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Climate Change in the North and the Oil Industry

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FRIDTJOF NANSENS INSTITUTT
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Climate Change in the North and the Oil Industry

Input to Strategic Impact Assessment
Barents Region 2030

Report commissioned by StatoilHydro ASA

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Abstract

How will climate change affect oil industry operations in the High North? The report analyses impacts in the North that are different from, or come in addition to, the impacts felt globally, from two angles: one outlining climate-related changes in nature and their impacts on oil industry operations, and the second discussing actual and possible policy responses and their impact.

Forecasts and scenarios developed by climate scientists indicate that the situation is volatile. The climate and weather will be less predictable. Although the long term tendency is clear, there will be large variations in ice from year to year, with some seasons colder and with more ice than what has been 'normal' in recent years. The industry cannot count on areas remaining ice-free, and when it comes to fixed installations it will have to prepare for a situation in 2030 with maximum ice not much different than today. Climate policies are not likely to have a strong direct impact on the operations of oil companies in the North, but the climate development in the North is likely to impact other political processes, public opinion and consumers. In turn they may affect industry operations. Thus there is an indirect link between the climate issue and the oil industry in the North.

Key Words
oil industry, climate change, climate policy

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This report has been commissioned by StatoilHydro ASA and undertaken by the Fridtjof Nansen Institute. StatoilHydro ASA has commissioned four parallel scenario reports for the Barents Region on respectively climate change, socio-economic consequences, environmental issues and reindeer husbandry. The joint project was initiated as part of StatoilHydro's preparations for a strategic action plan for future oil and gas developments in the High North.

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1 Introduction

Over the last couple of years climate change has been given radically increased attention at the regional and global level. Whereas the causes of climate change were frequently questioned earlier, the consensus on this point is now very strong. The IPCC (Intergovernmental Panel on Climate Change) concludes in its most recent reports that it is *very likely* that a wide range of global climate trends are caused by anthropogenic greenhouse gas emissions.[1] Human activities are interfering with natural systems. Other questions now dominate the international debate: How will climate change affect the environment in the future? How can an escalation of climate change be prevented, and what can be done to adapt to the changes that will take place in any event? Any serious authority or business will need to include climate issues in its long-term planning.

The oil industry will be affected by climate change in many ways, and is of course also a major source of emissions. This report discusses just one relatively narrow issue: How will climate change affect oil industry operations in the High North? We will try to isolate impacts on the industry in the North that are different from, or come in addition to the impacts felt globally.

The report has two components: one outlining climate-related changes in nature and their impacts on oil industry operations, and the second discussing actual and possible policy responses and their impact. The discussion refers to the Barlindhaug report[2] (2005), where projections for future oil and gas development in the Barents Sea are put forward. In that report a comprehensive development in the Barents region is outlined. Our task is to discuss how climate change and climate policies may affect such a development.

2 Climate Change

Our analysis is based on the findings in the most authoritative sources of information about climate change.[3] On this basis we establish a frame-

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[1] Main greenhouse gases are carbon dioxide (CO2), methane (CH4), nitrous oxide (N2O) and chlorofluorocarbons (CFC).

[2] Barlindhaug AS, Petroleumsvirksomhet i Barentshavet: Utbyggingsperspektiver og ringvirkninger, Tromsø 2005.

[3] In this report there are two main sources of data: Intergovernmental Panel on Climate Change (IPCC) and Arctic Climate Impact Assessment (ACIA), 2004. IPCC was established in 1988 by the World Meteorological Organization (WMO) and the United Nations Environment Programme (UNEP). IPCC 'is to assess on a comprehensive, objective, open and transparent basis the scientific, technical and socio-economic information relevant to understanding the scientific basis of risk of human-induced climate change, its potential impacts and options for adaptation and mitigation.' (www.ipcc.ch). ACIA is an international project of the Arctic Council and the International Arctic Science Committee (IASC). The results of the assessment were released in November 2004. Knowledge on climate variability, climate change, and increased ultraviolet radiation and their consequences was evaluated and synthesized (www.acia.uaf.edu/). See also references for more background material.

work for analysis of potential impact on the environment and socio-economic structures. First, we need to identify the broad global climate scenarios and second, scale down such findings to the regional level (here understood as the Barents region and adjacent sea areas). Third, we will address the various impacts climate change could have in the region in general and in respect to the petroleum industry. The main ambition is to present central findings and scenarios developed by climate researchers and relate them to petroleum developments in the Barents Sea until 2030. In this process we will also highlight major uncertainties that still exist. But the existence of uncertainties does not change the overall picture. It is virtually certain that we will experience higher global and regional temperatures in the 21st century irrespective of any mitigation efforts. Global climate changes will influence humans everywhere, but these changes will have heterogeneous affects on a regional level.

2.1 Barents Region

Global climate change will most likely contribute to changes in the Barents region by 2030, but at the same time it is important to see the larger picture. That is exactly what IPCC and ACIA (Arctic Climate Impact Assessment) are doing by developing scenarios for 2100. Probably most important, higher temperatures will contribute to melting of ice, which again is crucial to take into account when planning in the field of socio-economics, transport etc. The central point to make is that the region cannot be analysed in isolation. On the other hand, some climate changes have more impact in the Barents region than elsewhere.[4] They are therefore more crucial in this context. At the same time natural climate variations in the region differ from the rest of the global trend and the climate change is more rapid. [5] Arctic temperatures also vary highly from year to year and over decades.[6] Thus, it is more complicated to develop reliable scenarios for this region than elsewhere.

It is also difficult to predict how climate effects will be inter-related. The processes are interwoven. Both the IPCC and ACIA[7] are working with scenarios and not predicting a coming reality. Thus, it is important to stress the uncertainties regarding climate change and regional impact. But the tendency is clear. Higher temperatures due to both natural variations and human actions are changing the prospects for the Barents region.

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[4] The International Polar Year (IPY) is an arena where specific attention is given to the Arctic and Barents Region. This may be seen in the Arctic project CAVIAR.

[5] Jorunn Gran (2004) 'Klimaendringer flytter miljøgifter' in *Cicerone,* 6. www.cicero.uio.no/cicerone/index.asp?issue=6&volume=2004.

[6] IPCC (2007) "Summary for Policymakers" in *Climate Change 2007: The Physical Science Basis,* Cambridge. p. 7.

[7] The baseline of the Arctic Climate Impact Assessment (ACIA) was the B2 scenario from IPCC of climate change over the next century. B2 is a moderate scenario. The predictions are below the mid-range among the various scenarios used by the IPCC.

The Barents Sea is a shallow sea with an average depth of about 230 meters. The region is quite easily accessible during most parts of the year. It covers the area from the deep Norwegian Sea in the west to Novaya Zemlya in the east, and in the south from the coast of Norway and Russia to 80N. The Gulf Stream transports Atlantic water to the north-east, while arctic water is transported to the south. This exchange of currents makes the Barents region a special case with respect to climate change.[8]

Here we will put forward a range of climate issues that will have impact in the region: earth and sea temperatures, sea level, sea ice cover and drifting ice, snow cover and permafrost, extreme weather and ocean salinity and ocean currents.[9] The issues are interwoven, but here they will be presented more or less separately. When addressing the areas, main climate projections are presented and then the Barents Region is given attention. When clear projections are lacking, this is underscored.

2.2 Earth and Sea Temperature

Both the global climate and the Arctic climate are warmer than before. The average annual temperature in the Arctic has, however, increased twice as much as in the rest of the world in the course of the last decades.[10] Depending on different emissions scenarios, researchers expect that the earth average temperature will rise between 1.8 to 4.0 C by 2100. There are two main explanations for the lack of a more accurate projection. First, policy development; how high will human emissions be in the future? Second, the complexity of climate models and natural variations makes it impossible to present totally coherent figures. The projection of different scenarios is based on observed temperature evolution.

In the Arctic region it is expected that the temperature increase will be twice the average global temperature increase. This is based on measurements over the last 150 years.[11] One important point to make is that Arctic temperatures have a high variability. This is especially evident during winter, where temperatures have increased even more than during summer. At the same time there may be large variations from year to year. If we look at the coming decades, a global warming of 0.2 C is projected regardless of emission cuts. It is difficult to make clear projections in absolute figures with respect to the Barents Region in 2030 compared to 2000, but it is important to stress once again that the increase in temperature will be significantly higher in the Arctic region than the global average.[12]

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8 See The Norwegian Polar Institute, http://npweb.npolar.no/geografi/barents

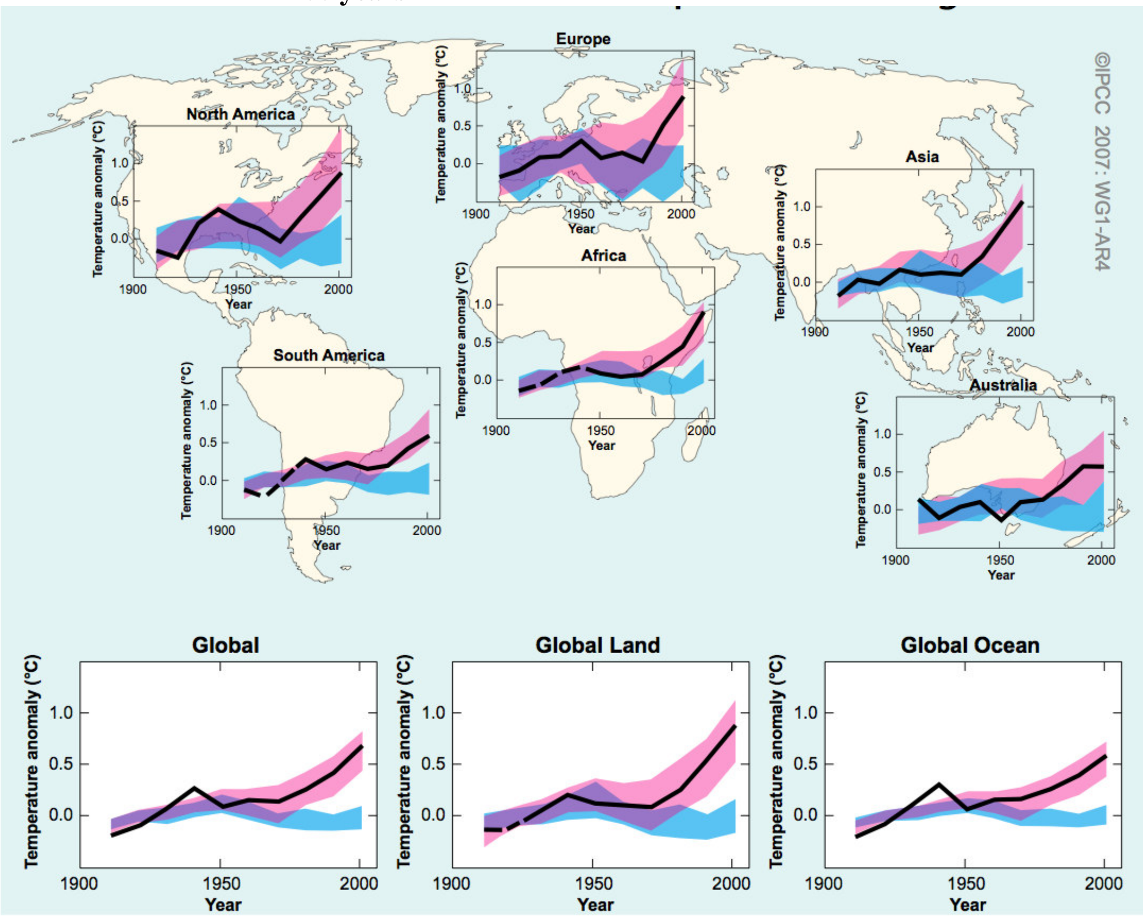
9 The list could be made longer including for example the thinning of the ozone layer and sea water becoming more acidic (ACIA: Impacts of a Warming Arctic, Cambridge, 2004). The issues focused here are most important in respect to the arguments put forward and in giving input to the Strategic Impact Assessment Barents Region 2030.

10 ACIA (2004).

11 ACIA (2004).

12 IPCC (2007).

Figure 1 Global and continental temperature change over the last 100 years



Source: IPCC (2007), p.11

An increase in sea temperatures has been observed down to 3000 meters. This again will have impacts on ocean currents like the Gulf Stream. Data on sea temperature in the Barents Sea is to some extent identified, but it is important to emphasise that we are not talking exact numbers.[13] It is projected that the sea temperature in the Barents Sea will increase (1-2 C),[14] with impacts on the fisheries in the region. Russian researchers have measured the sea temperature in the Barents Sea since 1970, and in 2006 the highest sea temperature in the Barents Sea was measured.[15] This leads to changes in the migration of fish stocks, for example cod, a point stressed below. Further research and studies on the co-variations between climate changes and fish stocks are needed, however.[16] There are many

[13] See Havforskningstema 2-2006 for figures on sea temperature in the Barents Sea 1900-2000, www.imr.no/dokumenter/hitema In respect to sea temperature, a wide range of factors are interwoven, for example ocean currents and ocean salinity. In this report the complex causal mechanisms will only partly be addressed. Our ambition is to draw the big picture.

[14] *Ibid.*

[15] Mork, Kjell Arne et al. (2007), 'Rekordvarmt vann langs norskekysten' in *Klima*, 1.

[16] For more input see www.imr.no

different scenarios with different outcomes. Some projections may nonetheless be made.

Impact

Increased earth and sea temperature will probably not have any significant direct impact on oil industry operations in the time period in focus. On the other hand, as already pointed out, increased sea temperature will have an impact on fisheries. The essential question is how rising temperatures will affect the migration of fish and how and to what extent we will witness a development where new species are introduced in the ecological system. At the Institute of Marine Research in Bergen considerable work has been done to develop scenarios for migration of fish stocks, but clear conclusions are lacking. Svein Sundby at IMR shows that the increased sea temperature has led to an increase in plankton production, which will be followed by an increase in the cod stock. But shorter periods with lower temperature might reverse such a development.[17] Again, clear projections are hard to make.

A more fertile Barents Sea could lead to increased activity both on- and offshore. Both the national and international fishing fleets would increase their activity in the region. Most experts expect a positive development for fisheries. This may have a direct impact on the oil and gas industry, if fishing and petroleum acticivities must compete for the same areas. It may also change the political environment (see below) under policy response.

2.3 Sea Level

The sea level is rising. As in the scenarios for temperature, a broad range of estimates exist. The average sea level rise in the course of the 21st century is estimated to be 19-58 cm.[18] It has been estimated that the sea level has increased globally by 17 cm during the last 100 years. The increase has been significantly more rapid from 1993 to 2003, which may be evidence of an escalating development.

At the same time one will find regional differences, as figure 3 shows. In most parts of Norway the land level is rising, which to some extent will reduce the effect of sea level rising. The numbers in the figure represents the net increase in different regions. Thus, when projecting the impact of sea level rising it is important to take regional differences into account. In the Barents region we will witness relative sea level rising by 2030, and a net increase of 50 cm is projected by 2100. In IPCC the effect of changes in regional weather systems on sea level extremes has not been assessed,[19] which is an important issue when looking at regional socio-economic impact. At the same time, research tells us that we will witness

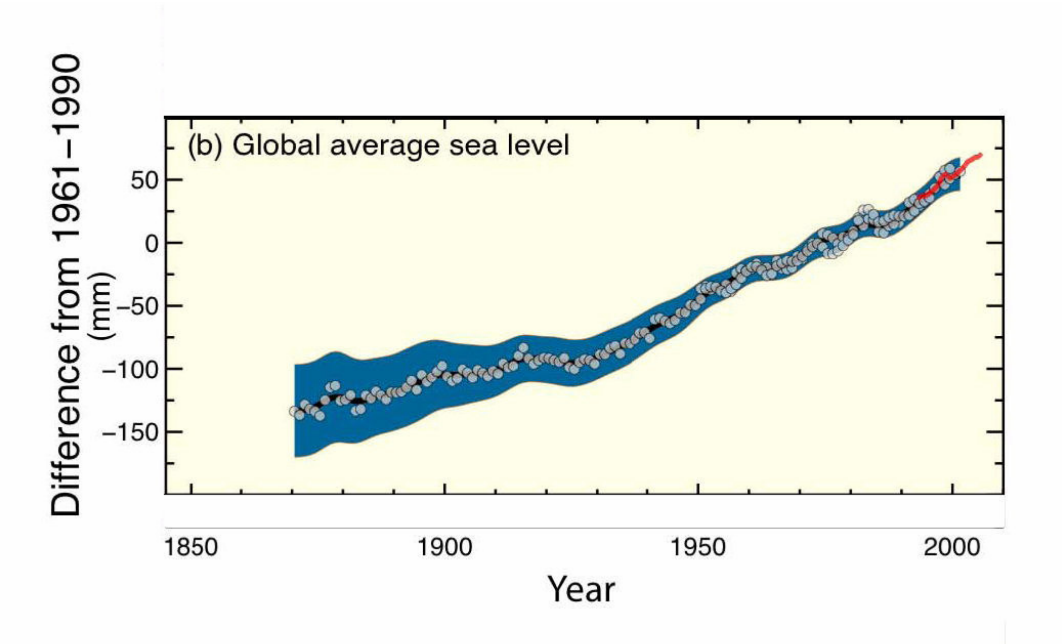
[17] www.imr.no/aktuelt/nyhetsarkiv/2007/mai/utv_barentshavets_fiskebestander

[18] IPCC (2007), p. 13, but other projections are even more pessimistic, Atle Nesje (2006) 'Isbreene smelter – havnivået stiger' in *Cicerone,* 3, 2006. www.cicero.uio.no/ cicerone/index.asp?issue=3&volume=2006

[19] IPCC (2007), p. 9. See NorKlima, www.norklima.no

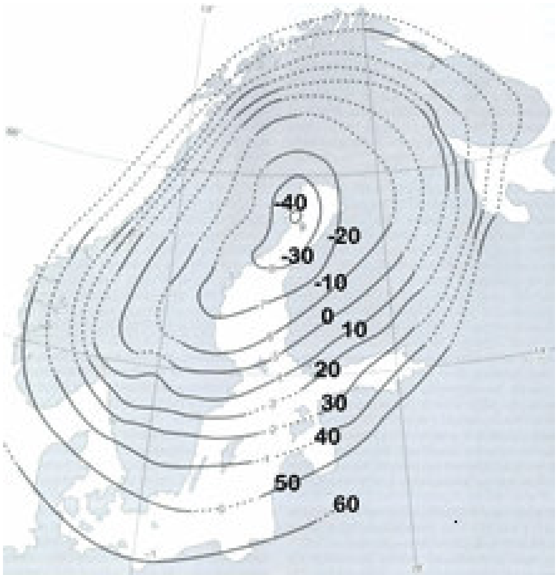
more rough sea.[20] Thus, in combination with more extreme weather, some locations could become more vulnerable already by 2030 (see below).

Figure 2 Average sea level rise



Source: IPCC (2007), p. 6

Figure 3 Projected relative sea level rise 2100 in cm based on a projected sea level rise of 50 cm



Source: Nesje ,Atle, Cicerone 3, 2006

[20] Debernard, Jens & Lars Petter Røed (2002), RegClim, *Cicerone,* 1.

Impact

In the Barents region sea level rising alone will have little impact, especially relative to other regions of the world. This is not to say that sea level rising should be disregarded when planning in the field of socio-economics in the region. When new infrastructure and oil and gas installations are planned, sea level rising must be taken into account. Some harbours could become more vulnerable when seal level rising is combined with more extreme weather (see below).

2.4 Ice Cover

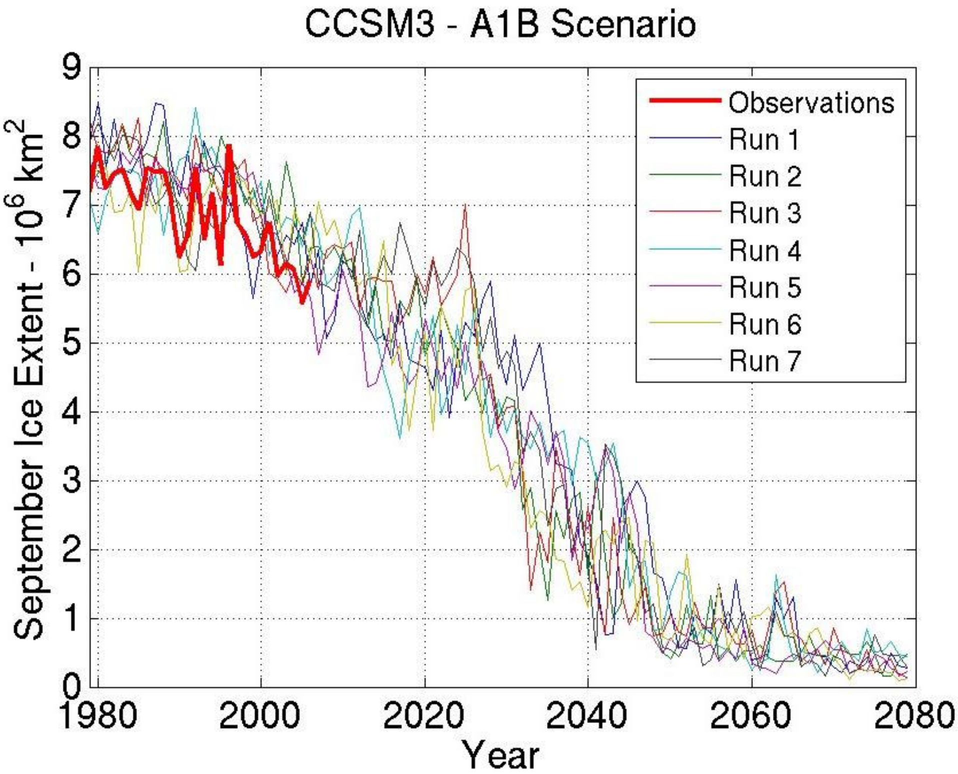
In all scenarios developed by IPCC (2007), the sea ice is projected to shrink. Satellite data from 1978 until today show decreasing sea ice in the Arctic amounting to 2.7% per decade, and a larger reduction in summer (7.4% per decade). Summer sea ice coverage has shrunk 15-20 percent during the last 30 years.[21] The ice edge has retreated northwards and will continue to retreat (see figures 4 and 5). Important distinctions to make are between glaciers, the Arctic ice and the ice sheets of Greenland and Antarctica. When melting they will have different effects on the sea level. The melting of the Antarctic and Greenland ice sheets are crucial when projecting rising sea level.

Figure 4 Ice edge year 2000

Source: Norwegian Polar Institute

[21] An important source of information here is www.damocles.eu.org

Figure 5 Scenarios for sea ice extent Northern hemisphere, September



Source: Bitz, Cecilia (2007), Arctic Sea Ice decline in the 21st Century, RealClimate.org

The impact assessments presented in ACIA, with respect to the climate change scenarios, conclude that half to all of the summer sea ice could disappear by 2100.[22] Regarding year-round ice coverage, a 10-50 per cent reduction is expected. There will be local variations in the Barents region towards 2030, but the overall observation is that we will observe a re-treating sea ice edge.

It is important in this context to identify the quantity of ice in the Barents Sea (and the Arctic as a whole) that is likely over the next decades. A continuing decrease of sea ice in the area can be expected, in line with developments over the last 30 years. During the winter of 2006, high sea and land temperatures led to a Barents Sea free of sea ice south of 76N.[23] Observations from the last few years seem to indicate that the melting is accellerating.

Although the trend is clear, the modelling exercises carried out indicate very high variations from season to season.Thus by 2030 we may see the same extension of ice for some years as we do in an average year today.

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[22] The projected impacts described in ACIA are not based on a worst-case scenario, but fall below the middle of the IPCC range of projected temperature rise. Others are even more pessimistic.

[23] Mork, Kjell Arne et al. (2007), 'Rekordvarmt vann langs norskekysten' in *Klima*, 1.

This is a very important point, and has implications for development plans.

The overall observation is that we will probably witness single summers without ice in the Polar Ocean around 2030. This also means that the winter ice will be softer and younger. An important question is whether this will lead to a greater amount of *drifting ice* in the Barents Sea by 2030 and the following years. In the Northern parts of the Barents Sea, higher temperatures could lead to new challenges from drifting ice. The breaking up of the ice edge could lead to increased iceberg occurrences. Data on this issue are yet to be identified, so one should be careful about making any clear projections. Another question would be about the size of blocks of drifting ice. Changing patterns of drifting ice are likely, but also here we find much uncertainty.

Impact

The developments outlined will have impact on the socio-economic situation in the region and direct implications for oil industry activities. First, larger areas could be accessible for exploration. Second, less ice could pave the way for a longer exploration season. However, it is important to stress that seasonal variations must be considered. According to the Barlindhaug scenario, it is in the period after 2020 that the industry will venture into new areas that are particularly ice-prone today, i.e. the Barents Sea North, but also the eastern part of the Barents Sea – outside the coast of Novaya Zemlya.[24] Developments in the ice-infested Pechora Sea, however, are foreseen already before 2012.[25] It is in these regions that the likely improvement in ice conditions will be felt.

As noted above, the variations from year to year will be considerable. Exploration can take advantage of seasonal opportunities, but fixed installations must be able to tolerate maximum ice conditions not very different from today. On average the ice will be thinner. This means less often need for use of icebreakers to go through ice, although icebreaker capacity must be available. There is uncertainty regarding the behaviour of a thinner, softer winter ice. As noted above it is possible that this will mean more drifting ice, which creates its own sets of problems for installations and may require icebreakers to tow icebergs out of way.

Another operative aspect is that these climate changes could make the problems caused by ice on production installations less profound most years. The risk of acute pollution close to the sea ice edge will demand increased attention, however, a point that is given attention in the Barlindhaug report. Such considerations are also important when addressing operational discharges.

Another issue is what impact a retreating ice edge may have on maritime activity in the Arctic, including transportation, fisheries and tourism. Today there is hardly any transit traffic on the Northern Sea Route. One

[24] Barlindhaug, p. 27.
[25] Barlindhaug, p. 23

reason is the ice situation, and with less ice the navigation season will increase.[26] But this does not directly translate into substantial traffic increase. Also by 2030 one should be careful not to exaggerate the Northern Sea Route transit potential to and from the Pacific. Many factors other than ice must be taken into consideration: administration of the route, water depths, (still some) reliance on ice breakers. These all limit the predictability required for modern large-scale shipping operations. Also, sea ice *variability* could make shipping more challenging, since it makes planning for regular marine transportation difficult. The situation is somewhat different in the western part of the Northern Sea Route (from Yenisei westwards), where there already is substantial traffic. Here the ice situation is less severe, and sailing conditions are likely to improve. There are, however, limitations on the cargo potential that make a drastic increase in traffic unlikely. The largest potential is for oil shipments.

With a rapidly disappearing polar ice cap, the prospects for trans-Polar navigation has also been brought up. Again, the high variability from season to season makes regular traffic difficult, even if it may become technically possible during some seasons by 2030. On the other hand, more flexible actors such as the fishing fleet and tourist operators could take advantage of a long ice-free season.

Nevertheless, the main question here is whether the traffic developments outlined above will have a strong impact on oil industry operations. Our conclusion is that they will not have much direct impact, at least not by 2030.

2.5 Snow Cover and Permafrost

During the last 30 years the snow cover in the Arctic has shrunk by 10 per cent and the snow cover will shrink a further 10-20 percent over the next century. At the same time permafrost coverage and depth has decreased in the region.[27] The map below gives a projection of the permafrost boundary in 2070-2090.

In the Arctic, temperatures at the top of the permafrost layer have generally increased – up to 3 degrees C – since the 1980s. In the Northern Hemisphere the maximum area covered by seasonally frozen ground has decreased by about 7 percent, with a decrease in spring of up to 15 percent. In the coastal region of Norway we do not find permafrost, but changes in the permafrost boundary will have impacts if we look at the region as a whole.

Impact

In the Barents region permafrost will steadily decrease. This will, as already pointed out, not affect Norwegian infrastructure to a large extent,

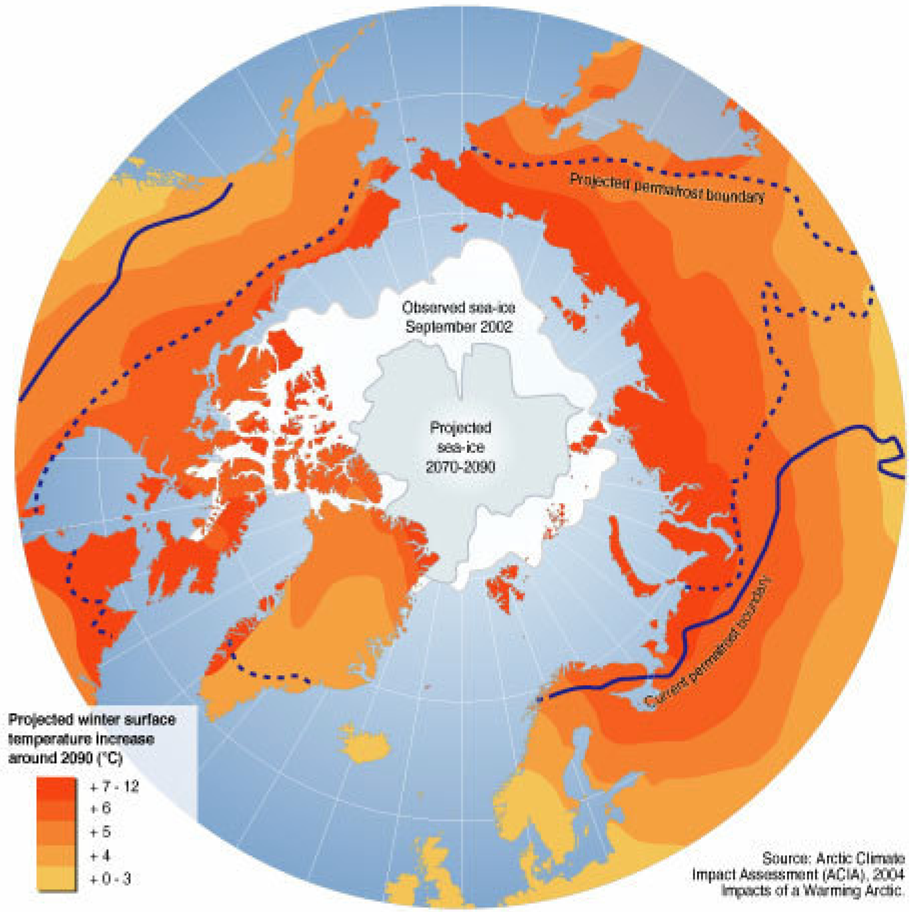
[26] ACIA (2004), p. 83. An important source of information is ‘The Challenges of the Northern Sea Route’ (INSROP Working Paper no. 167, Fridtjof Nansen Institute, 1999), despite the fact that the report was published in 1999. Russian researchers are the main contributors in identifying ice cover data in the area.

[27] ACIA (2004), p. 86.

because only some parts of the county of Finnmark have permafrost.[28] On the Russian side of the border the question of how to handle such a development is more pressing. As a result of permafrost thawing in Russia, infrastructure failure has become more common. Sub-grade railway systems are deformed and oil and gas pipelines are breaking, etc.[29] This is a problem in terminals along the Nenets coastline. The shallow Pechora Sea also has permafrost on the seabed. Some specialists argue that reduced seabed permafrost will make it easier to construct installations such as pipelines. This area is where industrial development is expected in the coming years, according to the Barlindhaug reprort.

Retreating onshore permafrost boundary could make new infrastructure more costly. Permafrost establishes stable ground, and a retreating permafrost boundary will create new challenges in some areas. A more catastrophic scenario would be leakage of radioactive waste stored in the permafrost. This could have great consequences in the Arctic region.[30] In Russia, attention is now given to this threat.

Figure 6 Projected sea-ice in September and permafrost boundary



[28] Challenges due to decreasing permafrost could, however, be more pressing on Svalbard. Monitoring changes in permafrost has been the subject of a three-year EU project called PACE (Permafrost and Climate in Europe), started in December 1997.

2.6 Extreme Weather: Precipitation and Wind Patterns

Precipitation in the Arctic has increased on average by 8 percent during the past century. The precipitation has mainly fallen in the form of rain. This development will escalate during this century, and we will experience an increase in precipitation of 20 percent by 2100.[31]

By 2100 Norway could have up to four more days annually with wind stronger than 15 m/s. The lack of analysed data makes it difficult to identify any clear projection beyond the recognition that the region will witness more extreme precipitation and winds.[32] On the other hand, polar low pressure fronts reaching the shores of northern Norway may decrease due to a retreating sea ice edge.[33] Towards 2030, however, precipitation will increase steadily in the region in focus. At the same time, events of extreme precipitation will occur more often. The most credible scenario is one of moderate increase of precipitation in the Barents region by 2030, but extreme precipitation events and strong wind will occur more often. Such a development will have both direct and indirect impacts for the oil and gas operations in the region.

Impact

Extreme weather may have a profound impact, as witnessed in January 2007 when Snøhvit experienced a short breakdown. This was due to a combination of heavy snow, wind and low temperatures. It is the combination of several factors that have an impact. The combination of strong winds and drifting ice will have a stronger impact in some areas, notably the shallow Pechora Sea (average depth only 6 meters), where most of the confirmed and expected oil fields in the Russian Barents Sea are located. This is an ice-prone area today, with both permanent and drifting ice creating serious problems for oil installations. Drifting ice is clogging and constitutes an obstacle for shipping from November to June. More drifting ice and wind in the future may increase the challenges, which include the risk of icebergs tearing up sub-sea installations. Thinner and less extensive ice will create more open waters, allowing stronger wave generation by winds and increasing wave-induced erosion along arctic shores. The important point to make here is that we will most probably witness large local, seasonal and annual variations. As stressed earlier, the exploration season will probably be longer, but there will be variations both in respect to ice cover extent and extreme weather situations. The oil and gas industry must be prepared to meet maximal situations.

Stronger winds will lead to stronger waves, and this again should be taken into consideration when preparing for a possible incident of acute

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[29] ACIA (2004), p. 88-89.

[30] Aftenposten 10.04.07, www.aftenposten.no/nyheter/miljo/article1727625.ece

[31] ACIA (2004), p. 29.

[32] For figures on precipitation in the Barents Region see Meteorologisk instiutt, www.met.no

[33] Grønås, Sigbjørn & Jens Rytter (2004), RegClim, *Cicerone,* 5.

pollution.[34] Oil spill is seen in the public opinion as the most disastrous consequence of more activity in the region. The probability of an incident of acute pollution in connection with extraction of oil and gas in the region has been been discussed by the Norwegian Pollution Control Authority.[35]

In conclusion, if we look at the operative aspect, more extreme weather should of course be taken into account when establishing technical specifications for installations. Extreme weather introduces new challenges for the supply industry and for the construction of land based processing facilities, as suggested in the Barlindhaug report.[36] A complicating factor may be trade-offs between safety and environmental considerations in some instances. For safety, open systems permitting rapid release of smoke and other emissions in case of accident, are to be preferred. Environmentally, closed systems which can trap emissions are better.

2.7 Ocean Salinity and Ocean Currents

Two climate issues not yet addressed here, less saline waters and ocean currents, should also be given attention. They are interwoven. Less saline waters due to the melting of ice may reduce the strength of the Gulf Stream. This again should be seen in connection with the ocean currents along Greenland. We may move towards a more saline North Atlantic and a fresher Arctic under global warming.[37]

Decreasing ocean salinity gives lighter water near the surface. A consequence may be that the amount of heavier water in the Greenland Sea decreases. Researchers project that the Gulf Stream will weaken if the amount of heavier water in the Greenland Sea decreases. The most pessimistic projections leading to a new ice age in the region in focus have, however, been abandoned. IPCC states that it is *very unlikely* that there will be large abrupt climate changes due to changes in the large-scale ocean circulation (MOC) or ice sheets over the 21st century".

Impact

Looking more directly at oil and gas operations, variations in ocean salinity and ocean currents will probably not have extensive impacts by 2030. The projections sketched above, however, will affect water temperature and hence the migration of cod, for example, in the area. Another point to stress with regard to ocean salinity is its more direct impact on plankton production in the Arctic Region. The distribution of plankton is related to ocean salinity, ocean currents, water temperatures and acidity. Seen in isolation, variations in ocean salinity could reduce

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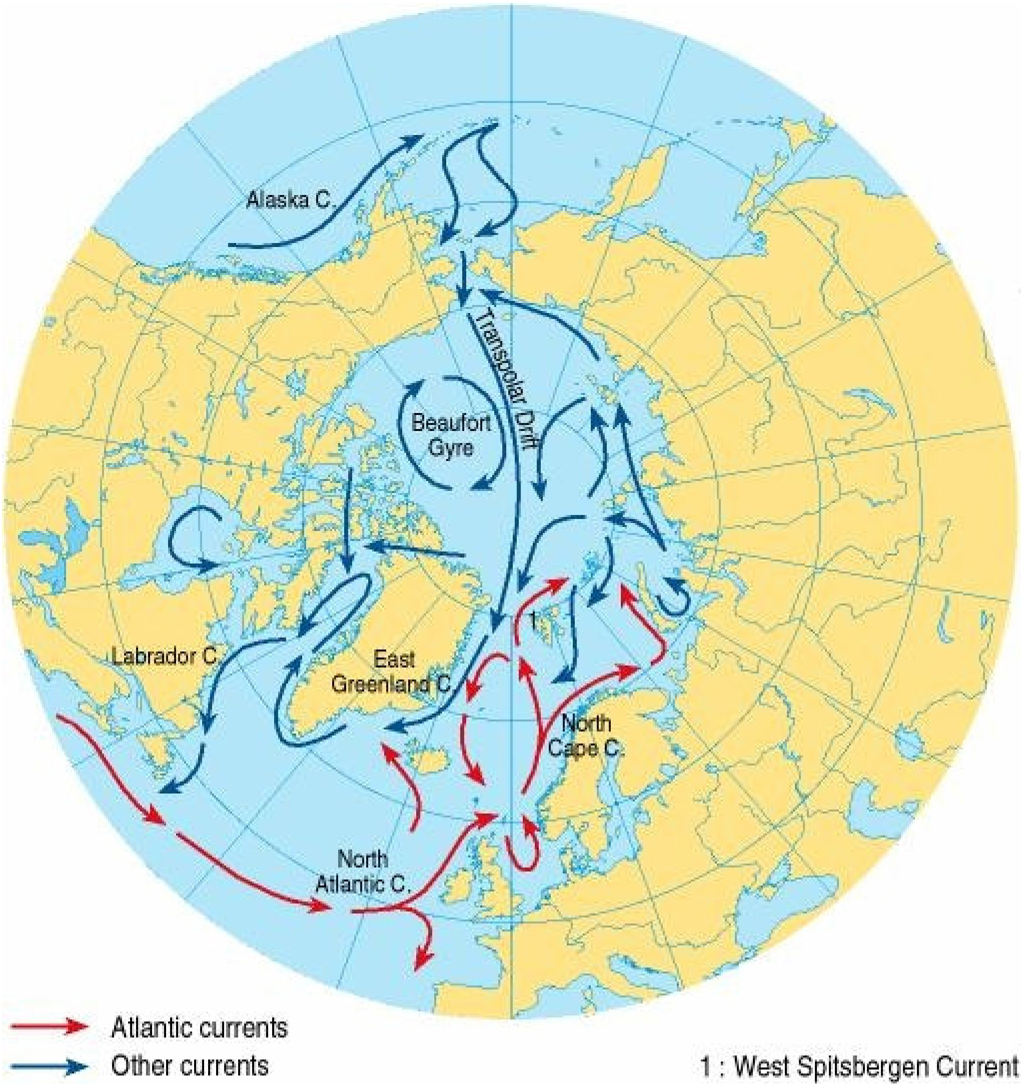
[34] *Ibid.* and St. meld. nr. 14 (2004-2005) 'På den sikre siden – sjøsikkerhet og oljevernberedskap'.
[35] See for example Norwegian Pollution Control Authority (2006), 'Boring av letebrønner 7122/7-4 og 7122/7-5 i utvinningstillatelse 229 Goliat'.
[36] Barlindhaug, p. 20.
[37] Bethke I., Drange H. and Furevik T. (2006) 'Towards a more saline North Atlantic and a fresher Arctic under global warming' *Geophys. Res. Lett.,* (32).

the amount of animal plankton in the Barents Sea, with corresponding impact for fisheries. Such variations may become apparent in the Northern part of the Barents Sea, where organisms like shells will be affected by more acidic water.[38]

Figure 7 Ocean currents in the Arctic



Source: AMAP, 1998[39]

However, as discussed above, increasing water temperature and a retreating ice edge have the opposite effect. They will lead to a more fertile Barents Sea. Although on balance there seem to be expectations for better fishing conditions in the Barents Sea, there is a great amount of uncertainty. Research has been undertaken on the combined effect of climate changes on marine ecosystems, "but because this is an extremely com-

[38] Wassmann, Paul & Marit Reigstad (2007), 'Klima og økosystemrespons i Barentshavet' in *Klima*, 1.

[39] *Arctic Pollution Issues: A State of the Arctic Environment Report*, Arctic Monitoring and Assessment Programme, Oslo, 1998

plex process, we still find it difficult to quantify the relationship between variations in climate and fish stocks”.[40]

The extent and location of fisheries in the Barents Sea will have a direct impact on the conditions for oil industry activities if there is competition for acreage, but also indirectly since it affects the configuration of interests in the region. This relates to climate *policy* response.

2.8 Concluding Remarks – Climate Change in the North

Temperature is presented here as the central variable in all projections regarding the global and regional climate. The rising sea and earth temperatures cause the snow and ice to melt and the ocean level to rise. But temperature is not an entirely independent variable. Regional temperatures are also dependent on ocean currents, and in the case of the Barents region, the Gulf Stream is of course vital. Recent research tells us, however, that it is not likely that the Gulf Stream will be weakened to such a degree that it will profoundly affect the environment in the region in the near future. It is important to stress that we find many different scenarios and projections regarding climate change, and we will witness various sub-regional impacts.

Our overview of climate developments may seem to confirm the common perception that by 2030 in the Barents Sea the petroleum industry, the fishing fleet and tourism operators will have more opportunities and easier operating conditions than at present. However, seasonal variations complicate this picture. The main change is of course less ice, but there are also developments that have a negative impact on operating conditions, particularly related to extreme weather. Although such developments do not put any absolute restrictions on oil industry activities, they may require new technical specifications both offshore and onshore and thus translate into higher costs.

The main finding is that the situation is volatile. The climate and weather will be less predictable. Although the long term tendency is clear, there will be large variations in ice from year to year, with some seasons colder and with more ice than what has been ‘normal’ in recent years. This insight significantly limits the ‘positive’ effect of a retreating ice edge. The industry cannot count on areas remaining ice-free, and when it comes to fixed installations it will have to prepare for a situation with maximum ice not much different than today, even if on average the ice will be thinner. The situation for exploration is different. Ice free years can be utilised to extend the range of exploration activities as well the season.

On balance, based on knowledge existing today, it seems that the changes that can be expected by 2030 do not radically alter the operating conditions for the oil industry in the Barents Sea. However, when we reach 2030 the situation for the next 30 years or so may look different. Thus investments which are intended to last several decades will have to be made on the basis of assumptions about the climate situation in 2060

[40] Havforskningstema 2-2006, www.imr.no

or thereabout. At present we can say that the tendencies which will be seen in the coming two decades are likely to be reinforced.

To discuss the operating conditions on a purely technical level, as done above, is of course insufficient. Climate change is also triggering political processes of potentially great significance for the oil industry. The second part of this report will address this policy response.

3 Climate Policy Response

The climate developments described above, and the perceptions of the climate threat will undoubtedly have political consequences, but it is difficult to say exactly which. In this section we will point to possible processes or mechanisms at the international as well as the national level that may be affected and in turn have implications for the framework for oil industry operations in the North.

3.1 The International Level

The climate issue entered the international political agenda in the late 1980s and led to negotiations for the most challenging international environmental regime ever seen, centered around the United Nations Framework Convention on Climate Change (UNFCCC) (1992). The Kyoto protocol to the convention (1997) made goals into operative emissions targets and launched mechanisms to help reach the targets. This is not the place to review development of the climate regime, but to ask more narrowly whether the international climate regime is likely to develop special targets, rules or regulations that will affect oil industry operations in the Arctic.

The UNFCCC recognized climate change as a truly global problem – underscoring that greenhouse gas emissions have the same impact on the climate irrespective of where they take place. It did, however, put the *responsibility* on developed nations to find solutions and combat the problem. The Kyoto mechanisms developed flexibility mechanisms – emissions trading, joint implementation and the clean development mechanism – to secure cost-efficient emission reductions across borders. Specific regions or economic sectors have not been singled out for emission cuts. There has been discussion, however, both internationally and not least nationally in Norway about the proportion of emission reductions to be carried out *domestically vs. abroad* by using the flexibility mechanisms (see below).

The Kyoto protocol only covers commitments for the period 2008-2012, referred to as the first commitment period. The plan from Kyoto was to extend the regime into new commitment periods with gradually stricter targets. But the negotiations for the post-2012 period have hardly started, and it is very uncertain what the international climate regime will look like after 2012. Major uncertainty is related to the *strictness* of new targets, but also more fundamentally the *extension* of the regime, i.e. whether more countries will take on binding commitments, notably the US and large LDCs. Most observers seem to expect that there will be an extension of a regime with the main elements from Kyoto.

In such a regime we find it very unlikely that specific areas or economic sectors may be singled out for special regulations. Doing that would contradict the recognition of climate change as a global problem and undermine the international quota transfer mechanisms.

The 'Kyoto-track' is not the only international climate policy process underway, however. The US effort to establish technology-focused voluntary cooperation is the most important alternative, or rather supplement to Kyoto. This effort is reflected in the Asia-Pacific Partnership on Clean Development and Climate (APP) and includes the US, Australia, China, Japan, India and South Korea. The partnership focuses on technological innovation and transfer, especially targeting the coal industry. The most recent US proposal, before the G8 summit in June 2007, goes in the same direction. Any direct regulation of activities in special regions or sectors goes against the grain of this approach, which is based on voluntariness, technological improvement and cost efficiency.

Thus we conclude that the international climate *regime* will not put constraints on oil industry activities in the Arctic. Climate policy processes, however, are not the only international processes affected by climate change. The climate development in the Arctic is likely to increase the broader environmental awareness in the North. More comprehensive international monitoring of climate change and its socio-economic impacts can be expected. A series of reports on Arctic challenges due to climate change have been prepared, including ACIA and two comprehensive AMAP Assessment Reports.[41] Under the Arctic Council, hydrocarbons are among the pollutants prioritized. In 2007 the Oil and Gas Assessment will be finalized. This in turn may give political energy to more comprehensive *environmental co-operation* in the Arctic, addressing negative consequences of industrial development in the region and thus affecting oil industry operations. The impact of regional emissions of soot on the ice cover's ability to reflect the sun may become an important issue.[42] A logical response would be further restrictions on flaring of gas from Arctic operations.

There has been speculation about the possible establishment of a comprehensive International Arctic Environmental Agreement. Support for this idea has come i.a. from environmental organisations. A recent FNI study, however, concluded that the difficulties of establishing a comprehensive regime will be very substantial, and that 'the best answer [to solving environmental problems] would seem to be a flexible approach to norm-building that seeks productive interplay with existing institutions.'[43]

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[41] Stokke, Olav Schram, 'A Legal Regime for the Arctic? Interplay with the Law of the Sea Convention'. *Marine Policy*, Vol 31, No 4, 2007, pp. 402-408; AMAP, www.amap.no

[42] 'Arctic climate study reveals impact of industrial soot' www.eurekalert.org/pub_releases/2007-08/dri-acs080607.php

[43] Stokke, op cit.p.

In addition, industrial activity on the continental shelf remains under national jurisdiction, and the coastal states are unlikely to yield much influence to international agreements. An emerging conflict between coastal states due to overlapping claims for the extension of the continental shelf to the North is conceivable, but is not likely to influence petroleum activities in the Barents region directly.[44] But the risk of conflict may help bring forward a legal regime that is internationally accepted. International actors (US, EU and Russia) will be forced to establish mechanisms for settlement of disputes in the region.

A spillover from climate concerns to environmental co-operation can also be expected at the regional level. One example is how environmental risks related to oil transportation along the coast are given priority in a new cooperation agreement signed by the governor of the Murmansk region and the head of the Finnmark county council. The agreement covers the period from 2007 to 2009.[45] Such regional agreements will also have to address challenges emanating from climate change, particularly ice changes and extreme weather. The Norwegian Coastal Administration is also working together with Russian authorities on challenges caused by increased oil and gas marine activity.[46] Again our argument is that climate change awareness will lead to stronger environmental cooperation and standards also on the regional level.

3.2 The National Level

This brings us to the national level. Whereas we argued above that the international climate regime is unlikely to single out specific regions and sectors for emission reductions or special regulations, this line of reasoning does not apply to the national level. It is the states that have taken on commitments, and how they realise their commitments is basically a national political issue. Of relevance here are two states: Norway and Russia. We can rephrase our overarching question in this section thus: Is it likely that *national* climate policies will put particular constraints on oil industry activities in the High North?

On the national political arena, symbols play an important role. The strong symbolic effects of climate change in the Arctic may put pressure on authorities to impose stronger climate regulations in the Arctic than elsewhere. A prime example would be stronger regulations of climate gas emissions in the North than elsewhere on the continental shelf. So far this has not happened, as witnessed in the new government white paper on Norwegian climate policy.[47] More probable perhaps, is that climate concerns also here lead to stronger *environmental regulations* in the North. (This is not to say that stronger regulations are not warranted for non-climate environmental reasons, but that climate concerns may give political energy to stronger environmental regulations in the North than

[44] Hoel, Alf Håkon (2007) 'Climate Change' in *International Cooperation and Arctic Governance. Regime effectiveness and northern region building.* Stokke, Olav S. & Geir Hønneland (ed.) Routledge, New York.

[45] www.sr.se/euroarctic/artikel.asp?artikel=1381674

[46] www.kystverket.no/?did=9103236

[47] St.meld. nr. 34, (2006-2007) Norsk klimapolitikk

elsewhere, all other factors and conditions remaining the same). Political action may of course go beyond regulations; a relevant issue is what areas of the High North will be *opened* for exploration and production.

More environmental restrictions may also foreseeably be brought about indirectly due to climate change. If increased sea temperatures lead to radical changes in the location of fish stocks, improving conditions for fisheries in the Barents Sea, the domestic configuration of interests will be altered. This in turn could lead to a demand for more restrictions on oil industry operations in the north, other factors remaining unchanged. (A similar development on the international level is also conceivable. If climate change seriously damages fisheries in other oceans, the Barents Sea may stand out as an even more important food source, which could mean that concerns for fisheries will receive more weight internationally).

So this is mainly a matter of domestic politics. If oil companies sense that climate concerns in the public are likely to lead to severe limitations on their operations in the North, they may try to forestall such developments by self-imposed restrictions, going further than current regulations to maintain their "license to operate". One idea might be to promote the Arctic as a pilot region for climate friendly oil and gas production.[48]

This line of reasoning regarding national politics applies to Norway. What about Russia? Russia is, like Norway, party to the Kyoto protocol, but most other conditions are different:

1. Russia does not have a strong public awareness of climate problems;
2. the channels that could be used to influence policy, such as civil society and democratic institutions are weak
3. The government itself has shown very little interest in climate policy.[49]

It seems totally unlikely that Russia would impose special climate-based regulations in the Arctic. However, environmental regulations stemming from awareness of climate problems are perhaps not totally unlikely, especially if they can be related to a disaster.

3.3 The Market

The public concern over climate developments in the Arctic may have another possibility to influence oil industry operations in the North in addition to the political institutions on the national level. It may also work through the international marketplace. If international public opinion, with transnational NGOs as an important catalyst, is highly concerned with Arctic climate developments, pressure against oil industry operations in the North might be expressed in consumer preferences. The historical parallel here would be the campaign against Shell caused by

[48] Important here are CO2 capture and zero-discharge.
[49] For a recent overview see Korppoo, Anna and Arild Moe, 'Russian Climate Politics: Light at the End of the Tunnel?' Briefing Paper. London, Climate Strategies, 2007.

human rights concerns in Nigeria and the handling of the Brent Spar buoy. Such campaigns would presumably target companies associated with environmental disasters in the region. Certification of oil products – 'green oil' – guaranteeing that the oil has been extracted in non-controversial areas, is also conceivable.

3.4 Summing up Political Response

A major conclusion here is that *climate policies* are not likely to have a strong direct impact on the operations of oil companies in the north, but that the *climate development* in the North is likely to impact other political processes, public opinion and consumers. In turn they may affect industry operations. Thus there is an *indirect link* between the climate issue and the oil industry in the North. But whereas we believe that the argument for the existence of such links is quite plausible, the *strength* of the impact is very uncertain. This will depend *inter alia* on broader international developments as well as the political situation on the national level.

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