suggests non-linearity[15]. The introduction of the ecosystem approach is to some extent the management response to that paradigm shift, and demands governance arrangements to be responsive and adaptive to

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[14] An an example, maximum sustainable yield (MSY) in fisheries management is based on the idea of ecosystems in equilibrium.

[15] As mentioned in the former chapter, a scientific paradigm suggests that some accepted principles of scientific practice provide the models for further coherent traditions of scientific research. A new paradigm, resulting from a paradigm shift, implies a new synthesis and a new and more rigid definition of a field Kuhn, T. S. 1970. *The structure of scientific revolutions*. Chicago, University of Chicago Press.

the dynamics, complexity and flux of ecosystems (Grumbine 1994, Yaffee 1999, Browman and Stergiou 2004).

The construction of an ecosystem – the search for order in a particular geographic area - does not start before there is some form of human interest in that area. By defining an area as an ecosystem, experts and spokespersons create a space where they can speak on behalf of nature (Asdal 2003). In *Pandora's Hope* Latour (1999) illustrates how a geographer, a zoologist, a botanist and an anthropologist (Latour himself) carried out fieldwork in the Amazon rainforest, starting out from a totally unmapped, wild area – a raw field - to completed categories and a description of the rainforest. This process consisted of labeling, annotation, categorizing and mapping that circulated among the participants. Latour showed how a network of humans and artifacts co-constructed 'the real' through a process of *circulating references*.

It is thus through processes of classifying and categorizing that an ecosystem comes into existence. This involves simplifications based on actor's choices. It is important to emphasize that there is a diversity of ways to carry out these practices, and that they involve a variety of possible choices. Processes of categorizing and classifying provide the material and mental infrastructures upon which policy instruments and management practices are designed. If such processes of classifying and categorizing work well, they can provide a powerful infrastructure of practices, beliefs, narratives and organizational routines (Bowker and Star 1999). When classifications are embedded in such working infrastructures they become "powerful technologies, relatively invisible without losing any of that power" (ibid.: 319). The stabilization of boundary infrastructures solidifies the choices made during the process of categorizing and classifying, and reinforces governance practices. This will be most clearly demonstrated in paper 2.

During the practices described above, boundary objects are created. The notion of boundary object was first introduced by Star and Griesemer (1989) and refers to objects which maintain a common identity across sites, but can also adapt to local needs. Boundary objects can have different meanings in different social worlds (science and politics) "but their structure is common enough to more than one world to make them recognizable means of translation" (Star and Griesemer 1989). In environmental governance, ecological indicators are a good example of boundary objects (Turnhout 2009). They are established in such a way that they reflect the complexities of the ecosystem, yet they remain simple enough to be easily and continuously monitored (Dale and Beyeler 2001). Ecological indicators describe the 'normal situation' of the state of the ecosystem and form the basis for monitoring programs that are aimed to keep track of the state of the environment. In monitoring programs, indicators are complemented with objectives, reference values, and action thresholds. Through the construction of ecological indicators, scientific practices make the ecosystem readable and measurable.

Then, if scientific practices make the ecosystem readable and measurable, can they also help to make the ecosystem governable? Or is the construction of management instruments on the basis of scientific ecological understanding a pure political act? As I will show in this thesis, science does not only provide politics with ecological knowledge, but also helps to build its governance instruments through the construction of critical limits and measuring devices that become the foundation for restrictive regulations or technological transformations.

Exploring marine ecosystem governance in the making

I have briefly outlined a post-constructivist approach to the study of marine ecosystem governance. A critical sociological method with central focus on human relations does not offer satisfactory insights, and I have therefore argued for an actor-network theory inspired approach as a starting point for the analysis of the practices in marine governance. The point of departure for this study is the understanding that ecosystems are constructed through heterogeneous processes of categorizing and classifying, involving humans, objects, technologies and artifacts. This has implications for further processes of policy design and political action and allows one to analyze marine ecosystem governance as processes of ordered co-production (Jasanoff 2004). Governance relies not only on the actions of policy-makers and politicians, but also on a wide range of scientific practices.

These practices involve the construction of normal situations and critical limits. Ecosystems, then, are not out-there waiting to be discovered. In this understanding, they are not ‘real’. They are not socially constructed either, since, as Latour argues, “the more we insist on the social-constructivist argument with respect to nature, the more we avoid addressing what has actually happened with the nature that we have abandoned to science and scientists” (Latour 2004: 52). I have outlined an approach that lies between (or beyond) these two positions, wherein the ecosystem is constructed through the methods and practices of science. It is upon these constructions that policy design for ecosystem governance is built. I believe that with the insights provided in this introduction, one will be better able to grasp the practices of marine ecosystem governance *in the making* that are presented in the papers that follow.

Introduction to the papers

This section provides a brief introduction to the papers and the way in which they are related to each other. Paper 1[16] provides a detailed empirical investigation of the organization of the process towards the integrated management plan for the Barents Sea-Lofoten area, and analyzes, in particular, the role of science in that process. It covers the period from 2002, when the planning process was initiated, to 2006, when the government adopted the management plan. The paper provides insight into the mandated exercises that groups of experts from various institutions were assigned to carry out. This paper uses the notions of Mode 1 and Mode 2 sciences, and indicates the complexity of producing 'socially robust knowledge'. It provides an analysis of the scope of interdisciplinary (though natural-scientific) advice for ecosystem-based management. This includes the ways in which this context-specific scientific knowledge has been useful, as well as the limitations in answering questions that reach beyond the interdisciplinary scientific domain.

Paper 2[17] offers a more detailed account on how scientific advice is translated into policy instrumentation. It provides an in-depth empirical description of the construction of a map depicting valuable and vulnerable areas, which was later translated into a political instrument – a zoning system – to regulate petroleum activity. The paper combines critical cartography literature and actor-network theory in order to analyze more theoretically how scientific categories are translated into policy instrumentation, and how mappings, as such, become political performances. Ecological values and notions on vulnerability were translated into a boundary infrastructure (Bowker and Star 1999) for ecosystem governance, which was consequently distilled into a user-oriented grid that provided a temporary framework for oil and gas activities. As mappings are continuous processes, the paper shows that ongoing processes of translation of and through the policy instrument result in constant redefinitions of the relations between actors and information, and of regular reinterpretations of the reality that is created.

Paper 3[18] also takes this 'political map' – the zoning system – as its point of departure. The management plan states that the temporary character of the regulations result from

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[16] Knol, M. 2010. Scientific advice in integrated ocean management: the process towards the Barents Sea plan. *Marine Policy* 34(2): 252-260.
[17] Knol, M (Accepted) Mapping ocean governance: from ecological categories to policy instrumentation. *Journal of Environmental Planning and Management*.
[18] Knol, M. 2010. Constructing knowledge gaps in Barents Sea management: how uncertainties become objects of risk. *MAST* 9(1): 61-79.

'uncertainties in the knowledge base', largely related to the environmental risk of acute pollution from petroleum activities. The paper provides insight into risk perceptions among industry stakeholders, marine scientists, and policy makers. In line with the risk literature within science and technology studies it demonstrates the importance to study risk assessment and management to be part of a complex process that includes politics as much as science. Then, again inspired by actor-network theory, the paper shows how different risk *realities* are constructed and reconstructed. The paper concludes with a critical discussion on the use of uncertainties as knowledge *needs* in environmental governance, and can be regarded as an appeal to rethinking the concept of risk in environmental governance circles, since 'risk' will never be free from uncertainties.

Paper 4[19] investigates the way in which the precautionary principle is implemented in order to regulate petroleum activity within a broader context of marine ecosystem governance. It does so by looking into the regulation of operational discharges of petroleum activity in the Barents Sea-Lofoten area. These discharges constitute another type of risk through their 'latent side-effects', a concept borrowed from Ulrich Beck. The paper describes the physical zero discharge regime that is introduced in the Barents Sea, which is much stricter than the 'zero-harm' requirements on the rest of the Norwegian Continental Shelf. This regime cannot be explained from a purely scientific point of view. By looking into the various uncertainties of precaution it is argued that a less general, more *in situ* implementation of the zero discharge principle could be more effective from an environmental, economic, and technological perspective. By indicating, however, that the strict zero discharge regime seems to be the most politically feasible measure, the paper shows how science becomes politicized, and politics become scientized in solving controversies over risk.

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[19] Knol, M (in press). The uncertainties of precaution: Zero discharges in the Barents Sea. *Marine policy*

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Epilogue

This thesis aimed at providing meaning to the idea of *marine ecosystem governance in the making*. It has assembled some of the practices and instruments that it consists of, with particular reference to the planning and management of petroleum activity in the Barents Sea-Lofoten area in Norway. The expansion of petroleum activity in the northern part of Norway worked as a catalyst in the preparation of an ecosystem-based management plan. This centrality of the oil and gas sector and the planning and management of its activities have been idiosyncratic to the Norwegian case. Nevertheless, this case study has provided general insights into marine ecosystem governance design practices.

The 'post-normal controversies' related to the planning of petroleum activity in a comprehensive context are characterized by scientific and social indeterminacy, disputed values and facts, and high stakes, which are governed through sets of practices and instruments. This thesis studied the package of practices and instruments that are introduced and aimed at governing the controversies surrounding the planning and management of petroleum activity in a comprehensive context of ecosystem governance. To what extent do these practices allow for long-term policy transformation? To investigate this question, this epilogue analyzes the potentials for further stabilization. In addition, it looks specifically into the development of environmental risk, as risk has been the central organizing concept around the introduction of marine ecosystem governance in the Norwegian case study. This epilogue can simultaneously be read as an update of the status quo of the Barents Sea-Lofoten area, as well as an indication of directions for further research.

Designing mobile and durable instruments

The papers in this thesis traced the establishment of practices and the design of instruments that are directed at performing a relatively stable network that can be built further on. In ANT language, such a relatively stable network is embodied in and performed by a range of durable materials, routines, practices and instruments (Law 1992). Stabilization involves acceptance, taken-for-grantedness, routinization and governance instruments that 'work'. Law argued that instruments for 'governance-at-a-distance', which ecosystem governance can clearly be considered, require to be durable and mobile (Law 1992). They must be durable, in the sense that they have the capacity to order through time. And they are designed to be mobile, so that they can order through space and across actors and sectors. Processes and practices in marine ecosystem governance are directed at designing such durable and mobile instruments.

It should be emphasized here that problem solving takes place through the design of a set of proposed solutions. The proposed solutions that this thesis described in detail, and which can be considered to be the most-prominent policy outcomes of these design processes, are the zoning arrangement and the zero discharge regulation. While paper 2 analyzed more local processes of translation, paper 4 took on a larger risk society perspective to explain the implementation of the zero discharge regulation. The choice to develop the zero discharge regulation and the zoning arrangement signified the larger choices in politics concerning the question how petroleum activity in the Barents Sea-Lofoten area will be developed further. Here, it should be noted that there are multiple possible alternatives in the design of solutions. The paper about mapping practices demonstrated empirically how ‘method assembly’ enacted a reality (Law 2004). If the practices had been different, another solution - not necessarily better or worse – would have been the outcome.

Policy instruments for ecosystem governance are designed to be easy to read. More so, the implementation of both instruments can be considered as *obligatory passage points* (Callon 1986) for the expansion of petroleum activity into the Norwegian Arctic. Nevertheless, the instruments are not without legitimacy problems, which concern their broader social and environmental consequences.

Establishing routinized practices

As paper 2 and paper 3 have most clearly shown, the practices and designs on ecosystem governance are not completed by implementation. The stabilization of marine ecosystem governance is dependent on the establishment of routinized practices, as much as on the design of mobile and durable instruments. These routinized practices refer as much to scientific assessment practices, as to the more formal organization of the science policy interface.

The establishment of expert groups at the science-policy interface has been an important step in the stabilization of associations. An *advisory group on monitoring, a forum on environmental risk management*, and a *management forum* were established with the implementation of the management plan in which actors from various governmental directorates and other research institutions have been enrolled. Each of these groups received a specific mandate, however, the exact roles are still in the process of further crystallization.

The long run challenge relates to whether this network of formalized relations can be sustained. A similar ecosystem-based management plan has been introduced for the Norwegian Sea, and a plan for the North Sea is in development. These plans build upon parallel practices and resources. One the one hand, this might make the processes more efficient. On the other hand, it might place too much weight on available resources. The practices for ecosystem-based management requires the gathering and synthesizing of large amounts of data of various institutions, and it can be questioned whether the existing expert groups for the Barents Sea have the capacity to work on parallel processes for the Norwegian Sea and the North Sea (Ottersen et al. in press).

Ecosystem-based management, it is argued, should have built-in practices of responsiveness to ecological change. The *advisory group on monitoring* received the task to further develop the monitoring system, which was initiated in the process towards the management plan (as paper 1 explains). In the preparation towards the management plan, the Norwegian Polar Institute and the Institute of Marine Research received the task to identify a set of indicators. Through the identification of environmental quality objectives and reference values, the experts constructed the ‘normal situation’ of the ecosystem. While indicators serve as a framework for the assessment of the quality of an ecosystem, they also provide a framework for the evaluation of policy performance (Turnhout et al. 2007).

The *advisory group on monitoring* built further on this work, and continued to define action thresholds. The action threshold is the point at which a change in an indicator in relation to the reference value is so great that intervention must be considered. The assemblage of action thresholds makes up the critical limits of the ecosystem. Questions for further research relate to the actual construction of the monitoring system. What is being measured becomes relevant, and therefore it is vital to analyze the actual construction of the monitoring system and the related practices of classification and categorization. Furthermore, it is relevant to look into the construction of the critical limits of the ecosystem: how are threshold values determined? At this point, the management plan provides little guidance about what should be seen as critical limits and what sort of initiatives can be put to work when such limits are within reach. A persisting dilemma is that most of the environmental changes will not refer back to single causes. A detailed study of the workings of the monitoring system will generate relevant insights into the potentials for responsiveness in ecosystem governance.

The refinement of risk assessment practices

The establishments of expert groups with the implementation of the management plan underline that ecosystem-based management is a continuous design process. In the work of the expert groups, in particular the *forum on environmental risk management*, risk assessment has been a central task in the work towards the revision of the management plan.

In paper 3, I could only cover a part of the process towards the revision of the management plan. This paper was critical about the rather traditional risk assessment procedures, in which risk was treated as the product of probability of an event and its consequences. It demonstrated that the focus on either low probability of an accident (supported by the oil industry), or on the large potential consequences (supported by environmental interests), polarized interests. Furthermore, one of the central arguments was that it is a dilemma in risk governance that there are such widespread attempts to finding an ultimate risk reality. In essence, risk was treated as a 'tame' problem that could be solved by optimal solutions. I pointed out that there is no such ultimate solution, as there is no ultimate risk reality. This is not simply the consequence of different risk *perceptions*, but is also the result of the different practices that lead to the enactment of different risk *realities*. Moreover, there exists no ultimate risk reality as there are always uncertainties embedded in the very notion of risk.

On the 15th of April 2010, the management forum finished its updated overall scientific report that was prepared for the revision of the management plan (Von Quillfeldt 2010). The report builds on new studies and contains an updated chapter on the risk related to acute pollution, in particular in the areas of the islands of Lofoten, Vesterålen and Senja. One of the central novel elements is the use of *oil drift models* in the risk assessments of acute pollution from petroleum activity. This oil drift modeling assessment was carried out by Det Norske Veritas (2010). It contained simulations from different potential spill locations. Different durations of the spill were modeled, as well as different types of oil, and various weather circumstances. Through these more nuanced models, the 2010 risk framework puts considerably less weight on the statistical probability of worst-case accidents, but brings in more elements and thereby provides a refined framework to assess the potential impact of an accident. When the updated scientific report was made available on April 15, a public hearing process was opened through which actors could comment on the contents of the report.

Five days later, on the 20th of April 2010, the oilrig of BP's Deepwater Horizon exploded, which led to one of the greatest oil spills in history. The severity of the spill, in volume and duration, led the Norwegian government to postpone the revision of the Barents Sea management plan, which was scheduled for the second half of 2010. The government asked the *forum on environmental risk management* to carry out an assessment of the Deepwater Horizon accident, and of the lessons that could be learned for the Norwegian case, which I will come back to.

On the 8th of June 2010, a stakeholder conference took place in Svolvær (the main centre of the Lofoten islands), which attracted well over 200 participants. This was the arena where the report of the management forum - the overall scientific update that included the oil drift simulations (Von Quillfeldt 2010) - was discussed with the wider public. The timing of this conference and the BP blowout contributed to an engaging debate and the discussions during this conference cannot be analyzed detached from the blowout in the Mexican Gulf.

While the incorporation of the oil drift models in the scientific update for the revision of the management nuanced the debate, it also worked as a force to enlighten the controversy over risk. Various public actors pointed at how the premises that were used in these models could be improved. While some argued that the model should better reflect ocean currents, others argued that the volumes of spilled oil were taken too low, and new models had to be carried out in order to simulate a 'worst-case' accident. The numbers that were used for a worst-case scenario in terms of spill duration and volume were considerably lower than the total BP spill. Moreover, some demanded additional modeling based on the Petroleum Directorate's new report on prospective petroleum areas (Norwegian Petroleum Directorate 2010). The latter report was based on an analysis of seismic surveys that were carried out in the summers of 2007-2009. Because of the timing of the assessments Det Norske Veritas had not been able to include the updated knowledge about potential oil and gas resources and their locations in its oil drift models.

While the fine-tuning of the risk assessment led to greater visualization of the possible impacts of potential accidents, they continued to be contested because of the incompleteness of the inputs, and the uncertainties of the outcomes. Despite the fact that the inclusion of the oil drift models led to a displacement of the risk controversies, it looked like the refinement of the risk assessment practices brought scientists, decision-makers and the wider public more closely together. The technical approach of Det Norske Veritas turned out to be a success in the risk discussions, since the widely agreed-on practice of oil drift modeling straightened the path towards a (temporary) settlement over the risk controversy. In creating this common ground, the stabilization of assessment practices appeared to be a vital element.

Lessons from the Mexican Gulf accident

The blow-out of the Deepwater Horizon strongly influenced the ongoing discussions in the Barents Sea-Lofoten area. It can be seen as a node in the risk network, which influenced the learning process about risk. It mobilized other actors and their knowledges. As mentioned before, the Norwegian government decided to postpone the revision of the Barents Sea management plan as a consequence of the BP accident. It mandated the risk forum to carry out an assessment of lessons that could be learned from the accident in the Mexican Gulf, and this assessment was supposed to be incorporated in the updated material for the revision of the Barents Sea plan. The assessment was finished and presented to the Ministry of the Environment on the 29th of November 2010 (Forum on Environmental Risk Management 2010).

The report pointed at the large challenges related to oil spill response systems. Special conditions related to distances, infrastructure, darkness, climate and access to crew complicates oil spill response in the management area. With reference to regulation and control, the report stated that there should be a strong emphasis on (stricter) requirements, better and more control, and stricter measures when the regulations are not followed. As a direct lesson from the Mexican Gulf case, the risk forum argued for improved procedures and security checks during operations.

Furthermore, it raised the question whether the management plan area should have special requirements related to emergency preparedness systems. The report put large emphasis on the development of response systems, which should make up an integrated part of marine ecosystem governance when risky industrial activities are involved.

With respect to risk assessment practices, the risk forum considered the newly integrated oil drift models to be very relevant elements in the revision of the management plan, but also emphasized the uncertainties and limitations of the results, in particular related to the impact on the coastal zones. It suggested that improved, and more realistic modeling should be carried out, which could be done by integrating better information about coastal currents, and they could be made more realistic by modeling oil spills that were located closer to the coast, and were larger in volume.

The risk forum emphasized that it is very difficult to assess the long-term environmental consequences of the Deepwater Horizon blowout. This underlined the importance for policy-makers to be aware of these uncertainties, despite the constant refinement of risk assessment practices as outlined above. Nevertheless, the risk forum suggested possible improvements at the organizational, technological and assessment level that could make the risks of acute pollution more controllable.

Although risk is to a large extent uncontrollable and incalculable as a consequence of persisting uncertainties, important initiatives can be taken that render risk more controllable and lead to routinized practices of marine governance. The lessons learnt from the Deepwater Horizon blowout are rather practical and straightforward, and will probably meet high levels of agreement among all interests involved in the planning and management of petroleum activity in the Norwegian north. Nevertheless, seen in the light of long-term policy transformation, some further questions can be raised in particular about the functioning of oil spill response systems. An empirical area for further research concerns the extent to which the planning and management of petroleum activity in the north goes hand in hand with the development of oil spill response systems. What kinds of initiatives are taken to strengthen the latter? Moreover, what (financial) costs will such required developments generate? The question about the acceptable levels of risk is intricately related to the development of oil spill response systems and their related costs.

Governing contradictions

The turn towards marine ecosystem governance can be considered as a process of long-term policy transformation (Voß et al. 2009). The design processes on ecosystem governance open up for complicated processes of consideration of and across objectives, and in which different (potential) impacts have to be weighed against economic and political considerations. In other words, this case study shows how long-term design for sustainable governance is linked to expectations of development and progress (planning to realize), and to expectations about unintended consequences and possible damage (planning to avoid) (Voß et al. 2009).

While the design of policy instruments (the zoning system and the zero discharge regulation) worked as obligatory passage point for the development of petroleum activity in the north, the practices of monitoring as well as the continuous work on refining risk worked to govern the potentially negative side-effects of the industrial activities in an ecologically valuable region. Most controversy still resides over the areas outside the islands of Lofoten and Vesterålen. Here, it turns out to be most difficult to combine oil and gas developments with acceptable levels of risk. Although refined modeling, improved systems for oil spill preparedness, and better control are important elements towards the stabilization of governance practices, I expect that these elements will not lead to a closure of the controversy that is so deeply embedded in this geographical region.

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