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Government-industry dynamics in the development of offshore waste management in Norway: from prescriptive to risk-based regulation

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Petroleum activities are associated with high risks. In the 1980s, concerns arose about the environmental impacts of 'normal' petroleum activity. Regular operations go hand-in-hand with emissions to air and discharges to sea. Both have been subject to extensive regulation since the 1990s. This paper analyzes the design and implementation of the Norwegian system that regulates operational discharges to the marine environment. It analyzes the changing relationships among science, politics and the industry and describes how the turn from a prescriptive to a predominantly performance-based approach was fundamental in making progress toward less polluting practices. The article describes how risk regulation was institutionalized and highlights the benefits of involving the industry in the pursuit of environmental protection. It also cautions against a lax attitude toward control and oversight, as complexification of risk objects and the increase of institutional risks can lead to mismatches in risk management.

Keywords: offshore waste management; environmental regulation; petroleum; risk; Norway; performance-based management; operational discharges

1. Introduction

With her 1962 book, *Silent Spring*, Rachel Carson brought environmental concern to the greater public (Carson 1962). She revealed the destruction of wildlife through the pervasive use of pesticides. Her critique attacked the institutions and power structures supporting the environmental technologies that were used. Part of Carson's message concerned the relationship between the chemical industry and the government, in which the government was said to accept the industry's claims without question. The book was met with strong criticism from the industry, but it was so influential that it immediately put the environment on the political agenda in the US and beyond (Lear 1993).

Much has changed since the publication of *Silent Spring*. Today, all industrial activity – at least in Western countries – is regulated in some way. Governments have established environmental ministries and agencies that are tasked to control industrial behavior and keep track of the effect of industrial activity on the environment.

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Potential harms are defined as risks, which are to be known, quantified and managed in an accountable manner. This is based on the assumption that the industry, when left to its own devices, cannot be expected to exert the necessary concerns for environmental protection. The primary objective of the companies is to generate profits for their shareholders. As competition in many business sectors is intense, extra regulations and requirements are not looked upon as favorable. It is therefore required that the authorities keep a watchful eye on the industry, set out rules and standards and control the impact that the operations have on the environment.

Government regulations, however, also have their limitations and pitfalls. One such limitation is incomplete or asymmetric information (Freeman and Kolstad 2006). The companies usually possess more knowledge about industrial processes and the substances that are used, which implies that it can be difficult for government agencies to monitor and verify that the companies actually meet the requirements. Secondly, government agencies may lack knowledge about the instruments and incentives that provide the best results (Gunningham 2009). To achieve environmental improvements, it may be more effective to engage the companies and stimulate continuous innovation, rather than just ensuring compliance with some minimum technical requirements set by the authorities. A third limitation is blame attribution (Hood 2011). When public authorities intervene and regulate, they simultaneously assume responsibility and can be held accountable for errors and accidents that were not uncovered in advance by government inspectors. Consequently, there has been a lengthy discussion on how to regulate environmental risk. The supposed contradiction between commercial interests and environmental protection has also been questioned (Cairncross 1995; Porter and van der Linde 1995).

This article is a contribution to the debate on roles and responsibilities in dealing with environmental risk. It scrutinizes the development of an environmental regime to regulate risks related to offshore petroleum activity in Norway and analyzes the changing relationship between the industry and the government. The petroleum sector has, for many decades, been associated with high risk (Lindøe, Baram, and Renn 2013). Ever since oil and gas operations began on the Norwegian Continental Shelf (NCS) in the mid-1960s, the health, safety and environmental risks associated with workplace hazards and the risk of oil spill disasters have received attention. Concern for these risks was accounted for in the Norwegian petroleum management system that took shape during the 1970s (Al-Kasim 2006; Engen and Lindøe 2017; Sabel, Herrigel, and Kristensen 2018). In the 1980s, a new concern arose. This was related to the environmental impacts of ‘normal’ petroleum activity. During regular operations, offshore drilling and production go hand-in-hand with emissions to air and discharges to sea, and both have been subject to extensive regulation since the 1990s. This paper analyzes the design and implementation of a regulatory system that deals with the risks connected to the operational discharges to the marine environment during regular petroleum activity. It examines how this new field was institutionalized, and describes the evolving relationship between science, industry and government during this process. In doing so, the article reflects on the relationship between national and international efforts in the development of a waste handling regime for offshore petroleum activity. It identifies the central actors and the ways in which accountability for risk regulation was defined and allocated; and gives an account of what has been achieved in terms of reducing harmful discharges.

The article is based on an in-depth qualitative analysis of policy documents, academic literature and technical reports. In addition, it is based on thirteen semi-structured, in-depth interviews with key individuals who have worked extensively with the theme, representing environmental authorities (four interviews); petroleum authorities (two interviews); fisheries authorities (one interview); the oil and gas industry (two interviews); environmental NGOs (one interview); political parties (two interviews); and scientific institutions (one interview). The aim was to guide the authors through the history of the development of the environmental management regime, to gain an overview of the field and main developments, and to cross-check information. For the sake of confidentiality, the interviews are not referred to directly in this article.

The next section introduces operational discharges to sea from petroleum activity. Subsequently, section 3 outlines the analytical framework. It discusses the coupling of environmental risk and institutional risk and connects these notions to the development of regulatory systems in terms of principles of control. In particular, we discuss the difference between prescriptive command-and-control systems and performance-based approaches to risk management. Section 4 provides a general introduction to environmental management of petroleum activity in Norway, and section 5 gives a detailed account of the various phases in the development of the Norwegian regulatory system for handling operational discharges to sea. On the basis of this history, section 6 discusses how the relationship between industry and government has developed over time, and what has been achieved by joint efforts. The article concludes with reflections on the lessons that can be learned from this case. It highlights the benefits of involving the industry in the pursuit of environmental protection, but cautions against a lax attitude toward control and oversight. It shows how a complexification of risk objects and the increase of institutional risks can lead to mismatches in risk management.

2. Operational discharges to sea from offshore petroleum activity

During all stages of regular petroleum activity, there are discharges to the marine environment. The proportions and amounts of discharges, however, can vary significantly during the process. Discharges to sea from oilfield processes mainly consist of drill cuttings, drilling mud and produced water, but they also include displacement water, cooling water, waste water, ballast water and rain water run-off. Drill cuttings are particles of crushed rock that are removed from the borehole during drilling. The largest volumes of drill cuttings are produced in the early process, from the top hole section. When the well gets deeper, its diameter becomes smaller, and thus less waste is produced.[1] Drill cuttings contain residues of the drilling mud that is used. Drilling muds are essential to the drilling process, as they cool and lubricate the drill bit, counteract formation pressure and remove drill cuttings from the borehole. Drilling muds are normally divided into three categories, depending on their composition: oil-based (OBM), synthetic-based (SBM) and water-based (WBM) drilling muds (Neff 2010).

When oil fields come into production, produced water becomes the largest source of waste. This is a mixture of formation water, injected water containing production chemicals, brine and dispersed oil. Formation water can be found in the natural water layer in reservoirs below the hydrocarbons and is, together with brine, extracted along with the oil and gas.[2] To achieve maximum oil recovery, water is injected into the reservoir to force the oil to the surface. As a result, a mixture of formation water and injected seawater is produced together with the oil. Produced water is thus a complex mixture of dissolved and particulate organic and inorganic chemicals, including inorganic salts, metals, radioisotopes and a wide variety of organic chemicals, primarily hydrocarbons (Neff, Lee, and DeBlois 2011). Produced water needs to be cleansed before it is discharged to sea. Nonetheless, small levels of chemicals and oil will remain. With the maturation of fields, the volume of produced water increases, as more water is injected into the well to force the oil to the surface (Ekins, Vanner, and Firebrace 2007). Hence, the volume of produced water discharged to sea, including oil components and chemicals, increases. In 2018, the oil activity on the Norwegian shelf led to 133 million Sm^3 of produced water being discharged into the marine environment, while 40 million Sm^3 were reinjected into the wells (Norwegian Oil and Gas Association 2019). Produced water is diluted rapidly upon discharge to sea, but components in produced water can cause a range of negative effects with consequences for the status, functioning and reproduction of fish and invertebrates (Norwegian Research Council 2012). Although the long-term consequences seem to be moderate, there are uncertainties connected to the effects of chronic, low-level exposures to the different chemicals in produced water (Neff, Lee, and DeBlois 2011).

3. Risk regulation and shifting principles of control

Risk has become a central organizing concept in today's society. According to Ulrich Beck, we live in a risk society that systematically deals 'with hazards and insecurities induced and introduced by modernization itself' (Beck 1992). Beck contended that production of wealth has turned into production of environmental risks, which are the endemic side effects of scientific, technological and industrial progress. Many of today's manufactured risks are diffuse and long-term, and unlike the risks of previous eras, they are more globalized, less easy to detect, more serious in their effects and harder to manage.

Rothstein, Huber, and Gaskell (2006) distinguish between societal and institutional risks. They describe societal risks as risks referring to members of society and their environment. They include, for instance, environmental risks such as those associated with offshore petroleum activity. When managing and regulating societal risks, an organization's legitimacy is at stake, and "pressures toward greater coherence, transparency, and accountability of the regulation of societal risks can create institutional risks by exposing the inevitable limitations of regulation" (Rothstein, Huber, and Gaskell 2006, 91). Hence, the risk-managing organization itself becomes an object of risk that needs to be managed (either by itself, through a controlling agency, or both). Institutional risk thus refers to threats to organizations that regulate and manage risks and/or to the legitimacy of the rules and methods of regulation, and it is typically accompanied by a surge in audits and oversight (Power 2007).

The increase of perceived environmental risks and institutional risk can lead to the design of alternative regulatory models, in which accountability is redefined and reallocated. Accountability can be defined as "a relationship between an actor and a forum, in which the actor has an obligation to explain and justify his or her conduct, the forum can pose questions and pass judgment, and the actor may face consequences" (Bovens 2007, 450, cited in van Tatenhove 2010). In a changing governance environment, for example through the introduction of new instruments, accountability can be under pressure and give way to more diversified and pluralistic sets of accountability relationships (van Tatenhove 2010).

Given that rules and standards can be formulated in a variety of ways, and the responsibility for carrying out regulatory actions can be assigned to a range of bodies, risk-regulating regimes can also have different shapes. In discussions about health, safety and environmental protection, two approaches to the regulation of risk are often highlighted: prescriptive and performance-based (the latter is sometimes referred to as goal-based or functions-oriented) regulatory systems (e.g. Dagg *et al*. 2011; Grant, Moreira, and Henley 2015; Hanson 2011; McAndrews 2011).

In prescriptive systems, the governing agency enacts laws and regulations that set specific demands for structures, technical equipment and operations. The regulatory authorities thereby lay down the necessary requirements and monitor the companies to ensure compliance. For instance, environmental regulations in a prescriptive system might require an operator to install specific pollution control equipment that is proven to keep emissions or discharges at an acceptable level (Hanson 2011). The industry thus has to follow prescribed rules and is being controlled by a governing agency by which it is held accountable.

In a performance-based regime, the governing agency sets out objectives for industry performance, including design and operation objectives, as well as expectations for safety and environmental protection. The individual companies develop programs that describe how they plan to achieve these performance objectives. These programs are then reviewed by the governance agency (Grant, Moreira, and Henley 2015). With regard to environmental regulations, this can result, for instance, in the regulator setting a specific standard for an accepted level of pollution, but leaving it to the individual operators to decide how this standard would be attained and maintained (Hanson 2011). The premise of this approach is that industry actors are in a better position to react to changes in technology and risk than government agencies are (Grant, Moreira, and Henley 2015). The use of Best Available Techniques (BAT) is a central principle here.

In practice, most regimes contain elements of both approaches. The UK and Norwegian regulatory regimes for managing the risks associated with the petroleum industry have been characterized as predominantly performance-based (Sühring *et al*. 2020), while the US system is considered to be an example of a highly prescriptive regulatory approach (Bennear 2015; Grant, Moreira, and Henley 2015), although it has been noted that following the Macondo Deepwater Horizon blow-out accident in 2010, the US enacted performance-based regulations for the first time (McAndrews 2011). The next sections follow the development of the Norwegian petroleum regulatory system and focus on the interplay between government and industry in the handling of discharges to sea from regular petroleum activity.

4. Environmental management of petroleum activity in Norway

The models to regulate operational discharges of petroleum activity show similarities across countries (van Leeuwen 2010), but are at the same time unique, as they "reflect offshore operating experience, the size and the age of the industry, and the characteristics and sensitivities of their marine environments, environmental protection strategies and testing techniques, and political sensitivities" (CAPP 2001, 17). Thus, it is important to understand some key aspects of Norway's institutional framework before describing the various phases in which petroleum waste handling has developed.

When oil companies expressed their interest in exploring for oil and gas in the North Sea, the Norwegian government started to develop a national framework for the management of petroleum activities. It proclaimed sovereignty over the NCS and exclusive rights to its natural resources, and agreements were reached with the other

North Sea states on the delimitation of the continental shelf. The shelf was divided into blocks, in which companies could apply for licenses to explore, drill and extract oil and gas for a certain period of time. The first licensing round was held in 1965. This regime gave the government a steering position to determine the conditions and tempo of the developments (Al-Kasim 2006). Parallel to this, management institutions were established. In 1970, the government commissioned a committee to draft the organization of Norway's petroleum administration. This led to the establishment of the Norwegian Petroleum Directorate in 1972, which initiated a division of power and management responsibilities between the Ministry and the Directorate.[3] In the early years, the Ministry of Industry held the primary responsibility, but this was later transferred to the Ministry of Petroleum and Energy, established in 1978. The Ministry of Petroleum and Energy has the overall responsibility for all petroleum activity on the NCS. The Petroleum Directorate works as the competence base and professional advisory institution under the auspices of the Ministry, with the overall objective to contribute to the greatest possible value for society through efficient and sound resource management.

With respect to the management of environmental effects, the Ministry of Climate and Environment has overall responsibility.[4] Environmental regulations for offshore petroleum activities were formalized in 1981 with the implementation of the Pollution Control Act, which formed the initial prescriptive regulatory approach. The Pollution Control Act is an enabling act: the details for each field are outlined through discharge permits and regulations issued by the pollution control authorities. The responsibility for follow-up of the Pollution Control Act lies with the Norwegian Environment Agency, which is an advisory body under the Ministry of Climate and Environment. It plays an important role in establishing environmental regulations for petroleum activities. One of the predecessors of the Norwegian Environment Agency was The Norwegian Pollution Control Authority (*Statens forurensningstilsyn/SFT*), which was established in 1974 and plays a central role in the development of the regulatory regime that will be described in section 5, and will, from here, be referred to as SFT[5].

Although petroleum activities on the NCS started in the 1960s, Norway did not implement the Petroleum Act until 1985. This was a deliberate choice for the regulation of an 'infant industry' (Engen and Lindøe 2017), because the authorities wanted to gain experience in this new policy field before enacting laws. Therefore, prior to 1985, the petroleum sector was governed through a range of preliminary rules and regulations. By 1985, there were 47 highly detailed and prescriptive regulations in place. The Petroleum Act included both the internal control principle and the requirement of risk assessments (Bang and Thuestad 2013; Engen and Lindøe 2017).

5. The development of a regime to handle discharges to sea

Over the past fifty years, the regulatory regime for discharges to sea from regular petroleum activity has seen great changes. Initially, the discharges were given little attention and considered to have only negligible environmental effects, but gradually, the handling of operational discharges became institutionalized as a field of risk. The development can be divided into four main phases, gradually developing from a prescriptive into a more performance-based regime.

5.1. Phase 1: government and industry in a regulator-complier relationship

The rise of petroleum activities in the North Sea took place in parallel with the development of the international environmental movement and the establishment of environmental protection agencies in many countries around the world. The early 1970s saw a growing international awareness of the problems of marine pollution. This was a key issue at the 1972 Stockholm United Nations Conference on the Human Environment, and in the subsequent years, a number of international conventions were signed. One of these was the 1974 Paris Convention for Prevention of Marine Pollution from Land-Based Sources, which entered into force in 1978 and also applied to offshore installations (Mitchell 1994). In Norway, marine pollution became a key issue for the Ministry of the Environment and SFT, which were established in 1972 and 1974 respectively.

In the first years, the focus was primarily on the risk of acute oil spills. The Torrey Canyon accident in 1967 and the Santa Barbara spill in 1969 were oil disasters in fresh memory, and as early as 1970 the Norwegian parliament passed legislation on protection against water pollution and oil pollution. The following year an Oil Protection Council was established, which was later incorporated into SFT (Nøttestad 2002). Throughout the 1970s, the consequences of operational discharges to sea started to receive attention. This was partly a result of new research on the various sources of oil pollution and the effects of oil on marine life. Organizations such as the International Council for the Exploration of the Sea (ICES), the Joint Group of Experts on the Scientific Aspects of Marine Environmental Protection (GESAMP), and the Oslo and Paris Commissions helped to put operational discharges on the agenda. In Norway, the Ministry of the Environment launched a comprehensive research and monitoring program on marine pollution in 1976 (Ministry of the Environment 1984).

Petroleum activity in the North Sea increased rapidly during the 1970s. Many wells were drilled and new fields came into operation. Soon, it became clear that most of the oil released into the sea stemmed from the drilling operations and the associated discharges of drilling muds and cuttings. The first studies indicated that the negative biological consequences were confined to the immediate vicinity of the platforms (Gray *et al.* 1999)[6]. Nonetheless, it was evident that both the physical smothering of the seabed by the cuttings and the use of oil-based drilling fluids, which was common in the North Sea for technological and safety reasons, led to measurable changes in the benthic communities. In Norway, this triggered new legislation. The 1979 provisional regulations regarding littering and pollution caused by petroleum activities stated that oil companies could not use oil-containing drilling fluids without an approved plan for the treatment of these fluids and oily cuttings. The companies had to carry out surveys around all the installations and report about the discharged quantities of drilling fluid and cuttings. This was formalized in the Pollution Control Act (brought into force in 1983), which put a general ban on pollutant discharges and prescribed particularistic actions: it commanded oil companies to apply for discharge permits to which these companies needed to adhere. The Act also required polluters to document the environmental impact of their activities and to report on the state of the environment.

While the permit system provided the environmental authorities with a flexible tool for assessing each field's discharges, SFT was challenged with asymmetric knowledge. The number of wells drilled in the North Sea for exploration, production and appraisal was rising rapidly, and the agency was not able to verify all discharge plans and reports. In 1982, when the industry applied for a discharge permit for the Statfjord B platform, SFT required that research was carried out to assess the environmental effects of oil-based drilling fluids, including an investigation of methods and technologies to reduce negative effects. This resulted in a joint, three-year research project funded by the Statfjord Group, led by the operator Mobil Exploration Norway (SFT/Statfjord Group by Mobil, 1986). The project concluded with a conference in Trondheim in 1986, organized by the Norwegian Petroleum Society on "Oil based drilling fluids - cleaning and environmental effects of oil contaminated drill cuttings" (Bakke 1990). This was an early step toward collaboration in the regulatory system, and these relations gradually expanded and became more institutionalized.

In 1986, SFT established an expert group to analyze the quality of the oil companies' environmental impact assessment and their annual reports. A review of sixteen oil and gas fields for the years 1987 to 1989 showed that the contaminated areas were up to ten times larger than stipulated by the oil companies. In addition, non-conformities were found in implementation and reporting of monitoring programs for several fields (Gray *et al*. 1999; SFT 1994). These effects were considered unacceptable by Norwegian authorities, and new legislation prohibited the discharge of untreated cuttings contaminated with oil-based drilling fluids on the NCS from January 1, 1993 (Bakke, Green, and Iversen 2011; Gray *et al*. 1999). The same decision was adopted by the Paris Commission (PARCOM Decision 92/2), with the result that oil discharged as part of the disposal of cuttings contaminated with oil-based drilling muds ceased in all member states by the end of 1996.

Simultaneously, an initiative by SFT aimed to establish common guidelines for monitoring, both with respect to sampling and methods of analysis. These guidelines, mainly based on best practices and common methods, were proposed by the expert group in 1987 and discussed with oil companies during a common workshop (Gray *et al*. 1999). The Paris Commission adopted similar guidelines, and the new guidelines were made binding for all monitoring around Norwegian fields from 1991. The manual contained detailed requirements with respect to the frequency of surveys, deadlines, standard parameters, and methods of sampling, analysis and reporting (SFT 1990).

The first phase was thus characterized by problematization and knowledge acquisition, in parallel with the establishment of an environmental administration both nationally and internationally. The oil industry was required to apply for discharge permits and submit reports, with a particular focus on regulating the use and discharge of oil-based muds and cuttings. A harmonized system for monitoring procedures and protocols for sampling, analysis and interpretation was developed (Davies, Hardy, and McIntyre 1981; Bayne, Clarke, and Gray 1988). The companies were held accountable for their field-specific monitoring reports, for which they hired external expertise. This expertise became a necessary intermediary and catalyst to highlight the environmental effects of discharges. The nature of the early regulations was predominantly prescriptive, which put the government and industry in a regulator–complier relationship.

5.2. Phase 2: the industry becomes a more active partner

While the regulatory focus in the first phase was on reducing oily discharges, the second phase was characterized by a complexification of the risk object. During the 1990s, the attention shifted to regulating discharges of produced water, and in particular, the use of toxic chemical additives. The international North Sea Ministerial Conferences, which started in 1984, gradually took a leading political role with a view to protecting the marine environment. The industry started to play a more prominent part.

Following the fall in oil prices at the end of the 1980s, the government and industry joined forces in the early 1990s to strengthen the competitive position of the NCS. Several initiatives were taken. One of them was NORSOK, which aimed to reduce the implementation time and costs for the development and operation of petroleum installations on the NCS. The NORSOK project represented a break with the Norwegian 'infant industry policy' and a shift from dictating terms to various actors to promote more interaction and collaboration (Engen and Lindøe 2017).

Meanwhile, the Exxon Valdez oil spill in Alaska in 1989 had made the industry more aware of the importance of their environmental reputation. This contributed to several initiatives directed at improving the industry's image as an accountable environmental actor. MILJØSOK was launched by the Norwegian government in 1995, the same year as Greenpeace conducted its successful campaign against Shell's planned disposal of the Brent Spar oil platform. MILJØSOK was based on the initiative of the CEO of Statoil (MILJØSOK 1996). The aim was to "contribute to the further development of an effective environmental strategy that will lead to the NCS lying at the forefront when it comes to cost-effective and environmentally friendly petroleum activity, while facilitating a better overall understanding of this strategy nationally and internationally" (MILJØSOK 1996, 9, own translation). The outcome of MILJØSOK's first phase, in 1996, was an overview of environmental issues and objectives, targets and recommendations for the offshore industry and the government. The recommendations included a fifty per cent reduction in oil and production chemicals in produced water and a fifty per cent reduction in discharges of drilling chemicals (MILJØSOK 1996, 98–99). This would require a range of changes, such as replacing chemicals and developing reinjection and separation technologies.

In the 1990s, discharges of produced water increased rapidly on the NCS, and the quantity was expected to grow further in the years to come - a result of aging offshore fields discharging increasing volumes of produced water. This spurred a number of studies on the composition of produced water from different oil fields and its environmental effects (see Johnsen and Frost 2011 and references therein). Understanding the effects of produced water discharges was particularly complex, as its composition and the characteristics of naturally occurring substances are closely linked to the geological characteristics of each reservoir, and the composition of produced water varies over the lifetime of a well (Bakke, Klungsøyr, and Sanni 2013).

At the international level, the Paris Commission raised the issue of oil in produced water discharges in the late 1980s (Mitchell 1994; Gao 1998). PARCOM Recommendation 92/6 set a target standard of 40 mg/l oil in produced water from offshore installations. However, since produced water also contains a range of other substances, such as added chemicals, the focus of the discussion gradually shifted in the 1990s to restrict the release of hazardous substances. In 1995, parallel to the establishment of MILJØSOK in Norway, the fourth Ministerial Conference on the Protection of the North Sea (Esbjerg, Denmark) discussed how to handle produced water discharges. The Esbjerg Declaration's 'Generation Goals' stated that individual countries had to work toward cessation of discharges, emissions and losses of hazardous substances within one generation (25 years). This goal was subsequently incorporated into the OSPAR Convention, which replaced the Oslo and Paris Conventions and came into force in 1998.

From 1996, the Norwegian environmental authorities implemented a reform of the monitoring programs: it substituted field-specific surveys with regional surveys. Consequently, the NCS was divided into eleven regions, and each region was to be surveyed every third year. In addition to sediment monitoring, the water column was now included within the monitoring program. To achieve coordinated regional monitoring, the operating companies had to collaborate, which put the Norwegian Oil and Gas Association (OLF) in a central coordinating role on behalf of the industry. In addition, the governing agencies placed greater demands on the operating companies to identify and clarify potential problems regarding discharges to sea, and in such cases, the companies had to take initiatives for additional research and monitoring beyond what was mandated (SFT 1997, 1999). In 1998, SFT issued new guidelines for the reporting of discharges (SFT 1998a). These revisions in the regulatory regime were designed and implemented in close collaboration between the oil companies, their consultants, SFT's expert group and SFT.

The second phase was thus characterized by a new problem definition. Attention shifted from discharges of oil-contaminated cuttings to discharges of produced water and hazardous substances in general. In addition to the regulation of discharges, the *use* of chemicals became regulated, which also implied that connections were established between the environmental regulatory regime and the occupational health and safety regime. The industry became more heavily involved; partly because the companies recognized that they had to take environmental problems more seriously, and partly because only the industry possessed the necessary knowledge about the various substances that were used and discharged. Hence, as the governance object became more complex, the authorities had to delegate more responsibility to the industry. The oil industry demonstrated commitment in the development of monitoring programs, where the Norwegian Oil and Gas Association played an active coordinating role to develop cross-industry standards and a joint database. Apart from sediment monitoring, which had been developed as a routine monitoring practice, standards were made for more complicated water column monitoring.

5.3. Phase 3: collaboration toward zero discharge

In the third phase, the focus was on zero discharge. This became an important concept and a political lodestar for both the industry and government, which intensified their collaboration. In this phase, the oil companies built up their own environmental expertise, and a community of experts was established focusing on the effects of petroleum operations on the marine environment. Several of these individuals eventually alternated between working in the industry, management institutions, and research and consultancy agencies. Following up on the work in phase 2, the key focus was on the replacement of chemical substances. Political disagreement about petroleum development in the Barents Sea-Lofoten area led to a moratorium that almost caused panic in the oil and gas industry. The industry was willing to invest heavily to secure access to new exploration areas.

In Norway, the zero-discharge goal was first specified in White Paper No. 58 (1996–1997), Environmental Policy for a Sustainable Development – Joint Efforts for the Future (Ministry of the Environment 1997); and was gradually clarified in the subsequent years. In 1998, SFT established a working group (*nullutslippsgruppen*; the zero-discharge group) – consisting of industrial stakeholders, national authorities and expert institutions – to elaborate on the zero discharge goals, to set a schedule for the work and to provide advice for the implementation of national zero discharge policies (Marthinsen and Sørgård 2002). The group's first report discussed concepts and recommendations for further work and emphasized that zero discharge actually implied a zero *harmful* discharge philosophy (SFT 1998b).

In parallel, the Paris Commission worked on regulatory harmonization with respect to the use and discharge of offshore chemicals (Henriquez 2002). In 1995, the member parties agreed on the Harmonized Offshore Chemical Notification Format (HOCNF), which contained the necessary information for the assessment and evaluation of offshore chemicals. The following year, an agreement was reached on a Harmonized Mandatory Control System (HMCS), which was subsequently made binding through OSPAR Decision 2000/2. With the new system, discharge applications had to include information on all components of oilfield chemicals proposed for use and discharge, as well as data on their toxicity, persistence and bioaccumulation. Testing requirements were also specified, and OSPAR produced a list of production chemicals for priority action. The aim was to contribute to the use of Best Available Techniques (BAT) and Best Environmental Practice (BEP) and to achieve substitution of hazardous substances by less hazardous, or preferably, non-hazardous substances. The ultimate aim of OSPAR's strategy was to achieve concentrations in the marine environment near background values for naturally occurring substances and close to zero for synthetic substances.

OSPAR's decisions were interpreted and implemented in somewhat different ways in the North Sea countries. Already in 1998, SFT set requirements for ecotoxicological testing and environmental assessment of offshore chemicals and drilling fluids. SFT also decided to rank all chemicals in one of four color categories – black, red, yellow and green in increasing order of environmental acceptability. The black and red categories included the most hazardous and harmful substances; the yellow category comprised substances that may be potentially harmful; the green category contained substances that pose little or no risk to the environment. The green list was eventually based on OSPARs PLONOR list, and the substances in this category were exempted from the testing requirements.

The zero discharge goals were reiterated in White Paper No. 12 (2001–2002), Protecting the Riches of the Sea (Ministry of the Environment 2002), through which the government wanted to ensure that the goals would be met for existing fields by 2005. The targets for the oil and gas industry on the NCS included: (a) zero discharges or minimal discharges of naturally-occurring environmentally hazardous substances that are also priority substances; and (b) zero discharges of chemical additives that are black-category (use and discharges prohibited as a general rule) or red-category substances (high priority given to their replacement with less hazardous substances). In addition, zero discharge was required for oil components, yellow-category substances, drill cuttings and other substances if these might cause environmental damage (Ministry of the Environment 2001).

In line with OSPAR Recommendation 2001/1 for the Management of Produced Water for Offshore Installations, objectives for reducing oil content in discharged produced water were also formulated. The prevailing discharge target of 40 mg/l was revised; the OSPAR Commission recommended that by the end of 2006, no individual offshore installation should exceed a performance standard for dispersed oil of 30 mg/l for produced water discharged into the sea. The OSPAR Commission also recommended an absolute reduction (fifteen per cent) of oil in produced water discharged to sea relative to discharges in 2000. Given the number of aging oil fields discharging higher amounts of produced water, this was perceived as a demanding task for the Norwegian petroleum industry.

In 2003, the zero-discharge group delivered a second report on the status of the work and technological development (SFT 2003). It discussed how the zero discharge goals could be met for each field based on the field's specific types of produced water and the chemicals in use. Important measures to reach the zero discharge goals included dosage and process optimization, cleansing and substitution of added chemicals. The industry now invested in a variety of new technologies to reduce the discharges related to drilling, well operations, production and transport. The companies also introduced new technologies for reinjection into boreholes, as well as for retaining material and disposing it on shore. New drilling procedures and types of drilling fluids were tested, and substitution of hazardous substances was given high priority (Norwegian Petroleum Directorate 2003).

The work toward zero discharge gained extra momentum when the new government took office following the 2001 general election. It imposed a moratorium on all new oil and gas activities in the Barents Sea – Lofoten area, awaiting an impact assessment of year-round petroleum activities in this area (Knol 2010). There was a strong political opposition concerning northwards expansion of petroleum activities (Arbo and Hersoug 2010), due to consideration for the fisheries and because most discoveries were expected in environmentally vulnerable areas. At the same time, the oil industry was eager to gain access to new exploration and development areas. The fields in the North Sea became increasingly mature, and large undiscovered oil and gas reserves were expected on the northern part of NCS. Hence, the oil industry and the related public sector agencies went a long way toward promising zero discharge in this area. The perspective that all waste (drill cuttings, drilling fluid and produced water) would be re-injected into the well or brought ashore for treatment was on the basis of the impact assessment program, which was presented by the Ministry of Petroleum and Energy, the Ministry of Fisheries and the Ministry of the Environment in the summer of 2002. The Norwegian Petroleum Directorate also considered this a realistic approach from a technological standpoint (Norwegian Petroleum Directorate 2003). It was pointed out that an absolute requirement for zero discharge would stimulate rapid progress in technology development. Zero harmful discharge thus turned into 'zero physical discharge'.

The zero-discharge work can be perceived as a highly functional approach to environmental regulation. Rather than focusing on prescribed actions and legislation, the regulatory focus shifted to results and outcomes, and the nature of rules and standards became highly goal-oriented. The industry was strongly involved in this third phase and it was no longer the government alone that set the standards. The leading oil companies employed their own environmental officers, and the industry took an active part in the zero discharge group. Regular meetings were organized between the Norwegian Oil and Gas Association and SFT.

5.4. Phase 4: embracing a risk-based approach

In the fourth phase, the industry took a leading role. Industry and government actors acknowledged that physical zero discharge was not an expedient measure, and petroleum proponents were concerned that such a precautionary approach could turn out to be an obstacle to northward expansion of activities. Instead, the focus shifted toward a comprehensive risk-based approach, which required cost-benefit assessments and field-specific solutions within the framework of goals drawn up by the authorities. Similarly, OSPAR implemented a risk-based approach in 2012. Since then the discharge regime has not undergone any major changes, and there has been less political attention regarding operational discharges to the sea.

The new physical zero discharge regime, which only applied to the northernmost part of the NCS, was implemented through White Paper No. 38 (2003–2004) On Petroleum Activities (Ministry of Petroleum and Energy 2002). No discharges to sea became a requirement for all regular operations in the Barents Sea – Lofoten area, however, with exceptions to the rule[7]. The White Paper also stated that if an operator could not demonstrate that the activities would meet the requirements of zero physical discharge, then year-round activities in that field would not be an option. The same requirements were repeated in the integrated management plan that was submitted to the Storting in 2006 – White Paper No. 8 (2005–2006) Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands (Ministry of the Environment 2006).

The zero physical discharge requirement was an initiative originating from the industrial partners. Both industry and authorities considered this more stringent regime as the only way to make it politically feasible to carry out the impact assessment in time, and to reopen the area for petroleum production without too long a delay (Hasle, Kjellén, and Haugerud 2009). Physcial zero discharge was a political compromise and, from that perspective, the moratorium on petroleum activities in the Barents Sea-Lofoten area can be considered as a crisis or 'focusing event' that fostered a significant policy shift. This shift was conceivable, since leading industry representatives believed and communicated that zero physical discharge was technologically realistic; a message that fitted well with the industry's lobbying for advancing its environmental profile. However, this policy was debated from the start. It was questioned whether it would have a net environmental benefit due to the increased emissions to air resulting from higher energy demands during transportation or reinjection of waste, as well as whether they would be cost effective (Hasle, Kjellén, and Haugerud 2009; Larsen and Dahle 2004). Another issue of concern was that the handling and transporting of large volumes of waste could lead to increased occupational risks for humans from accidents (Olsen *et al*. 2011).

The zero physical discharge regime did not last long. When the integrated management plan for the Barents Sea – Lofoten area was revised in 2011 (Ministry of the Environment 2011), the rules for the Barents Sea were aligned with those applicable to the Norwegian Sea and the North Sea. This alignment is referred to by many as the 'harmonization' of waste regulations on the NCS, including zero harm. There are several reasons as to why the zero physical discharge regime was given up after such a short time.

One is that the main objective had been reached: the Barents Sea was opened for petroleum activity. Even the skeptics accepted the stringent regime as a temporary solution to gain legitimacy and strengthen the political argument for a reopening of the Barents Sea for petroleum activity (Knol 2011). Much was at stake, and zero physical discharge was thus needed in order to achieve 'zero political discharge.' The most important reason for the return to the zero harm regime was the lack of a comprehensive environmental risk assessment. This need was emphasized in a report mandated by the Ministry of the Environment and the Ministry of Petroleum and Energy (and produced by SFT, the Norwegian Petroleum Directorate, and the Norwegian Radiation Control Authority) (Norwegian Petroleum Directorate 2008), which argued against zero physical discharge on the NCS and concluded that for each field (new and existing), there should be transparent cost-benefit analyses including integrated environmental assessments of measures to hinder discharges to sea. In addition, it stated that in special areas with vulnerable bottom fauna, or in spawning areas for fish, technology should be used that would make it possible to handle drill cuttings and mud in ways that lead to decreased spreading on the ocean floor. In other words, the discussions around discharge regulations in the Barents Sea – Lofoten area revealed general shortcomings of the waste management regime and spurred the further development of risk-based regulation.

Meanwhile, the work of OSPAR had led to the standardization of reporting formats, environmental test protocols, and the use of prescreening schemes. There had also been a long-standing effort to develop a Chemical Hazard Assessment and Risk Management (CHARM) model, with support from the European Oilfield Specialty Chemicals Association (EOSCA). This resulted in hazard ranking lists of offshore chemicals on a single substance basis, which did not include the exposure caused by the discharges and the sensitivity of the aquatic environment (Still 2002, Thatcher and Payne 2002). In Norway, therefore, the operators focused on developing a more advanced model for performing environmental impact assessments.

In close cooperation with SINTEF and other research institutions, new decision support tools were made and fine-tuned for the calculation of environmental effects of various substances, such as DREAM (Dose-related Risk and Effect Assessment Model) and EIF (Environmental Impact Factor), to support the industry to select the most optimal and cost-efficient mitigation measures for reducing potential harmful discharges to the marine environment (Reed and Rye 2011; Johnsen and Frost 2011; Smit, Frost, and Ståle Johnsen 2011). These instruments were adopted by all the major oil companies as part of their risk-based approach.

In this phase, the Norwegian Oil and Gas Association maintained its coordinating role around monitoring and reporting. Together with the Norwegian Environment Agency (former SFT) it arranges an annual Forum for Offshore Environmental Monitoring, in which the monitoring data from the preceding year is discussed and during which new monitoring plans are made. Through the Norwegian Oil and Gas Association, the industry is also an important co-financer of large national research programs, such as PROOF (2002–2006) and POOFNY (2006–2015) (Bakke, Klungsøyr, and Sanni 2013).

Thus, in this fourth phase, the management of environmental waste was further institutionalized and has turned into a routine activity. In this phase, the regulation and monitoring of operational discharges was brought further under control. Both industry and government embraced a risk-based approach, which left it to the companies to define and select the most appropriate solutions within the overall framework agreed upon by the partners at the national and international levels. During the last ten years, the work on reducing the overall impact of offshore chemicals on the marine environment has continued. The operating companies have invested in better cleansing systems and instruments for measuring effluents, and chemical suppliers have provided information about chemicals to be used and discharged offshore according to

OSPAR's Harmonized Offshore Chemical Notification Format (HOCNF). OSPAR now follows the EU REACH Regulation[8] concerning the registration, evaluation, authorization and restriction of chemicals, and attempts have been made to harmonize this with the EU's Marine Strategy Framework Directive, which aims to reach Good Environmental Status[9] of the marine waters by 2020 (Anderson *et al*. 2018). Likewise, the monitoring system has been formalized. In addition to what has become conventional monitoring of sediments and the water column, additional monitoring requirements can be demanded in special cases, for example in vulnerable areas (Norwegian Environment Agency 2015).

6. Discussion

The preceding sections described the development of a regulatory regime to handle offshore waste management. Unlike risks debated in terms of the probability of an accident and its consequences, the risks connected to operational petroleum activity are more invisible and the measurement of their effects is more complex. Their potential impact may not be revealed until after several years of discharges. These are the 'latent side-effects' (Beck 1992) of industrial activity. Parallel to Carson's story in *Silent Spring* (1962) about the use and effects of pesticides, which were long used unquestioned, in the early years of offshore petroleum activity, there was limited or no discussion of the effects of discharges to sea. When concerns about the effects arose, the industry initially responded as if the effects were non-existent, or at least not worthy of concern. Soon after the first regulations were introduced, however, the industry gradually became an active partner in managing and monitoring these risks. Over time, a governance system for the regulation of petroleum activities with more concern for the environment was established through interactions among many actors, including government agencies, businesses and science. In particular the zero harm work provides an example where distributed and decentered steering (Meadowcroft 2007) was fundamental to making progress toward more sustainable practices.

The regulations introduced since the 1980s have had a positive effect on the marine environment. Oil-based mud is now only used for particularly demanding operations, and it is no longer discharged to sea. The amount of oil on cuttings has reduced considerably. The zero harm regulations have also led to a large reduction of hazardous components since 2002. For added chemicals used in the exploration and in the subsequent production phases, the zero discharge goal is considered to be achieved, with a 99.5% reduction in the use of black- and red-category substances from 1997 to 2008. After concern about yellow category substances was raised by environmental organizations, more control was introduced around the use and discharge of these from 2009 onwards. The reductions in discharges of naturally occurring substances and oil have been lower than expected, although the fifteen per cent reduction of discharge of dispersed oil has been achieved (SFT 2010).

While it should be noted that knowledge around the environmental effects of discharges is still not uncontested (Blanchard *et al*. 2014), the large advancements made in the environmental waste management regime can be attributed to several factors. Apart from the dedicated cooperation among the industry, research institutes and environmental authorities, there was a constant pressure from an alert environmental movement putting environmental issues on the agenda, to which the industry and government needed to respond. In addition, in their role as end-users, the oil companies were strongly reliant on a committed supply industry for their chemicals. Without access to better chemicals, the large reductions in the use of red and black substances would not have been possible. The chemical supply companies shared a strong desire to phase out the red and black chemicals.

Throughout the phases described in this article, we have seen a complexification of the environmental risk object. Relatively 'simple' solutions, such as the ban on oil-based drill cutting discharges, were followed up by a more elaborate zero harm regime to deal with the growing complexity of the risk object. Risk was no longer 'simply' connected to drill cuttings, drilling mud or produced water: as there was more knowledge about their individual contents' effects on the marine environment, the risk objects were broken down into individual substances that became the object of regulation.

With respect to the reopening of the Barents Sea, the industry faced an increase in institutional risks. While the environmental risk remained largely similar in comparison to other areas on the NCS, the institutional risks had risen immensely due to the contested political climate in the Barents Sea – Lofoten case. This led to the introduction of regulations (zero physical discharge) that were – from an environmental and technological perspective – less rational than the regulatory instruments that were introduced earlier in the process. While the regulations in the early phases were introduced to control environmental risks, zero physical discharge was instead introduced to regulate institutional risks.

Rothstein, Huber, and Gaskell (2006) discuss 'risk colonization' in a situation wherein managers manage both their regulatory risk objects as well as the enhanced institutional threats. They warn that this situation can lead to mismatches between the management of societal and institutional risk. With the opening of the Barents Sea – Lofoten area, institutional risks arose and grew more complex, and the oil companies were very keen to gain access to the region. Trying to control institutional risks thus jeopardized the rationality of measures for the regulation of environmental risk, hence resulting in a mismatch between the management of environmental risk and institutional risk. The 'harmonization' of the discharge regime can therefore be regarded as a turn back toward what was otherwise considered the most rational approach from an environmental, economic and technological point of view.

The developments described in this article demonstrate that regulators were increasingly reliant on research-based knowledge and professional expertise to govern offshore waste. This has been inevitable, as the management object revealed a growing complexity throughout the four phases. It has been argued widely that innovation is promoted when there is close interaction between industry, government and research institutes (Etzkowitz and Leydesdorff 2000). The involvement of industry partners in designing policy solutions stimulated technological development and resulted in environmentally sounder solutions in the process toward zero harm.

In sum, the relationship between the government and the industry moved from a regulator-complier relationship in the first phase, toward a more differentiated relationship based on collaboration around risk management in the fourth phase. Ultimately, it can be argued that the risk governance regime evolved into a predominantly performance-based approach, where expertise to design and choose technologies and methods to achieve stated goals was primarily located within the industry, and as such, a prescriptive regulatory framework would not have been suitable for achieving complex environmental objectives. However, this system developed within a trust-based collaborative network with relatively well-defined roles and responsibilities. In the past decade, the number of industrial actors on the NCS increased considerably, which challenges the trust-based foundation of the regime. As one of the clear pitfalls of a highly expertise-based system is that central authorities have limited competence to control processes - in particular when they need to account for highly diverse site- and operation-specific parameters - this will become more complicated with a diversifying industrial sector. This is a clear challenge to the risk-based approach to offshore waste regulation in Norway.

7. Conclusion

From an environmental management perspective, the Norwegian zero harmful discharge regime can be considered a success, and one that owes to the trust-based collaboration between government and industry. The implementation of the discharge regulations demonstrates several of the characteristics associated with the performance-based approach to regulation, despite the fact that the regulations also contain prescriptive elements (such as prohibiting the use of certain chemicals). In work toward the risk-based zero-harm regime, the industry took part in formulating the goals to be met: the companies took responsibility, and there was a strong focus on self-inspection. It shows that flexible regulations can be effective in operational areas where rapid changes in technology are anticipated. This presupposes a strong reliance on the professional expertise of the industry. The premise of this approach is that industry actors are in a better position to react to changes in technology development and knowledge about risk than government agencies. This approach, together with the openness and transparency of the Norwegian system, invites constant improvements in technology and performance. It also encourages companies to strive to be the best.

With the active inclusion of the industry in the formulation of regulations, Norway experienced changes in accountability structures in the early phases of the development of a regulatory system for the handling of waste. Accountability has become shared between industrial and governmental actors. The distribution of steering power presupposes that the industry has high levels of expertise on environmental effects, but it also requires that the controlling government agencies possess similar knowledge in order to be able to audit the companies. Here lies a clear weakness of the system, as government agencies have fewer resources to maintain the level of expertise compared to capital-intensive industry partners.

This weakness can result in regulatory capture, referring to a situation in which a regulatory agency becomes dominated by the industry or the interest group it is charged with regulating (Stigler 1971; Birch 2020). In a 2019 report, the Office of the Auditor General of Norway criticized the Petroleum Safety Authority Norway (PSA) for relying too much on the companies' own reports and not verifying that the businesses actually take their responsibilities seriously (Office of the Auditor General of Norway 2019). The PSA was urged to strengthen supervision and respond more firmly when the companies neglect safety. These are also important issues when it comes to operational discharges and the marine environment. We can question the extent to which the environmental authorities have the capacity to keep control of the industry, as well as of the growing quantities and complexity of accumulated research and monitoring data.

While this paper has highlighted the importance of industrial involvement in environmental regulation toward more sustainable solutions, it has also underlined some of the pitfalls of a strong reliance on industry expertise. Environmental authorities have limited capability to interpret all off the available data in line with the latest research. They are strongly reliant on industrial actors and external expertise to enforce and adapt their regulations and to respond to new insights and emerging issues, which entails a risk of regulatory capture. This requires highly effective and up-to-date systems for sharing and translating expertise. The increasing complexification of risk objects together with changing institutional and political landscapes will constantly challenge and transform this relationship between industry, public authorities and science. Ultimately, there are two pitfalls to avoid: one is a system with detailed rules, government inspections and companies that refrain from taking responsibility for their own activities; the other is a trust-based system where regulatory agencies do not have the requisite distance, capability and authority to govern for environmental sustainability and the public good.

Notes

1. http://www.offshore-environment.com/discharges.html (last accessed February 15, 2019).
2. Ibid.
3. In 2004, the Norwegian Petroleum Directorate was split up into two bodies: the NPD itself, and the Petroleum Agency (Petroleumstilsynet), which is responsible for technical and operational safety and works under the auspices of the Ministry of Labor and Social Inclusion.
4. Norway established a Ministry of the Environment in 1972, and was the first country in the world to do so. The name was changed to the Ministry of Climate and Environment in 2014.
5. The Norwegian Pollution Control Authority (*Statens forurensningstilsyn/SFT*) was established in 1974. In 2010, its name was changed to the Norwegian Climate and Pollution Agency (KLIF). In 2013, it merged with the Directorate for Nature Management (which was also an agency under the Ministry of Climate and Environment) into the Norwegian Environment Agency.
6. The first sediment monitoring around platforms started in 1973, but this was not a routine activity until 1982 (see Gray *et al.* 1999).
7. Drill cuttings and drilling mud from drilling of the top hole could still normally be discharged, provided that the discharges did not contain environmentally harmful substances. A maximum of 5% of the produced water could also be discharged during operational deviations, provided that it was cleaned before it was discharged.
8. https://ec.europa.eu/environment/chemicals/reach/reach_en.htm
9. https://ec.europa.eu/environment/marine/good-environmental-status/index_en.htm

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