A HIGH NORTH STRATEGY?
An Assessment of Place-Vulnerability in Finnmark County and the Norwegian Government's Policies towards Mitigating Oil Spills in the Barents Sea

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Declaration

I, (name), declare that this thesis is a result of my research investigations and findings. Sources of information other than my own have been acknowledged and a reference list has been appended. This work has not been previously submitted to any other university for award of any type of academic degree.

Signature……………………………….
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Abstract

The objective of this thesis project is to determine how the Norwegian Government aims to mitigate Place-Vulnerability in Finnmark County, Norway from the risk of oil spills imposed by increasing volumes of maritime traffic along the Finnmark Coast in the Barents Sea – as part of its *High North Strategy*. This project reaches this objective by conducting a quantitative analysis of Place-Vulnerability within Finnmark County to determine where and why certain geographical regions are vulnerable. To complete the Place-Vulnerability analysis, separate assessments of Social Vulnerability and Biophysical/Technological Vulnerability towards shipping hazards were conducted utilizing the *Hazards-of-Place* framework for Place-Vulnerability. Once completed, the results from these individual assessments were combined and analyzed to present an overall depiction of Place-Vulnerability within the county. A subsequent qualitative inquiry was conducted to identify specific policies and practices aimed to reduce the risks of oil spills along the Finnmark Coast, adopted by the Norwegian Government as part of its *High North Strategy* over the past decade, and ultimately to estimate whether or not these measures are sufficient towards protecting the Finnmark Coast and mitigating the determined Place-Vulnerability values.

The results of the Place-Vulnerability assessment demonstrate that *all* municipalities within Finnmark County are vulnerable to the adverse socio-economic and ecological consequences of oil spills in its coastal waters. However, by delineating the county into three separate geographical regions, or *Blocks*, this project was subsequently able to determine and compare Place-Vulnerability among and across these regions. The results depict that the western municipalities (Block 3) of Finnmark County are attributed with the highest levels of Social Vulnerability, and that the coastal waters here are additionally the most hazardous towards maritime transport operations. This Block therefore has the highest overall level of Place-Vulnerability. Eastern Finnmark (Block 1) had the lowest levels of Social Vulnerability, but is particularly vulnerable towards shipping hazards, thus resulting in the second highest levels of overall Place-Vulnerability. Central Finnmark (Block 2) was attributed to have the lowest level of vulnerability towards shipping hazards, but the second highest level of Social Vulnerability, which resulted in carrying the lowest level of overall Place-Vulnerability within Finnmark County.

In addition to the Place-Vulnerability analysis, an inquiry into the adopted measures of the Norwegian Government towards reducing maritime shipping accidents and subsequent oil spills was conducted. This research highlights that the Norwegian Government has focused primarily on five priority policy areas to reduce shipping accidents along the Finnmark Coast: An Ecosystem-Based Management Regime within the Barents Sea; New maritime vessel traffic standards, requirements, and surveillance; Increased oil spill preparedness and response systems; Advanced cooperation with Russia in the Barents Sea; and support for the creation and implementation of an IMO Polar Code. Combined, these measures demonstrate a risk reducing effect towards shipping accidents. Ultimately, however, it is estimated that these measures are only sufficient to meet the protection needs of the vulnerable Finnmark Coast at the current volume of maritime traffic. Maritime Traffic in the Barents Sea is projected to increase by approximately five-times the current level by the year 2020. Therefore, additional measures such as further increasing the capacity of emergency response vessels and available equipment, in addition to adopting more stringent vessel certification regulations must be a priority area of the Norwegian Government to combat the increasing risks of oil spills directly correlated to the projected 2020 levels of maritime traffic.

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Oslo, 30.01.2012
Blake James Wergeland

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List of Abbreviations

AC	Arctic Council
ACIA	Arctic Climate Impact Assessment
AIS	Automatic Information System
DNV	Det Norske Veritas
EEZ	Exclusive Economic Zone
EIA	Environmental Impact Assessment
GHG	Greenhouse Gas
GIS	Geographical Information Services
IMO	International Maritime Organization
IOC	International Oil Company
IUA	Inter-Municipal Preparedness Region
KM	Kilometer
LNG	Liquefied Natural Gas
MARPOL	International Convention for the Prevention of Oil Pollution
NCA	Norwegian Coastal Authority
NGO	Non-Governmental Organization
NM	Nautical Mile
NOC	National Oil Company
NOFO	Norwegian Clean Seas Association for Operating Companies
O.E.	Oil Equivalents
PSA	Petroleum Safety Authority
PSSA	Particularly Sensitive Sea Areas
SOLAS	International Convention for the Safety of Life at Sea
SoVI	Social Vulnerability Index
SSB	Statistics Norway
STCW	International Convention on Standards of Training, Certification and Watchkeeping for Seafarers
TROOP	Guidelines for Transfer of Refined Oil and Oil Products in Arctic Waters
UNCLOS	United Nations Convention on the Law of the Sea
USGS	United States Geological Survey
VTS	Vessel Traffic Services

1.0 INTRODUCTION

As a result of rising global temperatures, the Arctic region is undergoing rapid changes that contribute to myriad of environmental, political, and economic issues (West 2008, 2). According to the Arctic Climate Impact Assessment (ACIA), increased concentrations of Greenhouse Gases (GHGs) are contributing to this warming effect, and are having larger and more rapid effects on the Arctic climate (Eskeland 2006, 81). It has been reported that the average temperature in the Arctic has risen almost twice as much as other parts of the world (ACIA 2004, 8; Ocean-Futures 2006). Perhaps one of the largest effects of the increased temperatures in the Arctic is the melting of sea ice cover. The ACIA report concludes that Arctic sea ice has been reduced by approximately 8% over the past 30 years, whereas there are current projections that indicate the Arctic could be entirely ice-free during the summer months over the next 100 years, but as early as in the next 15 (Arctic-Council 2009, 25; Eskeland 2006, 81; Ocean-Futures 2006).

Conversely, a U.S. Geological Survey's Circum-Arctic Resource Appraisal released in 2008, boasts that the Arctic is home to approximately 24% of the world's undiscovered hydrocarbons, of which the USGS Report estimates that 84% of these areas are likely to occur in offshore areas (Bird 2008, 4; Ocean-Futures 2006). These estimates, combined with the dramatic retraction of sea ice, have fueled large speculation that the Arctic is the next frontier for resource extraction activities, or in other terms – the world's next "petroleum province"(Arctic-Council 2009; Ocean-Futures 2006).

Therefore, as sea ice retreats northwards, Norwegian oil companies have shifted their focus from the North Sea towards exploring for new hydrocarbon resources in the South Barents Sea (Pettersen 2011). In a speech in 2011, the Norwegian Minister of Foreign Affairs, Jonas Gahr Støre, stated that, "If Norway were to just drop out [of oil & gas development], there'd be no significant difference in the future, as the world demand will get is supply from other sources" (Støre 2011). Already in 2011, there have been two large oil field discoveries, *Skrugard* and *Havis*, in the South Barents Sea amounting to an estimated 400-600 million barrels of oil (Fouche 2012). The Norwegian oil company, Statoil, projects that additional discoveries await in the near future as its CEO claims that they have "cracked the code" for discovering oil and gas in this region, suggesting that an oil-boom in South Barents Sea is imminent (Fouche 2012).

At the same time, Russia is increasing its interests and presence regarding petroleum resources in their portion of the Barents Sea. In less than a decade, there has been a surge of oil and gas transportation originating from ports in the Russian Barents Sea, from 4 million tons in 2002 to nearly 19 million tons in 2010, as oil terminals continue to increase their processing capacities (Bambulyak 2011, 80). As a result, increasingly larger volumes of petroleum resources are being shipped to European markets along the Finnmark Coast (Bambulyak 2011, 17-24, 80). In addition, once the Shtokmann gas field (the world's largest) comes online, an estimated additional 280 annual shipments of Liquefied Natural Gas (LNG) are expected to pass along the Finnmark Coast during the development's first phase alone (Storeng 2009).

Finnmark County is therefore at the epicenter of development within the Barents Sea Region, as petroleum extraction and maritime transport activities between Norway and Russia are poised to increase ten-fold over the next decade (Karlsbakk 2011). Given its location and its expansive coastline adjacent to the Barents Sea, Finnmark serves as the geographical link between extracting petroleum resources and delivering them to European markets. Increased volumes in hydrocarbon production directly correlate to larger volumes of maritime transport, and all shipping operations sail through the coastal waters along Finnmark County. However, these particular waters are notoriously difficult to navigate, as they are filled with "innumerable small islands, scurries, and rocky shallows" in addition to unpredictable and unique weather conditions (Kristoffersen 2010, 14). Consequently, shipping operations along the Finnmark Coast impose a great risk of accidents at sea, potentially resulting in acute oil spills. Therefore, expanding industrial activities pose *serious* vulnerabilities to the ecological and social welfare of Finnmark.

The Fishing Industry (open sea, aquaculture, and food processing), in particular, is critical to the lifeblood of Finnmark County, serving as a staple of the economy, culture, and livelihoods in the High North (Lindholt 2006; McDonald 2006; Sygna 2004; West 2008). An oil spill resulting from a shipping accident could induce serious harm to the coastal environment and its ecosystem, such as fish stocks and their spawning abilities (O'Brien 2003, 23). Thus, an oil spill would have a substantial economic and social impact on the communities of the High North that depend on these marine resources as part of their livelihoods. Neil Adger, a leading academic on vulnerability posits that, "Where institutions fail to plan for hazards or for changing social conditions and risks, vulnerability can be exacerbated" (Adger 2006). Foreign Minister Støre, however, asserted that the politicians of Norway "must make sure that this type of development [petroleum and maritime transport] doesn't jeopardize the future of this region" highlighting that Norway has the competence and resources "to ensure that commercial activities comply with stringent environmental standards," (Støre 2011).

1.1 RESEARCH QUESTION

Over the past decade, the Norwegian Government has made an effort towards achieving sustainable development towards petroleum and maritime transport operations in the Barents Sea Region. In particular, the government has aimed to achieve such results by mitigating the risks and vulnerabilities associated with these types of industrial operations, as emphasized in its High North Strategy, in which it claims to be its most important strategic policy area (Norwegian-Ministry-of-Foreign-Affairs 2006, 7).

Therefore, this project aims to understand what and where vulnerabilities exist in Finnmark County in regards to maritime petroleum operations, and what exactly the Norwegian Government is doing to reduce these vulnerabilities by asking the following research question:

How does the Norwegian Government aim to mitigate the Place-Vulnerability of Finnmark County from oil spills imposed by expanding maritime transport operations in the Barents Sea?

- What is the Place-Vulnerability of Finnmark County, and where, especially are the most vulnerable areas within the county?

- What specific policies and practices has the Norwegian Government adopted to mitigate these levels of vulnerability, and are they sufficient?

1.2 PLAN FOR THE THESIS

Chapter 2 presents an empirical background of the past, current, and projected state of the Arctic region, with particular focus towards the Barents Sea region, narrowing down to specifically the Norwegian High North. This chapter aims to paint a picture of the Barents Sea region and its ecological importance as well as an environmental impact perspective resulting from global climate change. In addition, Chapter 2 explores how the changing dynamics are presenting new opportunities for development within the petroleum and maritime shipping industries, on both sides of the Norwegian and Russian boundaries of the Barents Sea – demonstrating that the actions of one state directly influences the other, and how both nations are inherently linked through this vast sea area. Furthermore, this chapter addresses the official stance of the Stoltenberg II Government for developing the High North by introducing its policy framework documents for its *High North Strategy* and briefly highlighting and analyzing their key elements.

Chapter 3 introduces the theoretical framework from which vulnerability and risk assessment originate. Sections 3.2 – 3.2.2 specifically highlight the empirical foundations that have spun varying schools of thought in regards to historical approaches towards identifying natural hazards and assessing vulnerability to more contemporary approaches involved with an inquiry into the underlying, or root-causes of vulnerability to hazards, such as societal composition and its influence and affect towards understanding why places and groups are vulnerable in the first place. The latter half of this chapter introduces and unpacks the *Hazards-of-Place* framework for assessing Place-Vulnerability, the central theory adhered to in this project for assessing in Finnmark County.

Chapter 4 outlines the research design and strategy for how Place-Vulnerability is to be assessed for Finnmark County. The first half of the chapter presents the research design and strategy for this particular project, whereas the second half demonstrates the mathematical processes for calculating the quantitative assessment of Social Vulnerability and Biophysical/Technological Hazards Vulnerability – two subsection-calculations necessary to complete the holistic assessment of Place-Vulnerability. Chapter 4 additionally addresses the qualitative research methods, such as case study interviews and allocating secondary data sources, necessary to reflect upon and answer the second research question. Ethical considerations and limitations to the research design and strategy are also addressed in the concluding sections of this chapter.

Chapter 5 presents the results from the quantitative analysis of Place-Vulnerability, essentially answering research *Sub-Question A*. This chapter examines and interprets, in-depth, the results of the Social Vulnerability Index through identifying the specific areas within Finnmark County that carry varying levels of Social Vulnerability. In addition, this chapter displays the results from the assessment of Biophysical/Technological Vulnerability. To achieve these results, a particular focus on historical records of shipping accidents between 1981 and 2011 in the coastal waters of Finnmark County was analyzed to determine values of Hazard Frequency and Hazard Recurrence. Through the use of the Norwegian Maritime Directorate's ship accident database, additional information listed in accident reports were utilized to determine the environmental conditions occurring during each individual accident at sea. From this data, a summary of results as related to a set of unique Arctic environmental conditions (Darkness, Severe Weather, Visibility, Geographical Constraints, and Cold Weather) was further analyzed to depict the nature in which maritime vessels operate off the Finnmark Coast and how these attributes may have affected the accident outcomes. The final section of this chapter combines the results of the Social Vulnerability Index and Biophysical/Technological Vulnerability, as determined through shipping hazards, to achieve the overall results of the Place-Vulnerability assessment for Finnmark County. The results for Place-Vulnerability are additionally broken down by specific location, and extent within Finnmark County and are discussed in the concluding section.

Chapter 6 answers the first part of research *Sub-Question B*, as it identifies the Norwegian Government's policies and actions it has produced over the past decade as part of its *High North Strategy*. Section 6.3 discusses how the Norwegian Government has aimed to mitigate the risks of oil spills along the Finnmark Coast in cooperation with and among the international community through policy developments within the Arctic Council, in which it is a leading member. Sections 6.4 – 6.7 address the Norwegian Government's strategy for reducing maritime risks (and subsequent levels of vulnerability) through specific policies and actions, focusing its efforts first and foremost on oil spill prevention through 5 priority areas: An ecosystem-based resource management regime for the Barents Sea; New maritime shipping traffic standards, requirements, and surveillance systems; Increased capacity among domestic and international oil spill preparedness and response systems; Advanced cooperation with Russia in the Barents Sea in the areas of environmental protection, technological monitoring and surveillance, and increasing overall Arctic security; and its strong support for the creation and implementation of an IMO Polar Code – an internationally binding set of technical and environmental regulations for ships operating in Arctic waters.

Chapter 7 concludes on the results of the Finnmark Place-Vulnerability analysis, the policies and practices the Norwegian Government has adopted to reduce risk and vulnerability, and comments on whether or not these actions are sufficient to reduce vulnerability and prevent oil spills in Finnmark's coastal waters as the volume of maritime transport increases over the next decade.

2.0 BACKGROUND

2.1 THE BARENTS SEA REGION

The Barents Sea Region is a vast area with an average depth of 230 meters, from the Norwegian Sea in the west to the coast of Novaya Zemlya in the east, and from the northern coasts of Norway and Russia in the south to the Svalbard and Franz Josef Land in the north. Additionally, the western Kara Sea, the eastern Greenland Sea, and the northeastern portion of the Norwegian Sea surround it. The total surface area of the Barents Sea is approximately 1.4 million km^2, which is the equivalent of roughly 7% of the total surface area of the Arctic Ocean (Arctic-Council 2009, 23; Behrens 2004, 16).

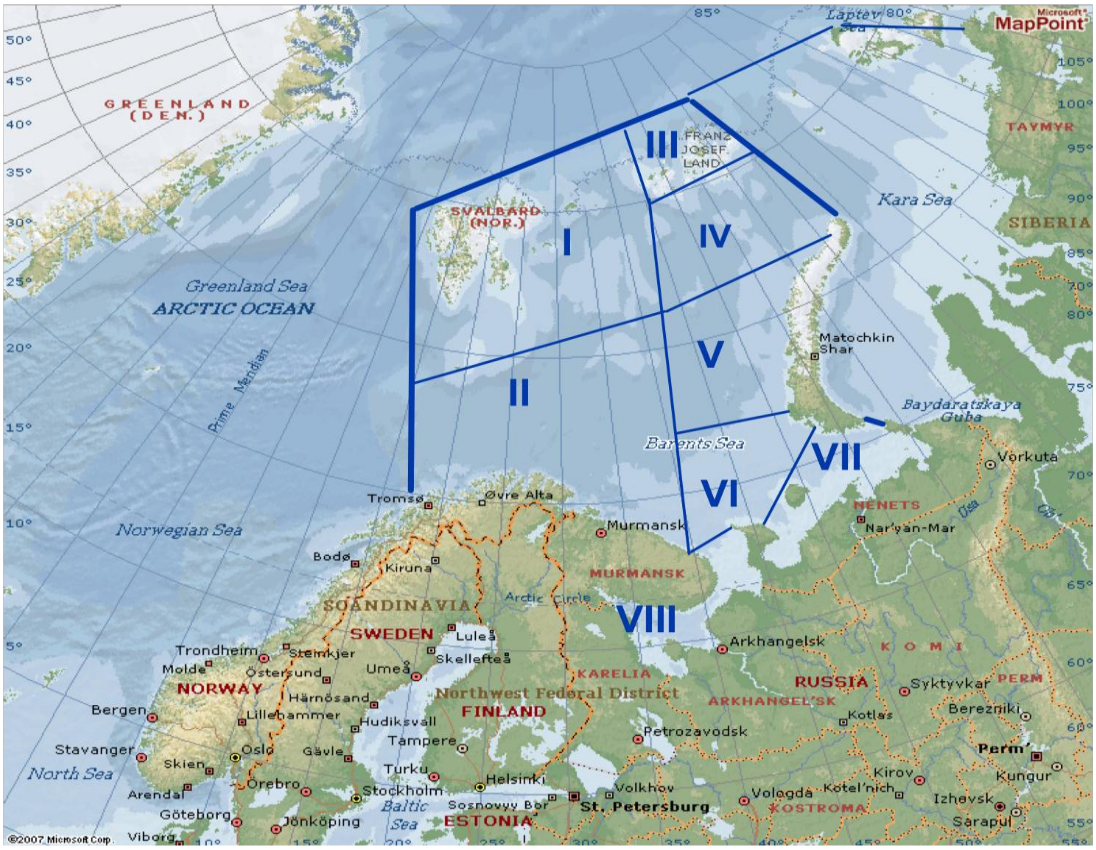


Figure 1: Map of the Barents Sea. Source: (Det-Norske-Veritas 2008, 61)

Ecologically, it is home to one of the most productive ecosystems on the planet, supporting rich stocks of fish, mammals, and birds (Norwegian-Ministry-of-Foreign-Affairs 2010-2011, 21-50). This is due to its location that allows for a unique blending of seawaters, from both the Atlantic and Arctic Oceans. This mixing of waters produces the perfect conditions for significant primary and secondary production of phytoplankton and zooplankton, which form the basis for sustaining the large populations of fish, mammals, and birds (Behrens 2004, 21). In terms of fish, this region supports capelin, northeast Arctic cod, and Altanto-Scandinavian herring stocks that are ecologically pertinent and economically lucrative (Behrens 2004, 21; Norwegian-Ministry-of-Foreign-Affairs 2010-2011, 32-35). The mammals present in this region include seals, walrus, whales, and polar bears. Additionally, this area is regarded as an important breeding and summering ground for international seabirds, of which approximately 5.4 million pairs breed annually (Behrens 2004, 31-31; Norwegian-Ministry-of-Environment 2005-2006, 26; Norwegian-Ministry-of-Foreign-Affairs 2010-2011, 36-37).

In the economic sense, this region is lucrative for the Fishing Industry. The Barents Sea accounts for approximately 5% of the world's total catch and 20-30% of the catches in the North Atlantic (Behrens 2004, 32-33; Norwegian-Ministry-of-Environment 2005-2006, 35-38). Additionally, it serves as the main location for the Norwegian Aquaculture Industry where some 436,736 tons of Atlantic Salmon were reared in the year 2000 (Behrens 2004, 35). In terms of employment, nearly 50% of all fishermen in Norway reside in this area and approximately 20,000 people hold fishing-related jobs as their main occupation – as this industry in one of the main sources of employment along the Northern Norwegian Coast (Behrens 2004, 35; Norwegian-Ministry-of-Environment 2005-2006, 52). Other significant industries that operate in the Barents Sea Region are the Petroleum and Maritime Transport Industries. Both of these industries are expected to increase their presence and activities in the near to long-term future, as the Barents Sea is under exploration for offshore hydrocarbon resources (Behrens 2004, 5; Norwegian-Ministry-of-Foreign-Affairs 2011, 15).

2.2 A CHANGING CLIMATE

The climate of the Arctic is undergoing dramatic changes. This is largely due to the effects of Global Warming, or the collective warming of the earth's surface temperatures, as a function of increasing levels of carbon dioxide (CO_2) in the Earth's atmosphere. The effects of global warming have resulted in changing climates across the planet, but nowhere else has the effect been observed and felt more than in the Arctic (Eskeland 2006, 81).

In fact, the Arctic Climate Impact Assessment (ACIA) report of 2004 concludes that average temperatures in the Arctic have increased nearly twice as much over the past few decades in comparison to other parts of the world (ACIA 2004, 8). Additionally, it has been reported that many of the findings in the ACIA report, which were confirmed in the fourth assessment report of the Intergovernmental Panel on Climate Change (IPCC) in 2007, largely underestimated these accelerating changes in the Arctic due to global warming and climate change (Støre 2009). Norwegian Foreign Minister, Jonas Gahr Støre, and former US Vice-President, Al Gore, have stated that "Data shows that [Arctic] climate change has occurred at an even more rapid speed than indicated by the most pessimistic scenarios in the ACIA and IPCC reports in several areas" (Støre 2009).

Therefore, the effects of increasing Arctic temperatures have induced profound changes in the Arctic environment. Many of the effects of these changes have global implications, such as ozone depletion and further impact on global warming, due to the thawing of Arctic permafrost and the subsequent release of trapped methane (CH_4), a potent greenhouse gas stated to be 23 times more powerful than CO_2 (ACIA 2004, 38). Additional impacts of a warming Arctic climate results in a reduction of the albedo effect, or the reflection of UV Rays back into space, and a significant reduction or shutdown of the thermohaline cycle, which drives global ocean currents, such as the Gulf Stream (ACIA, 34-35, 36-37, 43). All of these changes directly contribute to the melting Arctic of snow and sea ice.

Arctic sea ice cover, specifically, is one of the most important variables of climate change in the region. According to the ACIA report, sea ice is a "key agent and indicator of climate change," and has an effect on "surface reflectivity, cloudiness, humidity, exchanges of heat and moisture at the ocean surface, and ocean currents" (ACIA 2004, 30). One of the main findings in the ACIA report concludes that sea ice in the Arctic has decreased by approximately 8%, or the entirety of Scandinavia, over the past 30 years (ACIA 2004, 25; Norwegian-Ministry-of-Environment 2005-2006, 70). Furthermore, it is projected that sea ice cover will continue to decrease in the coming years, with some models projecting an ice-free Arctic as early as the year 2040 (Arctic-Council 2009, 25).

The extent of summer sea ice cover is, however, another pertinent factor in overall Arctic climate conditions. The retraction of sea ice is a normal function during the summer months, as the region is exposed to longer periods of sunlight and higher average temperatures (ACIA 2004, 25). However, as Arctic temperatures increase as a result of global warming effects, more and more summer sea ice cover has retreated northwards during this period. The ACIA report indicates that decreases in summer sea ice are considerably greater than the annual average, and are projected to decrease by some 50% by the year 2100 (ACIA 2004, 83; Arctic-Council 2009, 25). There are additional models that report that the Arctic could be entirely ice-free during the summer months in the next 100 years, but even as early as in the next 15, as average temperatures in this region are projected to increase by 7 to 10 degrees Celsius annually over the ocean areas (ACIA 2004, 28-30; Arctic-Council 2009, 25). The combination of higher average temperatures and larger extents of summer sea ice melt contributes greatly to the reduction in the formation of new sea ice during the winter months. In fact, satellite photography showed that a record minimum of sea ice was present in September 2007 (Brigham 2009, 2). In other words, sea ice seems to be on a path towards continual reduction in terms of both total mass and overall thickness (ACIA 2004, 25).

In addition to the aforementioned global effects, the loss of Arctic sea ice is likely to have widespread effects among the region itself. According to the report *Climate Vulnerability in the Barents Sea Ecoregion: A Multi-Stressor Approach*, decreases in sea ice cover will "alter the seasonal distributions, geographic ranges, patterns of migration, nutritional status, reproductive success, and ultimately the abundance and balance of species" (O'Brien 2003, 1). The report further suggests that these changes will ultimately influence the "entire food chain, from mammals to benthos" (O'Brien 2003, 1). Another report states that in Norway, specifically, these changes may have a direct effect on key fish species such as cod, capelin, and herring – stocks that are critical to the lifeblood of the Fishing Industry (O'Brien 2006, 52).

2.3 NEW OPPORTUNITIES

The changing environmental conditions have therefore created new opportunities for both the Petroleum and Maritime Transport Industries in the Barents Sea. As the sea ice retreats further north, the focus among the Petroleum Industry in Norway has begun to shift from the North Sea towards developing new oil and gas fields in the South Barents Sea (Pettersen 2011). Subsequently, traffic volumes among the Maritime Transport Industry have increased in direct correlation to the Petroleum Industry over the past decade (Bambulyak 2011, 83).

2.3.1 NEW PETROLEUM OPPORTUNITIES

In 2008, an updated version of the U.S. Geological Survey's Circum-Arctic Resource Appraisal reported that approximately 90 billion barrels of oil, 1,669 trillion cubic feet of natural gas, and 44 billion barrels of natural gas liquids are yet to be discovered in the Arctic (Bird 2008, 1-4). These estimates boast that the Arctic is home to approximately 24% of the world's undiscovered hydrocarbons, of which the USGS report estimates that 84% of these resources are likely to occur in offshore areas (Bird 2008, 1-4; Ocean-Futures 2006). These estimates, combined with the dramatic retraction of sea ice, have fueled large speculation that the Arctic is the next and last frontier for resource extraction activities, or in other terms – the "world's next petroleum province" (Arctic-Council 2009; Ocean-Futures 2006).

Of this vast amount of undiscovered hydrocarbons, Barents Russia projects to claim approximately 27.8 billion tons of oil equivalents (O.E.), representing 5% of the country's oil resources and approximately 19% of its gas reserves (Ocean-Futures 2006). An additional approximation of 830 million tons of oil equivalents await discovery on the Norwegian side of the Barents region (Ocean-Futures 2006). Therefore, the Oil and Gas Industry across both countries are extremely interested in the potential for future hydrocarbon extraction activities in this area.

Currently, there is no offshore petroleum production in the Russian parts of the Barents Sea region. However, the giant offshore field, Shtokman, projects claims of approximately 3.7 trillion cubic feet of natural gas, and more than 37 million tons of gas condensate (Ocean-Futures 2006). The development of this field has been off and on, as internal disputes between Russian national oil companies (NOCs), International oil companies (IOCs), the Russian government and its politics, international market fluctuations, and technological and environmental operating concerns have plagued the progress of its development (Nilsen; Pettersen 2011). Therefore, the operational date of this field continues to be pushed into the future, but it's likely that this field will be up and running in the next 10-30 years (Ocean-Futures 2006).

The Norwegians have already begun activities in the Barents region with the opening of Snøhvit, the Liquefied Natural Gas plant at Melkøya, in 2007, off the coast of Hammerfest. Additionally, a massive discovery of the oil field, Skrugard, (April 2011) claims that an approximate 150-200 million tons of oil equivalents lay 200 Nautical Miles (NM) north of Finnmark county. The Norwegian oil company, Statoil, claims that this is "one of the most important events on the Norwegian continental shelf in the last 10 years" (Nilsen 2011). Even more recent, another Norwegian company, Det Norske Veritas, reported that it found a field, Norvarg, consisting of approximately 63-315 million tons of oil equivalents in the Barents Sea (Pettersen 2011).

The future development of these offshore hydrocarbon fields on both sides of the maritime border in the Barents Sea will significantly impact the economy and increase industrial activities in the region. In terms of getting these resources to market, extraction is only half of the picture. The other half, which is intrinsically related to the Petroleum Industry, is ensuring the safe transportation of these resources to their respective destinations. Therefore, an increase in exploitation of resources directly contributes to a subsequent increase in the overall levels of transportation.

2.3.2 NEW MARITIME TRANSPORT OPPORTUNITIES

The key towards getting these offshore hydrocarbon resources to market will derive from a considerable increase in the overall volume in maritime transport. One of the main findings in the ACIA report is that, "Reduced sea ice is very likely to increase maritime transport" (Arctic-Council 2009, 28; Molenaar 2009). This report concludes that sea ice will continue to retreat northwards and away from Arctic land masses, strengthening existing shipping routes and possibly opening new ones. Warmer average temperatures in the region will also contribute to an extended shipping season during the summer months to approximately 90-100 days, with the potential of as much as 150 days with icebreaker capacities) by the year 2080, a figure 3 to 5 times longer than the 2004 summer shipping season in the Arctic (ACIA 2004, 83; Arctic-Council 2009, 25).

2.3.3 INTRA-ARCTIC SHIPPING

The majority of Arctic shipping is intra-Arctic, or destination-based to and from existing ports. This is especially the case in the Barents Sea region between Russia and Norway. Currently, the majority of international maritime traffic in this region is to and from the Russian ports of Murmansk, Arkhangelsk, and Vitno, and the Norwegian ports in Kirkenes and Hammerfest, where petroleum-based resources are a sizeable percentage of the total cargo (Bambulyak 2011).

In addition to a regular presence among the Fishing Industry, small tankers transporting a low volume of crude oil have historically contributed to the overall maritime traffic in this region (Arctic-Council 2009, 75). Over the past decade, however, there has been an increase in the overall number of oil tankers and their carrying capacity from these ports. In 2002, approximately 170 tankers made voyages carrying a total of 4.2 million tones of petroleum-based cargo. In 2003, 240 tankers transported approximately 8.4 million tones of petroleum-based cargo (Dragsun 2003, 2). In 2004, approximately 12 million tones of petroleum-based cargo was transported over 290 tankers (Norwegian-

Ministry-of-Environment 2005-2006, 45). It is now projected, however, that the volume of exported petroleum-based cargoes are to increase to approximately 36 million tones involving more than 400 tankers from Norwegian ports alone, with Russia adding an additional 80 million tones of crude oil over 650 tanker voyages by the year 2015 (Dragsun 2003, 7 ; Norwegian-Ministry-of-Environment 2005-2006, 45).

This largely coincides with the projected increase in offshore petroleum production in Norway waters in addition to higher levels of onshore petroleum production in Russia being exported via tankers on the Barents Sea. In a scenario where offshore Russian field (such as Shtokman) resources are to be produced, or for example, a pipeline connecting Siberian oil fields to Murmansk, the total volume of exported petroleum-based maritime cargo from Russia alone has the potential to reach 150 million tons in the region beyond the year 2015 (Norwegian-Ministry-of-Environment 2005-2006, 45). Such a scenario implies a dramatic increase in both the volume of tanker traffic and the carrying capacities of the tankers themselves. The current cargo capacity of oil tankers operating in this region is between 15,000 and 100,000 tones, but they are projected to increase to 300,000 tones per tanker under such a scenario (Norwegian-Ministry-of-Environment 2005-2006, 45). This type of scenario will also see an increase in support, supply, and other commercial vessel traffic related to Petroleum Industry operations (Norwegian-Ministry-of-Environment 2005-2006, 45). Therefore, as the Petroleum Industry develops and expands, so too will the Maritime Transport Industry in this region. Subsequently, a higher volume of marine shipping traffic directly increases the risk of oil spills and the environmental and social vulnerability of Finnmark County.

2.4 THE NEW "HIGH NORTH"

In light of the offshore developments in the Barents region over the past decade, there has been considerable attention paid to the region at levels unseen since the end of the Cold War. Historically, the Barents region was a strategic front zone for Cold War operations – the border between Norway and Russia serving as the divide between the Eastern and Western worlds. Here, there were much high-tension debates over the operations of nuclear powered submarines and their capabilities to reach either side of the "Iron Curtain" with long-range cruise missiles; over striking the balance between deterrence and reassurance (Young 2009). Long gone, however, are the days of the proverbial "mouse in bed with a bear," point of view, at least in terms of security issues in the Arctic (Norwegian-Ministry-of-Foreign-Affairs 2006, 14) .

Most recently, there has been a considerable amount of attention paid to the Arctic after the publishing of the USGS report on the vast amount of undiscovered natural resources in the region. There have even been notions among popular media dedicated to the premise of an "Arctic Black Gold Rush," where the world's Arctic nations will scramble to define and defend every inch of valuable Arctic territory (Borgerson 2008). Instead, however, through the apparatus of the Arctic Council, the five littoral Arctic states (Norway, Russia, USA, Denmark (via Greenland), and Canada) have asserted, by means of the Ilulissat Declaration of 2008, that they are committed towards the legal framework set in place by the United Nations Convention on the Law of the Sea (UNCLOS) to solve any and all territorial disputes in the Arctic region, thereby squandering any notion of an all-out resource war in the region. In light of that, especially in regards to Norway and Russia, peace and cooperation, environmental conservation, and sustainable development is the goal instead (Norwegian-Ministry-of-Foreign-Affairs 2011).

2.4.1 NORWEGIAN HIGH NORTH POLICY TAKES SHAPE

In 2005, the newly formed Stoltenberg II Government sat down and drafted its policy priority areas in a document referred to as the *Soria Moria Declaration*. In this declaration, the newly formed Government created the foundations for a policy for the northernmost areas of Norway, with energy, security, and the environment as core tenets – stating that,

> "The Government regards the Northern Areas as Norway's most important strategic target area in the years to come. The Northern areas have gone from being a security policy deployment area to being an energy policy power centre and an area that faces great environmental policy challenges. This has changed the focus of other states in this region. The handling of Norwegian economic interests, environmental interests and security policy interests in the North are to be given high priority and are to be seen as being closely linked" (Offerdal 2010; Stoltenberg-II-Government 2005).

The Stoltenberg II Government thereby has worked since 2005 to lay the framework conditions for the "Oljeeventyr" (the Norwegian Oil Adventure) to move north. Shortly after the *Soria Moria Declaration*, the new Minister of Foreign Affairs, Jonas Gahr Støre, announced the creation of the program *Barents 2020* (Offerdal 2010; Støre 2005). Støre stated that the purpose of this program is "intended to function as a link between international centers of expertise, academic institutions, and business and industry in the countries that are interested in the High North," and furthermore, "to find new Russian and Western partners for Norwegian-led development projects in the High North" (Støre 2005). Essentially, the Barents 2020 program served as a means for carrying out an environmental and technical assessment of the known issues revolving around potential future petroleum and marine transport activities in the Northernmost areas of Norway before they occur (Barents-2020 2006).

In 2006, the Stoltenberg II Government released their strategy for the High North. Their report, *The Norwegian Government's High North Strategy*, aims to communicate that the "Government's overall objective is to create sustainable growth and development in the area through more extensive international cooperation on the use of natural resources, environmental management, and research" (Norwegian-Ministry-of-Foreign-Affairs 2006, 2006). In essence, this report clearly lays out the policies of which the government will introduce and implement over the coming years, in regards to the development of petroleum resources and environmental safeguarding of the region. The government emphasizes that petroleum developments will occur, yet the protection of the Arctic environment must be of high priority (Norwegian-Ministry-of-Foreign-Affairs 2006).

In 2006, the Norwegian Ministry of the Environment drafted and presented the White Paper *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas of the Lofoten Islands* to the Norwegian Parliament. In this report, the Ministry identified key areas of vulnerability and levels of risk associated with increasing industrial activities in the High North. This report asserts that all current and future activities occurring in this region must adhere to an ocean-based ecosystem management regime, in which all parties of interest operating in the region (Petroleum, Maritime Transport, and Fishing Industries) must work together in harmony towards achieving sustainable development for the vast and various resources present, while simultaneously the structure, functioning, productivity, and ultimately the biodiversity of the ecosystems of the area (Norwegian-Ministry-of-Environment 2005-2006, 15). It therefore calls for stringent environmental standards across all active industries with the primary focus of safeguarding the environment in which they operate. Furthermore, the report identifies particularly sensitive areas within the region in which the standards set forth are even more stringent, especially in relation to petroleum and marine transport activities (Norwegian-Ministry-of-Environment 2005-2006, 53).

In 2009, the Stoltenberg II Government released an updated version of their strategy, titled *New Building Blocks in the North: The Next Step in the Government's High North Strategy*. In this report, the government addresses that many of the 22 action points in the first report of 2006 have been implemented and carried out. They stress that the work in the High North is not finished and this policy initiative will continue to be updated and strengthened as time progresses.

The importance of these policy initiatives is numerous. First and foremost, the Norwegian government is clearly communicating that it has every intention of promoting offshore hydrocarbon extraction and transport and fostering in a new era of the Oil Adventure in the High North. This is significant, considering that it has been reported that oil resources in the North Sea have reached peak production levels (Norwegian-Ministry-of-Foreign-Affairs 2005-2006). Therefore, the government is focusing on the new frontiers in the Barents Sea region to supply the growing global demand for petroleum and maintain its status as the world's 3rd largest exporter of this resource (Norwegian-Ministry-of-Petroleum-and-Energy 2011). Norway is additionally the 2nd largest exporter of natural gas to the European Union and developing resources in the Barents Region provides the opportunity for sustaining this level well into the future (Norwegian-Ministry-of-Petroleum-and-Energy 2011).

Additionally, the Norwegian government has attempted to lay the framework conditions and groundwork for increasing industrial activities and the spinoff effects these activities will induce on the economy of the region. These spinoff effects include values generated by the natural resources in the form of jobs, competence, and activities (Norwegian-Ministry-of-Environment 2005-2006, 42) Foreign Minister Støre, in regards as to why the High North remains the government's highest priority area, recently stated that, "There is future in the North. The Petroleum Industry is an industry for the future, and the Norwegian Petroleum Industry is moving north," and additionally that, "There are great opportunities in the North: economic growth, employment, and welfare. Through knowledge, activity and presence we build with our High North policy strategic capacity that allows us to meet the new challenges and opportunities" (Støre 2011).

2.4.2 COOPERATING WITH RUSSIA

Furthermore, the *High North Strategy* emphasizes that the Norwegian Government is striving to work in cooperation and partnership with Russia in order to achieve sustainable development for the Barents Region as a whole.

The largest political hurdle towards a higher level of cooperation in the Barents region between Norway and Russia was the disagreement over overlapping maritime claims the Barents Sea (Karlsbakk 2010). This particular area was the result of a decades long maritime border dispute between the two countries. The Norwegians argued that the maritime border should follow the *Median Principle*, or that the boundary should be an extension of the land border northeastern into the Barents Sea. The Russians, however, argued for the

Sectoral Principle, where the maritime border would start at the land border between the two nations and run directly north to the North Pole (Østerud 2011). This dispute was, however, laid to rest on September 15th, 2010 with signing of the *Treaty Concerning Maritime Delimitation and Cooperation in the Barents Sea and the Arctic Ocean*, and the new maritime border is the result of a 50-50 compromise of the total area of debate (Brigham 2011). Both sides were eager to end the 40-year dispute and focus on a new cooperation towards developing hydrocarbon resources in the Barents Sea region (Karlsbakk 2010). The result has lead towards advanced cooperation between the two states, and solidified the framework for cooperation on joint energy extraction and marine transport projects and guidelines in addition to new environmental standards, regulations, and compliance mechanisms for the Barents Sea region (Norwegian-Ministry-of-Foreign-Affairs 2011, 9-11).

2.5 THE BIG PICTURE

Ultimately, The Norwegian Government claims to be responsible for the protection of the vulnerable Barents Sea region for the good of the planet (Norwegian-Ministry-of-Foreign-Affairs 2009, 7) . However, protection of this environment cannot be restricted only to the Norwegian side of the maritime border. The Norwegian Government therefore recognizes that it must work in cooperation with Russia in order to achieve the preservation and sustainable development of this region as a whole, as there is no “environmental border” in the region between the two states, where the actions of one state directly contributes to the effects in the other.

With that in mind, increasing petroleum and maritime transport activities in the Russian sector of the Barents region directly affect both the region as a whole, but also the Northern Coast of Norway specifically. This is largely attributed to the projected increase in maritime traffic volume transporting hydrocarbons along the northern coast of Norway, associated with the expansion of Russia’s onshore and offshore Petroleum Industry, as previously mentioned. Higher volumes of traffic equate to higher levels of risk of acute oil spills along the coast of Norway by means of ship groundings or collisions at sea, of which they are ten times more likely to occur than that during petroleum exploration or production activities (Dragsun 2003, 1). Environmental harm is much greater from acute oil spills during transport activities due to the proximity of vessels to the shore, where the most vulnerable resources and ecosystems lay. Therefore, oil spills and discharges from Russian vessels will have considerable consequences on the coast of Norway, especially when considering the projected increase in cargo carrying capacity for each tanker.

Russian offshore technological capacities, expertise, and environmental standards are commonly viewed as lackluster. On the other hand, the Norwegian Petroleum and Maritime Shipping Industries are regarded as being the leading expertise of offshore operations, and Norwegian environmental and operating regulations are comparatively considered to be the most stringent in the world. In light of this, it is of the highest priority of the Norwegian Government that it works in cooperation and partnership with Russia to increase its offshore technology capacities, expertise, and environmental regulation frameworks in an effort to lower the risks associated with offshore hydrocarbon activities and the potential negative effects they have on the Norwegian coast, its marine-affiliated industries, and the environment of the region as a whole (Norwegian-Ministry-of-Foreign-Affairs 2011, 9-11).

Even with the ambitious policies presented by the Norwegian Government for sustainable development in the Barents Sea region, many risks and vulnerabilities exist due to the operations taking place. Acute oil spills attributed to human error, whether by petroleum production or transport, are always possible. As a result, vulnerabilities to the local and global environment, the Norwegian coastline, marine-affiliated industries, and the livelihoods of the people in the High North are always present as long as these activities occur. This project therefore focuses on identifying the vulnerability that exists along the Finnmark Coast and inquiring into what pragmatic mitigation policies and actions the Norwegian Government has adopted, and the extent to which they are sufficient.

3.0 THEORY

3.1 UNDERSTANDING VULNERABILITY

In a broad sense, vulnerability is described as “the degree to which a system, subsystem, or system component is likely to experience harm due to exposure to a hazard, either a perturbation, stress, or stressors” (Turner II 2003, 1). However, it is pertinent to note that within the academic realm of vulnerability research, there exists not one universal theory or model towards defining, measuring, or understanding vulnerability (Adger 2004, 28). Instead, *vulnerability* is defined, interpreted, and applied in varying ways, dependent on differing social and environmental contexts, and over a range of disciplines within the field, all containing their own set of ontologies, definitions, and methods (Hufschmidt 2011, 621). Susan Cutter, a renowned expert in the field of vulnerability studies, points out that, “many of the differences in the meanings of vulnerability arise from different epistemological orientations (political ecology, human ecology, physical science, spatial analysis) and subsequent methodological practices” (Cutter 1996, 530). To that end, there has been an evolution of the term and its approach within this academic field and there is a myriad of varying definitions of vulnerability, from simple in nature to complex and multi-faceted[*].

Much like the definitions of vulnerability, there has been an evolution in conceptual models and frameworks over the past 70 years towards understanding vulnerability itself, in addition to explaining what conditions contribute to hazards, risk, and disasters.

3.2 THE FOUNDATIONS OF VULNERABILITY EMERGE

Originally, it was the work of Gilbert F. White during the 1940s that created the foundation towards beginning to understand the human occupancy of hazard zones, the range of societal adjustments available for reducing impact, and the

[*] For an extensive list of the evolution of vulnerability definitions, see: Cutter, Susan L. 1996. Vulnerability to Environmental Hazards. *Progress in Human Geography* 20 (4): 529-39.

social acceptance of the risks associated with placing human lives and livelihoods in harm's way (Cutter 2009, 4). From this background, White developed the Risk/Hazards approach towards understanding vulnerability, which ultimately tried to explain the relationship between people who lived in hazardous areas and the phenomena, or drivers, that contributed to natural hazard events and the degree of loss attributed to such events (Cutter 2009, 4). In other terms, the Risk/Hazards approach assumed that natural events are inevitable, and the proximity of groups of people to such hazardous areas greatly influenced and increased their level of vulnerability towards loss. Therefore, in order to combat loss from natural hazards, individual persons, groups, or communities must adjust to their surroundings in order to reduce their level of vulnerability. Adjustments were considered to be purposeful actions, such as the building of dykes, dams, or irrigation ditches (to combat flood-prone areas), or the structural design of buildings (to resist the effects of earthquakes) (Hufschmidt 2011, 623). In other words, the Risk/Hazards approach developed a *cause-effect* paradigm, based on the proximity of those affected to the hazard source, and focused solely on natural events as the cause contributing towards varying levels of vulnerability. This paradigm served as the bedrock for vulnerability and hazards studies, and prevailed for three decades before other researchers began to address the possibility of other root-causes (such as anthropocentric drivers) towards vulnerability, which ultimately evolved into two differing Schools of thought (Cutter 2009, 4).

The new focus on anthropocentric drivers developed in the 1970s and served as a departure from the Risk/Hazards approach as the sole model for explaining vulnerability. However, two varying schools of thought evolved as a subset towards explaining the relationship between human activity, hazards, and loss: The *Human Ecologist* or "Chicago School," and the *Structural View* School.

3.2.1 HUMAN ECOLOGIST (CHICAGO) SCHOOL OF THOUGHT

In essence, the *Human Ecologist* School is not a dramatic departure from the Risk/Hazards approach that dominated within the field for the previous 30 years. This School maintained the predisposition that natural hazard events are inevitable and that the vulnerability of a group or community depends on its ability to adjust to its surroundings through purposeful human activity intended to reduce negative impacts (Hufschmidt 2011, 623). However, the primary contribution of this School is focused on the temporal scales of human activity. In other words, the School posited a differentiation between human activity intended to reduce negative impacts into that of adjustment and adaptation. Adjustments, as mentioned previously, are purposeful human actions, such as the building of dykes, dams, or irrigation ditches towards combating a natural event. However, it was seen that adjustments are short term, or one-time activities towards reducing vulnerability. The School therefore introduced the concept of adaptation in contrast to adjustment. Adaptation infers human activities as a long-term response intended to reduce negative impacts. These include an ongoing and evolving implementation of new technologies (levees, slope stabilization), introducing and enforcing building codes, offering insurance schemes, establishing warning systems, and focusing on planned land use (Hufschmidt 2011, 624). Development within this School focused on and promoted the theme of adaptation, as opposed to simple adjustments. Again, much like the Risk/Hazard, this model assumed that natural events are inevitable, however, it posited that negative impacts occur primarily due to the inability of human-induced adaptation activities. In such a stance, criticisms of this model arose due to the nature that the model stood to be solely a reactive, or a learning approach towards reducing vulnerability only *after* a hazardous event has occurred. While this School focused on the human element, it neglected human living and community development conditions that contributed towards vulnerability levels, by focusing solely on altering the physical elements in a place that contributed towards combating loss from hazardous events. This led to the opposing development of the *Structural View* School in the 1970s.

3.2.2 STRUCTURAL VIEW SCHOOL OF THOUGHT

The development of the *Structural View* School arose in opposition to the core beliefs and elements associated with the *Human Ecologist* School. However, much like the *Human Ecologist* stance, adaptation to hazards was seen as a key element for reducing risk and vulnerability. The difference was, however, that the *Structural View* incorporated a more holistic approach towards mitigating vulnerability levels and the negative impact of hazardous events. It did so by shifting the focus towards the barriers that restrict access to necessary resources in order to implement adaptation activities, such as the social, economic, cultural, and political contexts in which people live their everyday lives (Hufschmidt 2011, 625). Thus, this represented a stark opposition to the sole focus on physical adaptations to the natural surroundings of a particular area that the *Human Ecologist* School emphasized at its core. Additionally, this School challenged the position that adaptations occur retrospectively and focused instead on the conditions present *before* an event occurs, or that allow for an event to occur in the first place. In essence, this School took a deeper look into the social fabric of a group or community, began identifying various social variables (such as socioeconomic status) and attributed the results of these variables as the root-causes that allowed for vulnerability to exist, in combination with, but separate from the physical adjustments necessary to reduce negative impacts (Hufschmidt 2011, 625). In other words, this approach applied more of a anthropological method towards understanding vulnerability and explaining why events had differing impacts within a community itself, and interpreted these findings to be the underlying causes leading up to, and in the aftermath of a hazardous event. This School therefore laid the foundations for the development of Social Vulnerability within the field of hazards studies.

3.2.3 SOCIAL VULNERABILITY

The focus on *Social Vulnerability* within hazards studies derived as a continuation from the *Structural View* School. Vulnerability within this School is also interpreted as a result of structural factors that make communities and societies at-large susceptible to damage from hazardous events (Adger 2004, 28). However, it is the predisposition of this approach that hazardous events and disasters are socially constructed and the causal explanations of vulnerability are often remote from the initiating hazard event itself – where the event itself should not be seen as random or independent (Cutter 1996; Morrow 1999, 534; 1).

A broad definition of Social Vulnerability is "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist, and recover from the impact of a hazard" (Holand 2011, 2). Additionally, Social Vulnerability is portrayed as an "inherent property of a human system before a potential event, independent of exposure to hazard" (Holand 2011, 2). Therefore, varying levels of Social Vulnerability contribute towards greater or lesser impacts of the event itself, in addition to the ability to recover in the aftermath.

Social Vulnerability research aims to look deep into the human systems, or "social fabric" of a community or society to uncover the underlying causes contributing to greater or lesser negative impacts. In doing so, this approach has identified key contributors, or indicators of at-risk groups that contribute towards increasing or decreasing the overall Social Vulnerability of a particular place. These categories largely include lack of access to resources, limited access to political power and representation, social capital, beliefs and customs, building stock and age, special-needs populations, and type and density of infrastructure and lifelines (Cutter 2003, 245). More specifically, however, Social Vulnerability can be reduced and attributed to key indicators such as those listed in *Table 1*

Population Indicators

- Total Population of a Place
- Population of Infants
- Population of Children (under 18 years of age)
- Population of the Elderly
- Population Density
- Population: Urban vs. Rural

Race and Ethnicity Indicators

- Immigrant Population

Gender Indicators

- Female Population

Housing

- Number of Housing Units
- Quality of Housing Stock

Socioeconomic Indicators

- High Household Income
- Low Household Income

Employment Indicators

- Employed Population
- Unemployed Population
- Population Employed in Vulnerable Industries

Education Indicators

- Low Education Levels
- High Education Levels

Family Structure Indicators

- Large-Family Households
- Single-Parent Households

Special-Needs Population Indicators

- Persons Receiving Pensions
- Persons Receiving Various Social Assistance
- Nursing Home Population
- Assisted Living Population

Table 1: Common Social Vulnerability Indicators. Source: (Cutter 1996, 10; 2000, 245; 2003, 726; Morrow 1999)

While each of the varying Schools (*Human Geologist, Structural View, Social Vulnerability*) have developed their own frameworks for identifying and monitoring vulnerability from the 1970s, the *Hazards-of-Place* framework for vulnerability came into fruition in the late 1990s. This particular framework incorporates elements from both the *Human Ecologist* (physical environment) and *Structural View* Schools (cultural and political contexts, Social Vulnerability).

3.3 THE HAZARDS-OF-PLACE FRAMEWORK FOR VULNERABILITY

The *Hazards-of-Place* framework for vulnerability was created and developed by Susan Cutter, beginning in 1996 with her work "Vulnerability to Environmental Hazards" (Cutter 1996). It is in through this framework where another paradigm shift occurs in the hazards studies field. In the *Hazards-of-Place* framework, Cutter focuses on the hazardousness of particular places, based on the interaction between the natural environment, society, and technology (Cutter 1996, 535). In doing so, Cutter aims to combine all the Schools towards contributing to the overall vulnerability of a particular place. Traditionally, the *Human Ecologist* perspective viewed vulnerability as a pre-existing condition contingent on the proximity of the source of a hazard to those that are potentially affected. Alternatively, the *Structural View* (and *Social Vulnerability*) perspective focused on the pre-existing and underlying social conditions that allow for vulnerability to exist in the first place. In a bold move, Cutter's framework combines and organizes both the traditional and contemporary approaches, in contrast to focusing separately on one or the other (Cutter 2000, 716). In light of this, Cutter posits that,

> "The interplay of social, political, and economic factors (Structural View, Social Vulnerability) – interacting separately, in combination with one another, and with the physical environment (Risk/Hazard, Human Ecologist) – creates a mosaic of risks and hazards that affect people and the places they inhabit,"

thereby creating a whole new, holistic type of vulnerability measurement in which she denotes "Place-Vulnerability" (Cutter 2000, 716).

Place-Vulnerability is the ultimate outcome in the *Hazards-of-Place* framework for measuring vulnerability. Cutter's framework essentially integrates the *Human Ecologist* and *Structural View* Schools and ties them directly to a particular place (Region, County, Community, Urban Area). By doing so, the framework provides for an opportunity to examine both the physical and natural environment elements, in addition to the societal attributes that contribute to overall vulnerability (Cutter 2000, 716). Furthermore, it allows for the assessment of the interaction and intersection between the physical and social elements and how this directly effects the vulnerability of a particular place (Cutter 2000, 716; 2003, 245).

3.3.1 UNPACKING THE HAZARDS-OF-PLACE FRAMEWORK

The ultimate outcome of the *Hazards-of-Place* framework is to understand the vulnerability of a particular place as it relates to both the natural environment and social elements that contribute towards overall vulnerability, in focus separately and in interaction with one another. However, in order to reach an assessment of Place-Vulnerability, there are many individual components that must first be examined, as depicted in the conceptual framework in Figure 2.

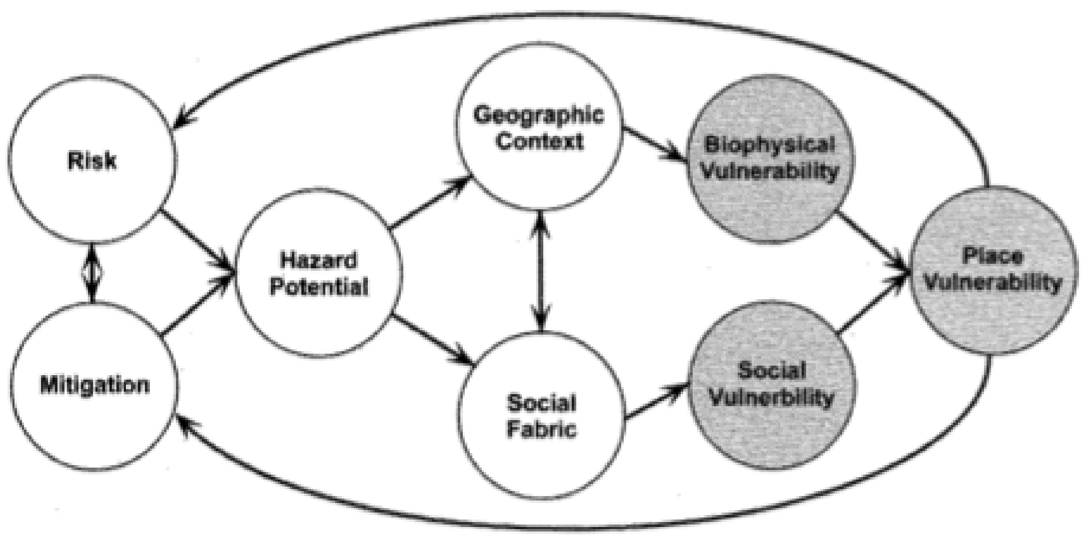


Figure 2: The Hazards-of-Place model for vulnerability. Source: (Cutter 1996, 536)

3.3.2 RISK

The first component to be addressed is to define and identify the elements of the known risks involved. Cutter defines risk as "the likelihood of occurrence (or probability) of a hazard" (Cutter 1996, 536). Additionally, risk includes three sub-elements. The first sub-element of risk is to first identify the potential source of the risk. An example of such could be a natural phenomenon, such as a known flood zone, or technologic in nature, such as an industrial accident like an acute oil spill or chemical release. The second sub-element of risk is to indentify the impact of the risk itself. Here it is pertinent to identify a potential hazard as either a high-consequence or a low-consequence event. The third sub-element is to estimate the frequency of occurrence of a hazard. In the natural environment, this could include estimates such as the frequency of flooding (100-year flood). In technological terms, this includes the percent chance of a failure, such as a pipeline leak, train derailment, or a maritime vessel accident at sea. When combined, all three sub-elements generate an overall assessment of the known risk itself, the probability of occurrence, and the size of the potential impact, representing the first step in assessing overall Place-Vulnerability in the *Hazards-of-Place* framework.

3.3.3 MITIGATION

The second component of the *Hazards-of-Place* model is to identify and expose any known mitigation efforts. Cutter defines mitigation as "any effort to reduce risks or the impact of the hazard itself" (Cutter 2000, 717). Mitigation efforts can take the form or policy frameworks and actions, or other forms of planning, knowledge applied from prior experiences, or structural improvements (Cutter 1996, 536; 2003, 717).

3.3.4 HAZARD POTENTIAL

The third component of the model is the Hazard Potential. Hazard Potential is the product of the interaction between the known risks and mitigation efforts. This can be influenced both positively and negatively dependent on mitigation efforts. For example, risks can be reduced in nature or their impacts lessened through good mitigation policies or structural adjustments and adaptations. Conversely, they can be amplified by poor or nonexistent policies and practices towards reducing risk and its impact (Cutter 1996, 537; 2003, 717). After the Hazard Potential is identified, the next step, according to the framework, is to separately address these elements in relation to the geographical and social contexts of a particular place. This is where the *Hazards-of-Place* framework is unique and differentiates itself from other theoretical models assessing vulnerability.

3.3.5 THE GEOGRAPHIC CONTEXT

The Geographic Context component addresses the elements typically involved with and in relation to the *Human Ecologist* School. This filter includes taking into consideration the context of the site and situation of a place, in addition to the proximity of a place to the sources of the known hazards themselves (Cutter 2003, 717).

3.3.5.1 BIOPHYSICAL/TECHNOLGICAL VULNERABILITY

Here, the Hazard Potential interacts with the Geographical Context filter to produce and identify the Biophysical and Technological Vulnerability of a particular place. Essentially, this identifies the vulnerabilities that exist due to the geographical surrounding, the technological constraints, or the combination of the two (the technological constraints that exist as a result of geographical attributes) that exacerbate the known risks of the Hazard Potential. In other words, it is the combination of the function of the hazard, its level of exposure, and the sensitivity of the area in which it may occur.

Therefore, Biophysical Vulnerability is ultimately concerned with the ultimate impacts of a hazard event. Furthermore, it is often calculated in terms of the magnitude of damage incurred as the result of an encounter with a hazard (Brooks 2003, 4). In addition, Biophysical Vulnerability itself includes both biological and physical components. The physical components are associated with the nature of the hazard and its first-order physical impacts. The biological components are the inherent properties of a potentially affected system that act to either amplify or reduce the damage incurred from the first-order physical impacts (Adger 2004, 29) (29).

In summary, Biophysical and Technological Vulnerability includes the identification of the known Hazard Potential (natural or technological), the frequency of the hazard (% chance of occurrence), and the locational impacts (proximity to the source, level of exposure, and sensitivity of the geographical area) in relation to a particular place (Cutter 2003, 717). In other terms, Biophysical Vulnerability is a function of the frequency and severity of a given type of hazard and measured by the potential outcome of damage incurred (Brooks 2003, 5).

3.3.6 THE SOCIAL FABRIC CONTEXT

Social Fabric addresses the components traditionally found in the *Structural View* School. Here, the Hazard Potential interacts with the Social Fabric (Socio-demographic characteristics, perception of and experience with risks and hazards) of a place. The product of this interaction results in identifying the Social Vulnerability of a particular place.

3.3.6.1 SOCIAL VULNERABILITY

Social Vulnerability encompasses a set of properties of a human system that exist and operate independently of the expose to natural or technological hazards (Brooks 2003, 4). Additionally, it is determined that these properties exist in a human system prior to a hazardous event, and may even contribute as a catalyst to the event itself (Holand 2011, 2).

Perhaps the most frequently cited definition of Social Vulnerability is that of Wisner et. al, where they state first and foremost that vulnerability to hazards is a social construct, and are "the characteristics of a person or group and their situation that influence their capacity to anticipate, cope with, resist and recover from the impact of a hazard" (Holand 2011, 2). Social vulnerability is thereby deconstructed into and rooted in historical, cultural, and economic processes (See Table 1), that when they interact create an overall level of vulnerability, essentially making particular places susceptible to incurred damage from external hazards (Cutter 2003, 243).

3.3.7 PLACE-VULNERABILITY

Place-Vulnerability is the ultimate result of the *Hazards-of-Place* framework for vulnerability. Therefore, Place-Vulnerability is the product of the interaction between the Biophysical Vulnerability and the Social Vulnerability components of the model for a particular place. In other words, Place-Vulnerability is the product of an assessment of the impact of a hazard and the extent to which a human system can cope, all tied to a specific place.

3.3.8 FEEDBACK LOOPS

The final component of the *Hazards-of-Place* framework is the Feedback Loops from Place-Vulnerability to the Risk and Mitigation components. Once Place-Vulnerability has been calculated, the Feedback Loops offer the possibility to re-identify the risks that exist and recalculate the extent to which the mitigation efforts have a positive or negative effect towards the overall vulnerability of a particular place. The Feedback Loops also posit that new risks may be manifested over time, and that Place-Vulnerability should often be re-assessed to reflect this.

3.4 CONCLUDING REMARKS

The *Hazards-of-Place* framework is a useful approach for examining vulnerability. It is in itself, a holistic approach towards measuring vulnerability, incorporating both the *Human Ecologist* and the *Structural View* Schools of thought, and utilizes them in cooperation with one another as opposed to assessing vulnerability based on either approach separately. The incorporation of the two Schools allows for an examination of both Biophysical/Technological and Social Vulnerability, and how the combination of the two affects a particular place. Furthermore, this framework can be used to generate a spatial representation of the geographical and social vulnerabilities that exist in direct relation to potential hazardous events for a specific location. Ultimately, this information can provide policy makers a comparative understanding of vulnerable places and the people who inhabit them, and serve as a distinct tool for developing or advancing mitigation and response efforts.

4.0 RESEARCH DESIGN AND METHODOLOGY

This chapter will describe the research design and methodology used to address and answer this project's research questions. This project utilizes research methods employed by the social sciences in both quantitative and qualitative capacities.

4.1 RESEARCH DESIGN AND STRATEGY

This project utilizes a mixed-methods research design to answer the overall research question and its two sub-questions. First, a quantitative analysis is conducted to describe varying levels of Place-Vulnerability (the product of Social and Biophysical/Technological Vulnerability) within Finnmark County (Sub-Question A). Subsequently, a qualitative analysis is conducted aimed at exploring the results of the Place-Vulnerability analysis, in addition to explaining what policies and practices the Norwegian Government has adopted to reduce vulnerability and the extent of their effect (Sub-Question B).

This mixed-methods research project adheres to a *Concurrent Transformative Design and Strategy* and takes on more of a nested approach (Creswell 2003, 219). This particular type of research strategy is utilized when quantitative and qualitative data used for each separate methodological analysis is collected over the same period of time throughout the duration of the project (Creswell 2003, 219). The necessary data for the quantitative assessment of Place-Vulnerability and the qualitative inquiry into the Norwegian Government's vulnerability reduction policies were collected simultaneously and ongoing throughout the process of this thesis project. Furthermore, this type of strategy is utilized when a specific conceptual or theoretical framework guides the project. The quantitative analysis of this research project adheres to the *Hazards-of-Place* framework for assessing and identifying Place-Vulnerability within Finnmark County. Moreover, this strategy follows more of a nested approach, where first the quantitative analysis and its findings is conducted, followed by the qualitative analysis that reflects and elaborates on the findings of the quantitative undertaking (Creswell 2003, 219).

By adhering to a Concurrent Transformative research design and strategy, I am able to answer the overall research question of this project and its two sub-questions that are suitable for a mixed-methods approach. This strategy has allowed for analysis, interpretation, and the reporting of results to occur throughout the entire process. Furthermore, this strategy allowed for flexibility in the research design by permitting the direction of the project to be steered as it developed, especially in terms of allocating additional qualitative data sources while determining the Place-Vulnerability for Finnmark County.

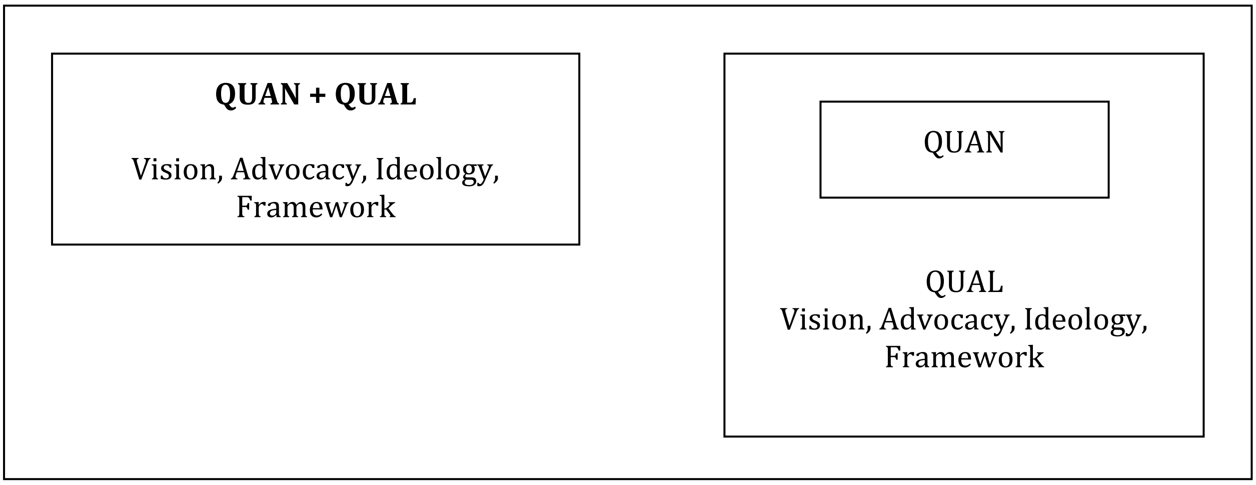


Figure 3: Concurrent Transformative Strategy[*]. Source: (Creswell 2003, 219)

4.2 CASE STUDY DESIGN

Robert Yin emphasizes that a case study is an empirical inquiry that investigates a contemporary phenomenon in-depth and within its real-life context (Yin 2009, 15). Additionally, Arend Lijphart posits that there are six different types of case studies: atheoretical, interpretive, hypothesis-generating, theory-confirming,

[*] A "+" indicates a simultaneous or concurrent form of data collection. Capitalization emphasizes a priority on either quantitative or qualitative data and analysis in the study. In the Concurrent Transformative Strategy, emphasis of quantitative and qualitative research methods are given equal weight, as illustrated in the box on the left. The box on the right hand side illustrates how a quantitative analysis was first conducted, and subsequently a qualitative analysis that explains and expands on the results of the quantitative analysis.

theory-infirming, and deviant case studies (Lijphart 1971, 691-692). In this project, I identify and evaluate the mitigation policies emphasized by the Norwegian Government as part of its *High North Strategy* aimed to reduce vulnerability towards oil spills off the Finnmark Coast. Therefore, this project can be perceived as an interpretive case study, as this type of case study is selected due to an inherent interest in the specific case itself, as opposed to the formulation of general theory (Lijphart 1971, 692). Interpretive case studies do, however, utilize established theories in practice (Lijphart 1971, 692). Therefore, I have utilized the *Hazards-of-Place* conceptual framework to determine Place-Vulnerability within Finnmark County. My intent is not to test or investigate the *Hazards-of-Place* theory nor to contribute towards its development, but rather to utilize it to emphasize the case itself.

As highlighted in Section 4.1, this project adheres to a mixed-methods research approach. The aim to include both quantitative and qualitative research methods within this case study is due to the nature that the two sub-research questions, while inherently interrelated, in fact, vary in their research objectives (Bryman 2008, 609). The qualitative research question (*Sub-Question B*) reflects upon and explains the results of the quantitative research question (*Sub-Question A*). This offers a sense of completeness for the project, and a comprehensive account for Finnmark county – by showing the risks and vulnerabilities that do exist, and then identifying the policies and practices aimed at reducing those very risks and vulnerabilities (Bryman 2008, 609). Therefore, the purpose of choosing a case study design is to utilize an existing theoretical framework (*Hazards-of-Place*) and apply it to a particular setting of research (Finnmark County).

4.3 VALIDITY AND RELIABILITY

Validity and Reliability are two crucial elements in regards to the research design. The research process must maintain that the design of the study itself, the applied theoretical approach, and the methods used to obtain data are unbiased, cross-referenced, and can be replicated. Ultimately, the research design must adhere to the notion that if the project were to be replicated, it would produce the same results.

4.3.1 VALIDITY

Yin posits that case study designs can often be criticized regarding Construct Validity through utilizing subjective judgments during data collection, ultimately leading towards developing insufficient operational procedures (Yin 1989, 34). However, there are various tactics available to increase Construct Validity. A main tenet to increase Construct Validity is through the use of multiple sources of evidence, both primary and secondary in nature. This project, specifically in regards to answering the qualitative research *Sub-Question B*, therefore, triangulates between multiple sources of evidence (peer-reviewed academic journal articles, official government documents and statistics, magazine and newspapers, manuscripts of speeches, scientific and technical reports, and key-informant interviews) to increase its Construct Validity.

External Validity is concerned with determining whether or not a research project has the inherent value to be generalized. Case studies are often criticized in regards to External Validity (Yin 1989, 36). In this research project, External Validity is both increased and decreased in nature. External validity is increased, as the *Hazards-of-Place* conceptual framework provides a standard set of indicators for assessing Social Vulnerability at the county-level.[*] However, due to the fact that the *Hazards-of-Place* framework also includes an assessment of Geographical Vulnerability in its design, the overall results for Place-Vulnerability cannot be generalized, even at the county-level, as geography varies from place to place. However, the results of this project could be generalized in comparison to other coastal counties located in northern Norway, as they tend to share similar geographical characteristics. Additionally, the results from this study cannot be generalized beyond the immediate case study, especially internationally, as the Norwegian Welfare State may have an altering

[*] The application of this framework has been utilized in other county-level assessments, particularly in the United States.

affect on Social Vulnerability indicators and the composite Social Vulnerability Index Scores.

4.3.2 RELIABIILTY

Yin emphasizes that "the goal of Reliability is to minimize the errors and biases in a study" (Yin 1989, 36). This can be achieved through thorough documentation and demonstration of the procedures performed in during the study (Yin 1989, 36). Another means to increase Reliability is to avoid subjectivity on behalf of the researcher (Yin 1989, 36). Therefore, I have attempted to increase Reliability by using multiple data sources (triangulation of data sources) and documenting the procedures and choices that I have made throughout the progression of this project.

4.4 QUANTITATIVE DATA COLLECTION

First and foremost, in order to calculate the Place-Vulnerability of Finnmark County, the county was delineated into three separate geographical areas (referred to hereafter as "Blocks"). These Blocks were chosen so that they were approximately the same in size (km^2) and in the length of coastline (km). The Blocks were assigned and termed "North" "Mid" and "South" based on their geographical location. The best method for delineating the entire county into three separate Blocks was to divide up the 19 individual municipalities in Finnmark. The Blocks were assigned as accordingly as shown in Table 2. Archival statistical records were allocated from Statistics Norway (SSB) and used for the quantitative analysis of Social Vulnerability within the county.

4.4.1 SOCIAL VULNERABILITY

The *Social Vulnerability Index* (SoVI) serves as the best method for determining the Social Vulnerability of the area of study. The SoVI is a relative measure of the overall social vulnerability, comprised of a set number of variables (Cutter 2003). In order to create the SoVI, statistical data was acquired pertaining to a myriad of social variable indicators (See Table 1 in Section 3.2.3). Each data set pertaining to each individual social variable in the SoVI was acquired through the use of the Statistics Norway's (SSB) online database and used accordingly to fit the 29 Social Vulnerability indicators determined by the *Hazards-of-Place* framework.

The method for calculating the scores for Social Vulnerability within the SoVI is similar for each vulnerability indicator, with exception to the Annual Average Household Income Indicator. An example of each will be illustrated in the Sections 4.4.2 and 4.4.3.

BLOCK 1: NORTHERN REGION

MUNICIPALITY	LAND AREA (KM²)*	COASTLINE (KM)**
Vardø	585.45	134.1
Vadsø	1233.9	90
Berlevåg	1082.43	186.5
Tana	3831.02	195.6
Nesseby	1366.89	142.3
Båtsfjord	1415.36	170.5
Sør-Vanger	3467.24	646.9
TOTAL	**12982.29**	**1565.9**

BLOCK 2: MID REGION

MUNICIPALITY	LAND AREA (KM²)	COASTLINE (KM)
Masøy	1066.56	727
Nordkapp	890.76	598.8
Porsanger	4640.95	624.2
Karasjok	5209.45	0
Leseby	3231.92	607.5
Gamvik	1353.64	389.2
TOTAL	**16393.28**	**2946.7**

BLOCK 3: SOUTHERN REGION

MUNICIPALITY	LAND AREA (KM²)	COASTLINE (KM)
Hammerfest	819.8	706.7
Kautokeino	8970.28	0
Alta	3653.36	567.7
Loppa	669.35	349.5
Kvalsund	534.46	502.6
Hasvik	1739.28	202.4
TOTAL	**16386.53**	**2328.9**

Table 2: Denotation of Finnmark County Geographical Areas (Blocks 1-3)

4.4.2 CALCULATING SOCIAL VULNERABILITY INDICATOR SCORES

A prominent indicator for determining the Social Vulnerability of an area is an assessment of the total number of Single-Parent Households. According to Social

* Source: SSB Statbank01Tab0142
** Source: SSB Statbank01Tab0145; Coastline includes both mainland and islands

Vulnerability theory, single-parent households are more susceptible to social vulnerability since they can often be attributed towards possessing limited resources, in terms of financial and human capital, and parents of these types of households often must balance work responsibilities and care for family members (Cutter 2003, 248).

The method for calculating Social Vulnerability Scores for this particular indicator is to first identify the number of Single-Parent Households for each of the three Blocks within Finnmark County. In this instance, Block 1 (North) has a total of 785 Single-Parent Households, Block 2 (Mid) has a total of 426 Single-Parent Households, and Block 3 (South) has a total of 1,171 types of these households. Together, Finnmark County has a total of 2,382 Single-Parent Households. The second step is to identify the total number of all registered households within Finnmark County. Data gathered from SSB shows that there are a total of 31,955 households registered within Finnmark County.

To calculate the Social-Vulnerability Score this indicator, the next step in the method is to divide the number of Single-Parent Households in each Block (Column 2) by the total number of registered households in Finnmark County (Column 3) to reach the value "X" (Column 4). For example, Block 1 would be 785/31,955 resulting in an "X-value" of 0.025. Continue this step until all Blocks have been calculated for "X". Then, divide all "X-values" (Column 4) for each block by the maximum "X-value" (Column 4) to get the overall Social Vulnerability Score (Column 5). Performing the last step gives weight in regards to the score across the county level. Ultimately, one is left with a Social Vulnerability score between 0.00 and 1.00, with 1.00 representing the maximum Social Vulnerability.

SINGLE – PARENT HOUSHOLDS INDICATOR				
AREA	*# OF SINGLE-PARENT HOUSEHOLDS*	*COUNTY TOTAL # OF HOUSEHOLDS*	*X-VALUE*	*SOCIAL VULNERABILITY SCORE*
BLOCK 1	785	31955	0.025	**0.33**
BLOCK 2	426	31955	0.013	**0.17**
BLOCK 3	1171	31955	0.037	**0.49**
FINNMARK	2382	31955	0.075	**1.00**

Table 3: Example of Social Vulnerability Indicator Calculations. Source: (Cutter 1997, 17-18)

4.4.3 ADDITIONAL SOCIAL VULNERABILITY INDICATOR CALCULATION

Calculating the Social Vulnerability Score for Annual Household Income follows similar procedure, only with some additional steps. These steps are necessary to eliminate negative values.

Annual Average Household Income is a pertinent indicator towards assessing Social Vulnerability, as it helps to determine the capacity of the population (on average) able to respond and cope with losses in the event of a hazard, based on an overview of available financial resources (Cutter 2003, 246).

Much like the Single-Parent Household Indicator, data collected from Statistics Norway (SSB) shows a variance in the average annual household income between each Block. To calculate the Social Vulnerability Score in this instance, the first step is to calculate the "X-Value" (Column 4) by finding the difference between the County Average Household Income and the Average Household Income for each Block.

$$X = \text{County Average Household Income} - \text{Average Household Income}$$

After calculating the "X-Value" for each Block, the second step is to calculate the "Y-Value" (Column 5). This step is meant to remove all negative values, and is most importantly where this indicator differs from all others in the SoVI. Calculate the "Y-Value" by finding the sum between the "X-Value" and the Absolute Value of the "Maximum X-Value".

$$Y = X + |X|$$

The completion of the third step results in the calculation of the Social Vulnerability Score (Column 6) for this particular indicator. To reach this score, divide the "Y-Value" by the "Maximum Y-Value". The result is a score between 0.00 and 1.00, with 1.00 representing the maximum Social Vulnerability (See Table 4).

ANNUAL AVERAGE HOUSEHOLD INCOME (NOK)					
AREA	*AVG HOUSEHOLD INCOME (NOK)*	*COUNTY AVG HOUSEHOLD INCOME (NOK)*	*X-VALUE*	*Y-VALUE*	*SOCIAL VULNERABILITY SCORE*
BLOCK 1	364717	365789	1072	13616	**0.57**
BLOCK 2	354500	365789	11289	23833	**1.00**
BLOCK 3	378333	365789	-12544	0	**0.00**

Table 4: Special Circumstance: Annual Average Household Income Indicator. Source: (Cutter 1997, 19-20)

4.4.4 CREATING THE SOCIAL VULNERABILITY INDEX

Social Vulnerability can be either increased (+) or decreased (-) depending on the individual indicator (See Table 1 in Section 3.2.3). The *Social Vulnerability Index* represents the summation of all the Social Vulnerability Scores across all 29 individual indicators to give an overall depiction of vulnerability levels for each Block. It is important to note, however, that individual weighting measures are *not* applied, and thus all indicators are treated as having equal importance towards the composition of Social Vulnerability for Finnmark County. This is attributed to a lack of scientific research within the theoretical model for explaining the variances in each causal mechanism (Cutter 2000, 728). Performing a Factor-Analysis could be an alternative to identifying and applying a weighting scheme to the indicators. However, a Factor-Analysis is difficult to perform at the *county-level*, where there are less areas of analysis (Blocks) than there are variables (Indicators). A Factor-Analysis is more appropriately used on a larger scale, such as at the national level, where there are more available areas for analysis. This is, however, beyond the scope of this project, but could be applied in further research. The results in this project's Social Vulnerability Index therefore depict an overall assessment of Social Vulnerability for Finnmark County among and between each Block (See Table 6 in Section 5.3).

4.4.5 BIOPHYSICAL/TECHNOLOGICAL VULNERABILITY

In order to assess the Biophysical/Technological Vulnerability of Finnmark County, historical shipping accident data between 1981 and 2011 was collected to create a *Hazards Frequency Table*. The necessary shipping accident data was collected from the Norwegian Maritime Directorate and the Norwegian Meteorological Institute.

Biophysical Vulnerability includes the identification of potential hazards (natural and technological), their frequency, and its locational impacts (Cutter 2000). Furthermore, Biophysical Vulnerability "is a function of the frequency and severity (or probability of occurrence) of a given type of hazard" (Brooks 2003).

In this project, the assessment of Biophysical/Technological Vulnerability specifically addresses the biophysical hazards that induce technological hazards on increasing offshore petroleum resource transportation activities along the Coast of Finnmark County. Therefore, calculating Biophysical/Technological Vulnerability is based on how historical Arctic natural conditions (and the hazards they create) affect or amplify the probability of Technological Hazards related to maritime transport of petroleum resources along the Finnmark Coast.

Analysis of Biophysical Vulnerability is broken down into three areas: *Hazard Identification*, *Hazard Frequency*, and *Hazard Zone Delineation*.

Hazard Identification includes an inquiry into the historical conditions of hazards along the Finnmark Coast for (1) Natural Environmental Hazards (Unique Arctic Environmental Conditions) and (2) Technological Hazards of maritime transport of petroleum resources (Hazards associated with operating in Arctic conditions; Hazards associated with normal transport operations) (See Section 5.5.1).

Hazard Frequency is the calculation of the historical data in comparison to the length such historical data has been record in years. Therefore, Hazard Frequency, or the rate of occurrence (per year) is calculated by the number of previous hazard occurrences in the area of study divided by the number of years.

Hazard Frequency = Total # Previous Hazard Events/Total # of Years on Record

Hazard Zone Delineation assigns *Hazard Identification* and *Hazard Frequency* to a specific place, based on where the greatest likelihood of a hazardous event may occur. This step identifies the areas that are vulnerable based on each type of hazard that is present. These results are represented in a Hazard Frequency Table (Table 11 in Section 5.5.8), displaying they various types of shipping accidents (Hazard Identification), their percent chance-per-year (Hazard Frequency), and the specific location of each type of accident assigned to specific shipping zones off the Finnmark Coast (Hazard Zone Delineation).

Once the Hazard Frequency Table is established, the next procedure is to determine a Risk Level Score for each geographical shipping zone. This is accomplished by coding the Hazard Frequency by Risk Level as High, Medium, or Low (*High Risk* = Hazard Frequency percentage of 50%+; *Medium Risk* = between 21-49%; Low *Risk* = between 0-20%). Subsequently, a score between 1 and 3 was assigned to each individual Risk Level identification (*High Risk* = 3, *Medium Risk* = 2, *Low Risk* = 1). The corresponding values are then summed to generate a Composite Risk Level Score per each geographical shipping zone. These results of the Composite Risk Level Scores are then ranked accordingly by specific geographical shipping zone, and subsequently by the shipping zone's geographical correspondence with the three Blocks in Finnmark County (See Tables 10, 11, and 12 in Section 5.5.8). These results, in essence, identify the areas along the Finnmark Coast most exposed to shipping hazards, suggesting (based on probability on past accidents) where potential future accidents (and the type of accident) are likely to occur, thus identifying the most vulnerable coastal areas.

4.4.6 ASSESSING PLACE-VULNERABILITY

Place-Vulnerability is the product of the interaction between Social Vulnerability and Biophysical/Technological Vulnerability in relation to a specific location. The overlap of the results from the Social Vulnerability Index and the Biophysical/Technological Scores results in the calculation of Place-Vulnerability. This assessment identifies which places are particularly vulnerable within the Finnmark County and directly answers *Sub-Question A* of this project.

4.4.7 GIS MAPPING

I have elicited GIS (Geographical Information Services) to visually represent the results generated in the SoVI and Hazards Frequency Table Scores to identify the areas most vulnerable to hazard in Finnmark County. Visualizing this information is useful for not only for providing a face to vulnerable areas, but for use in pre-event preparedness phases and for emergency response efforts before, during, and after an event occurs (Cutter 2003, 441). There were, however, limitations regarding the use and application of GIS throughout this project. While the visual representations GIS provide are pertinent to this project, the use and application of these services were limited, due to personal limitations with familiarity of GIS computer software, in addition to a limited ability to allocate GIS specialists to assist in transforming my raw data from its numerical form into a visual representation on map of Finnmark County. The visual representations from GIS in this project are basic in nature, but maintain the primary function to visually represent my data.

4.5 QUALITATIVE DATA COLLECTION

Qualitative research methods were additionally utilized throughout this project to answer the primary research question and provide a specific answer to the *Sub-Question B*. This methodology included the use of primary and secondary sources.

4.5.1 CASE STUDY INTERVIEWS

Yin highlights that interviews are one of the most pertinent sources for case study information (Yin 1989, 84). In order to obtain a more thorough and critical understanding of the mitigation policies implemented by the Norwegian Government to reduce vulnerability in Finnmark, I chose to conduct a series of semi-structured interviews with key-informants. Alan Bryman posits that semi-structured interviews are flexible in their design, and often include an interview guide, but do not necessarily follow a sequential form (Bryman 2008, 438). Furthermore, Yin identifies key-informants as persons able to provide insights into a matter and can also initiate access to corroboratory or contrary sources of evidence (Yin 1989, 84). There are, however, a series of limitations to be addressed. Yin points out four key weaknesses that may occur during the interviewing process. The first and second weaknesses are bias due to poorly constructed questions on behalf of the interviewer and response bias on behalf of the interviewee. The third area Yin posits as inaccuracies on behalf of the interviewee due to poor memory recall. The final weakness addresses reflexivity, or the notion that the interviewee gives information based on what they think the interviewer *wants* to hear (Yin 1989, 80). Due to these weaknesses during the interviewing process, Yin highlights that it's important to treat these accounts only as verbal reports, and not as empirical sources of data (Yin 1989, 85).

I therefore conducted a series of semi-structured interviews with select key-informants from the World Wildlife Fund (WWF) – Norway, the Norwegian Ministry of Environment, The Center for High North Logistics, and a PhD researcher at the University of Tromsø. I chose these key-informants to gain insight from multiple perspectives on the various aspects of the High North Strategy. The Ministry of Environment was chosen based on their role in developing and implementing the *Integrated Management Plan of the Marine Environment of the Barents Sea and the Sea Areas of the Lofoten Islands*, a central component of the *High North Strategy*. The Centre for High North Logistics was chosen to acquire more information on knowledge-sharing databases regarding maritime operations in the High North. A Ph.D. candidate from the University of Tromsø was chosen to gain insight from the perspective within academia regarding High North developments and their affect on its communities. Finally, the WWF-Norway was chosen to obtain an NGO perspective and as an opposing institution towards petroleum development in the Arctic. Due to time constrictions, I was unable to conduct further interviews with other relevant institutions. However, from these key-informant interviews, I was able to generate both corroboratory and contradicting information regarding the secondary sources previously allocated, in addition to being directed to further pertinent sources of quantitative research and qualitative literature. The interview process painted a broader depiction of the activities occurring in Finnmark County and a better understanding of their affect towards Social and Biophysical/Technological Vulnerability.

4.5.2 SECONDARY DATA SOURCES

In addition to the case study interviews, I acquired information from a myriad of secondary sources, including documents and archival records. According to Yin, documents that play an explicit role in data collection are useful sources of information that provide both corroboratory and potential contradictory evidence, in addition to increasing Construct Validity (Yin 1989, 34, 81). The sources of the documents used in this project include official Norwegian Government White Papers, administrative reports, intergovernmental scientific reports, industrial technical reports, transcriptions of speeches, newspaper and magazine articles, and peer-reviewed, scholarly research articles. This information was particularly useful in helping to develop the semi-structured interview guides during the interview process. Secondary data sources are also critical for increasing validity and reliability in this project (Yin 1989, 34).

4.7 ETHICAL CONSIDERATIONS

Ethical issues may arise during the qualitative and quantitative research process. Bryman identifies four areas of ethical concerns: Harm to participants; lack of informed consent; invasion of privacy; and whether or not deception is involved (Bryman 2008, 118). The sole primary ethical concern during this research project revolves around informed consent. This arose during the interview process with my key-informants. To address this concern, I asked for permission from my interviewees beforehand for the use of a recording device during the interview process. I additionally assured my interview participants that the information recorded during the process would solely be used for the purposes of revisiting the conversation during the writing process and in no other circumstance, without their expressed consent. Additionally, information requested to be “off the record” was not recorded during the interview process.

5.0 QUANTITATIVE ANALYSIS

This chapter will demonstrate the process and results achieved for determining Place-Vulnerability within Finnmark County. As discussed in the previous chapter, Place-Vulnerability is the product of the interaction between Social Vulnerability and Biophysical/Technological Hazard Vulnerability. Therefore, this quantitative analysis is conducted in three parts. First is an analysis to assess, score, and create a *Social Vulnerability Index*. These results will depict specifically the areas in Finnmark that are particularly vulnerable based on the 29 Social Vulnerability Indicators. Second, an analysis of Biophysical/Technological Vulnerability is conducted to expose vulnerable areas within the county towards shipping hazards. Finally, the combination of these two analyses will depict the results for overall Place-Vulnerability within Finnmark, ultimately displaying areas that are both socially vulnerable and exposed to shipping hazards.

5.1 DETERMINING THE AREAS OF ANALYSIS

As discussed in section 4.5.2, Finnmark County was delineated into three, distinguishable geographical blocks – based on their approximate total area (km^2) and the length of their corresponding coastlines (km). For the purposes of this analysis, the "Northern" Region Block," or *Block 1*, consists of the following municipalities: Vardø, Vadsø, Berlevåg, Tana, Nesseby, Båtsfjord, and Sør-Varanger. *Block 2*, or the "Mid Region Block" consists of Måsøy, Nordkapp, Porsanger, Karasjok, Leseby, and Gamvik municipalities. The "Southern Region Block," *or Block 3*, is comprised of Hammerfest, Kautokeino, Alta, Loppa, Kvalsund, and Hasvik municipalities. These geographical assignments are used for both the purposes of constructing the *Social Vulnerability Index* and the *Biophysical/Technological Hazards Table*. By breaking down Finnmark County into separate blocks, I am able to better distinguish and compare the results of the levels of both Social and Biophysical/Technological Vulnerabilities within the county as a whole. Below is a visual representation of how the respective blocks are distinguished (Figure 5).

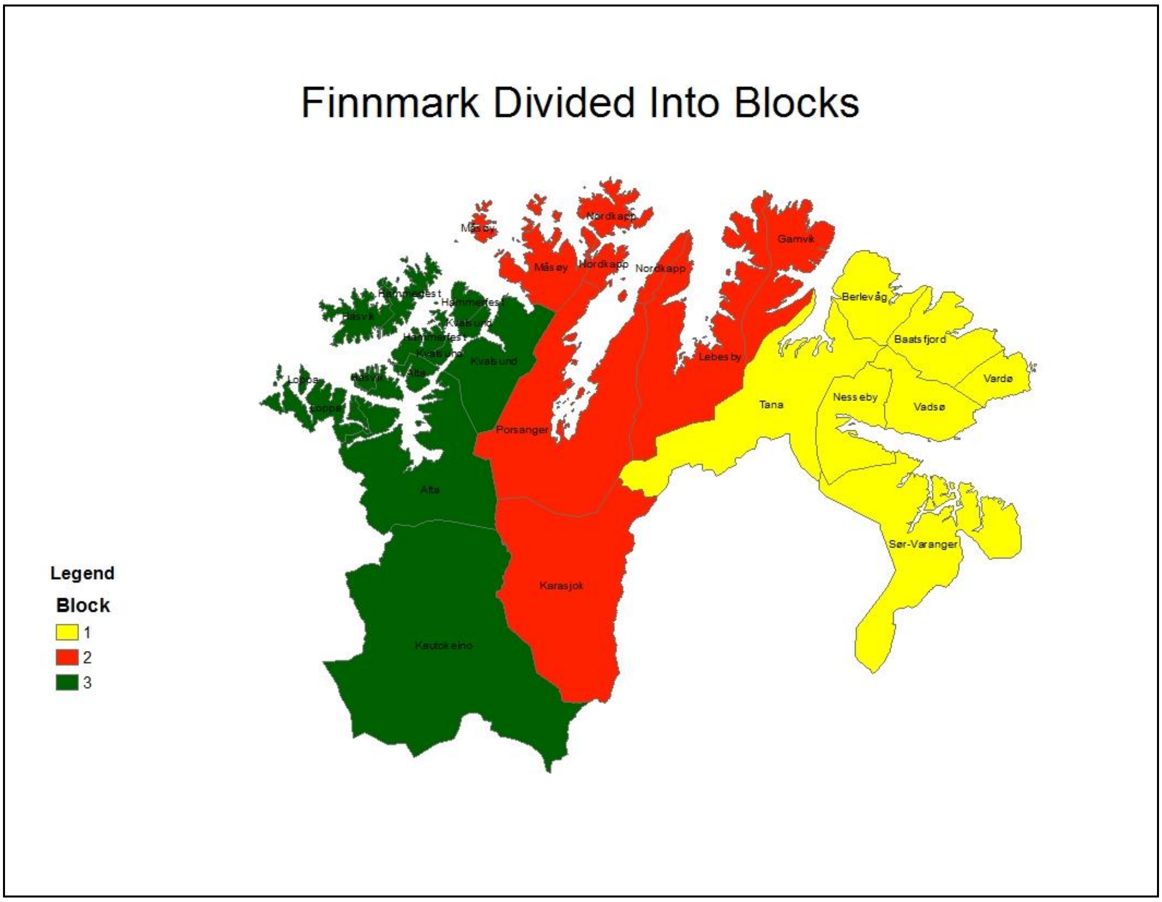


Figure 5: Map of Finnmark County Divided into 3 Geographical Blocks

5.2 THE SOCIAL VULNERABILITY INDEX

The first step towards calculating Place-Vulnerability is an overall assessment of Social Vulnerability. Analyzing Social Vulnerability aims to identify and explain the underlying “Social Fabric,” or the root social attributes (historical, cultural, and economic processes) of a particular place that either contribute to, or reduce levels of vulnerability towards hazards (Holand 2011, 2). The best method for demonstrating levels of Social Vulnerability within a particular place is to construct a *Social Vulnerability Index* (SoVI). The SoVI serves a relative measure of the overall Social Vulnerability of a place, comprised of a set number of social variables. 29 social variables were therefore selected in the analysis of Social Vulnerability for Finnmark County (See Table 5). Each one of these variables either increases or decreases Social Vulnerability.

INDICATOR	DESCRIPTION	INCREASES OR DECREASES SOCIAL VULNERABILITY (+/-)
POPULATION		
Total Population	An important indicator as it represents the sum amount of people that may be affected in an area due to an external hazard.	+ or -
Population < 5 Years Old	Defines and describes the most vulnerable portion of the total population. These persons are dependent on assistance during a hazardous event and are unable to make decisions regarding their safety in an emergency. These persons are also more likely to suffer from respiratory distress from certain inhaled toxins.	+
Population < 18 Years Old	A highly vulnerable portion of the total population. Dependent on assistance during a hazardous event and may be unable to make fit decisions during an emergency situation.	+
Population > 67 Years Old	These persons may have mobility constraints or other concerns requiring assistance during a hazardous event or emergency. These persons are also more prone towards health problems as a result of the event itself and may have less ability to recover after an event occurs.	+
Urban vs. Rural Population	Rural residents may be more vulnerable due to lower incomes and more dependent on locally based resource extraction economies (e.g. farming, fishing). High-density urban areas complicate evacuation.	+
GENDER		
Female Population	Females may have a lack of or to resources before or during a hazardous event. Certain hazards exposures can be harmful to women's reproductive health. Women may also be responsible for assisting other family members (especially children) during an emergency.	+
RACE & ETHNICITY		
Immigrant Population	Race and Ethnicity may pose language, cultural, social, economical, and political barriers that affect their ability to respond during a hazardous event and afterwards in terms of access to available resources	+
HOUSING		
Total # of Households	An important indicator towards determining the total number of potentially affected housing units.	+ or -
SOCIOECONOMIC STATUS		
Average Annual Household Income	An important indicator towards determining the capacity of the population (on average) able to respond and cope with losses due to a hazardous event.	+
Annual Household Income < 150.000 NOK	Lower annual income imposes barriers in terms of ability to access resources before, during, and after a hazardous event.	+

Annual Household Income > 750.000 NOK	Higher annual income reduces the barriers such as the access to resources before, during, and after a hazardous event.	-
EMPLOYMENT		
Employed Population 17 – 74 Years Old	The employed population of an area is an important indicator	-
Registered Unemployed Population	The unemployed population indicator is pertinent as it assists to determine a portion of the population that may have restricted access to resources, especially in the event of a hazard	+
VULNERABLE OCCUPATIONS		
Employed in Fishing/Aquaculture	The potential loss of employment due to being employed in an industry vulnerable to hazardous events exacerbates the number of unemployed workers in a community, contributing to a slower recovery from a hazardous event	-
Employed in Manufacturing of Food Products	The potential loss of employment due to being employed in an industry vulnerable to hazardous events exacerbates the number of unemployed workers in a community, contributing to a slower recovery from a hazardous event	-
Employed in Accommodation Services	The potential loss of employment due to being employed in an industry vulnerable to hazardous events exacerbates the number of unemployed workers in a community, contributing to a slower recovery from a hazardous event	-
Employed in Food & Beverage Services	The potential loss of employment due to being employed in an industry vulnerable to hazardous events exacerbates the number of unemployed workers in a community, contributing to a slower recovery from a hazardous event	-
FAMILY STRUCTURE		
Large-Family Households	Families with large numbers of dependents often have limited finances to outsource care for dependents which affect their ability to recover from a hazardous event	-
Single-Parent Households	Single-Parent households often have limited resources or finances and must also balance work responsibilities and care for family members	-
EDUCATION		
No or Unknown Education	Education is linked to socioeconomic status, where lower education constrains the ability to understand warning information and access to recovery information	-
Basic School Education Level	Education is linked to socioeconomic status, where lower education constrains the ability to understand warning information and access to recovery information	-
Upper Secondary Education Level	Education is linked to socioeconomic status, where lower education constrains the ability to understand warning information and access to recovery information	-

Tertiary Education Level	Education is linked to socioeconomic status, where higher education tends to result in higher lifetime earnings, and thus contributes towards a greater ability for financial resources and access to resources before, during, and after a hazardous event	+
SOCIALLY-DEPENDENT POPULATION		
Population Dependent on Pensions or other Social Assistance	Persons dependent on social assistance for survival are potentially already economically and socially marginalized and require additional support in the event of a hazard	+
SPECIAL-NEEDS POPULATION		
Population Living in Nursing Home	Persons dependent on others are vulnerable during a hazardous event and may have a limited access to necessary resources before and after an event occurs	+
Population Living in Assisted Living Dwellings	Persons dependent on others are vulnerable during a hazardous event and may have a limited access to necessary resources before and after an event occurs	+
MEDICAL SERVICE PROFESSIONALS		
Number of Physicians	Medical professionals are extremely important for post-event sources of relief. The lack of these resources exacerbate the means for relief and long-term recovery from an event	-
Number of Nurses	Medical professionals are extremely important for post-event sources of relief. The lack of these resources exacerbate the means for relief and long-term recovery from an event	-

Table 5: Social Vulnerability Indicators, Descriptions, and Metrics. Source: (Cutter 1996, 1997, 2003)

To create the *Social Vulnerability Index*, a relative Social Vulnerability Score was calculated based on the data collected for each of the three geographical blocks, based on each individual variable (See Section 4.5.4 for individual calculation methods). The individual scores for each variable were then summed to create a Composite Social Vulnerability Score for each particular geographical block. Again, it is important to note that all variables are given equal weighting in the SoVI, and thus equal relative importance towards the Composite Social Vulnerability Score. This again is due to a lack of scientific research within the development of the *Hazards-of-Place* framework for explaining variances in each causal mechanism (Cutter 2000, 728). Nonetheless, the Composite Social Vulnerability Score for each geographical block provides a solid overview of the varying levels of Social Vulnerability.

5.3 INTERPRETING THE RESULTS OF THE SOCIAL VULNERABILITY INDEX

The results from the *Social Vulnerability Index* (Table 6) give a broad overview of the varying levels of Social Vulnerability among the three geographical blocks within Finnmark County. In the Index there differing scores per each geographical block for each of the 29 individual Social Vulnerability variables. The Composite Social Vulnerability Scores for each geographical block are listed towards the bottom of the Index.

The overview presented from the SoVI depicts that the most socially vulnerable geographical block is the "Southern Region," or Block 3 within Finnmark County. Accordingly, Block 3 has a Composite Social Vulnerability Score of 8.07. The "Northern Region," or Block 1 has a composite score of 6.86 and is thus the second most socially vulnerable geographical area within the county. Block 2, or the "Mid Region," is the least socially vulnerable of the three geographical blocks with a composite score of 5.16. The same holds true when looking at the average scores among the 29 variables across the 3 blocks, with Block 3 holding an average score of 0.2784, Block 1 with an average score of 0.2366, and Block 2 with an average score of 0.1779 respectively.

5.4 ANALYZING THE SOCIAL VULNERABILITY SCORES BY VARIABLE TYPE

Going further in depth, the following graphics show how the type of variable assessed breaks down Social Vulnerability Scores. This information provides a more thorough analysis of how each geographical block compares against each other and offers an overview in which areas each geographical block could improve to lower its Composite Social Vulnerability Score and thus lower its overall level of Social Vulnerability.

SOCIAL VULNERABILITY INDICATORS & SCORES*

INDICATOR	BLOCK 1 SCORE	BLOCK 2 SCORE	BLOCK 3 SCORE
TOTAL POPULATION	0.34	0.18	0.48
POPULATION 0-5 YEARS	0.30	0.15	0.55
POPULATION < 18 YEARS	0.32	0.32	0.32
POPULATION > 67 YEARS	0.37	0.21	0.42
IMMIGRANT POPULATION	0.41	0.16	0.43
FEMALE POPULATION	0.34	0.18	0.48
URBAN POPULATION	0.34	0.17	0.48
RURAL POPULATION	0.33	0.21	0.46
TOTAL # OF HOUSEHOLDS	0.35	0.19	0.46
ANNUAL AVERAGE HOUSEHOLD INCOME	0.57	1.00	0.00
ANNUAL HOUSEHOLD INCOME < 150.000 NOK	0.32	0.22	0.46
ANNUAL HOUSEHOLD INCOME > 750.000 NOK	-0.33	-0.16	-0.51
TOTAL EMPLOYED POPULATION 17-74 YEARS OLD	-0.34	-0.18	-0.47
TOTAL REGISTERED UNEMPLOYED POPULATION	0.33	0.37	0.30
EMPLOYED IN FISHING & AQUACULTURE	0.28	0.26	0.46
EMPLOYED IN MANUFACTORING OF FOOD PRODUCTS	0.44	0.20	0.36
EMPLOYED IN ACCOMMODATION SERVICES	0.26	0.21	0.53
EMPLOYED IN FOOD & BEVERAGE SERVICES	0.30	0.16	0.54
SINGLE-PARENT HOUSEHOLDS	0.67	0.36	0.49
LARGE FAMILY HOUSEHOLDS	0.32	0.17	0.51
NO OR UKNOWN EDUCATION LEVEL	0.24	0.12	0.64
BASIC SCHOOL EDUCATION LEVEL	0.34	0.21	0.45
UPPER SECONDARY EDUCATION LEVEL	0.36	0.19	0.46
TERTIARY EDUCATION LEVEL	-0.33	-0.16	-0.51
POPULATION DEPENDENT ON PENSIONS/SOCIAL ASSISTANCE	0.33	0.22	0.44
POPULATION LIVING IN NURSING HOME	0.36	0.22	0.43
POPULATION LIVING IN ASSISTED LIVING DWELLINGS	0.28	0.22	0.51
# OF PHYSICIANS	-0.32	-0.10	-0.58
# OF NURSES	-0.33	-0.15	-0.51
COMPOSITE SOCIAL VULNERABILITY SCORE	**6.86**	**5.16**	**8.07**

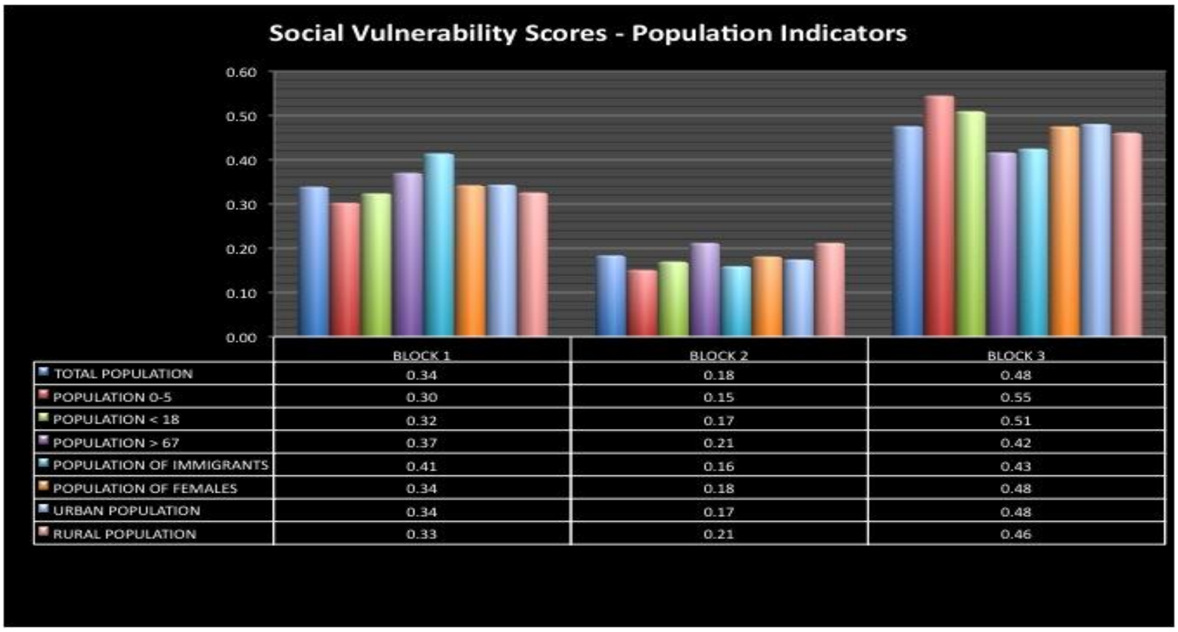
	BLOCK 1	BLOCK 2	BLOCK 3
Sum	6.86	5.16	8.07
Count (n)	29	29	29
Average (mean)	0.2366	0.1779	0.2784
Variance (s^2)	0.076505923	0.047585085	0.147901008
Standard Deviation (S)	0.005853156	0.00226434	0.021874708

Table 6: Social Vulnerability Index (SoVI)

5.4.1 POPULATION INDICATORS

* See Appendix 1 for Data Sources

Among the Population Indicator Variables (Figure 6), Block 3 scores relatively high across all 8 population type variables. This is most largely attributed towards general larger human populations within this region, correlated to the larger northern towns of Hammerfest and Alta. This trend holds constant as Block 1 also has higher concentrations of human populations among the towns of Kirkenes, Vadsø, and Vardø. Block 2 generally has lower scores in relation to population indicators as its centers of population are less than both Blocks 1 and 3. Therefore, based on human populations, it makes sense that areas with larger overall populations are more vulnerable to the effects of a hazard event.

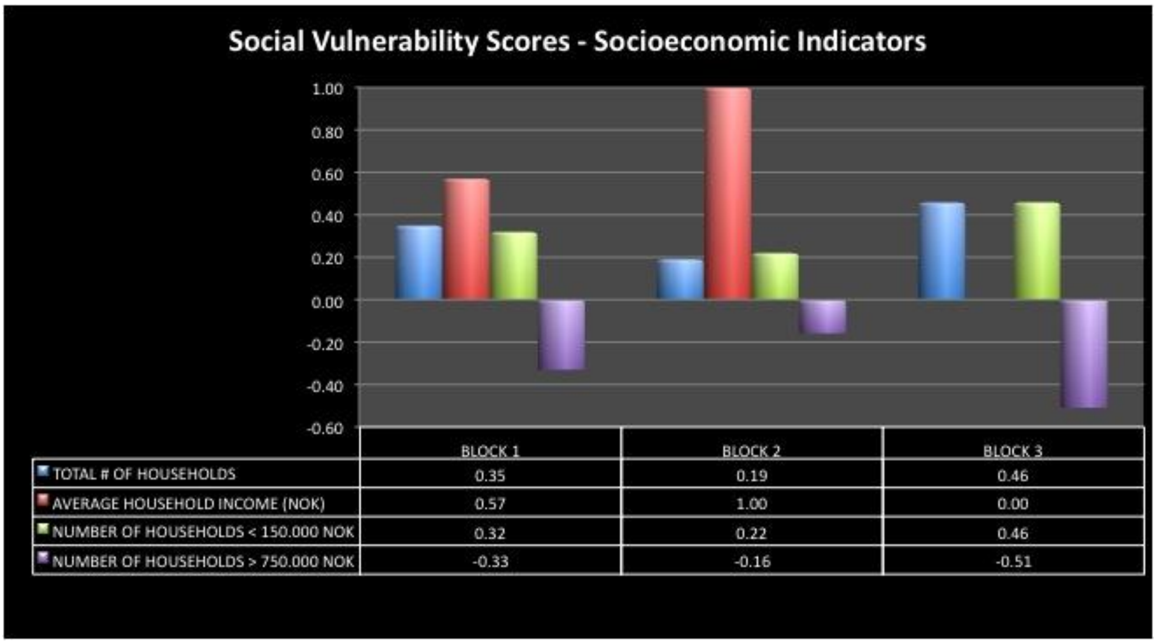


	BLOCK 1	BLOCK 2	BLOCK 3
TOTAL POPULATION	0.34	0.18	0.48
POPULATION 0-5	0.30	0.15	0.55
POPULATION < 18	0.32	0.17	0.51
POPULATION > 67	0.37	0.21	0.42
POPULATION OF IMMIGRANTS	0.41	0.16	0.43
POPULATION OF FEMALES	0.34	0.18	0.48
URBAN POPULATION	0.34	0.17	0.48
RURAL POPULATION	0.33	0.21	0.46

Figure 6: Population Indicators

5.4.2 SOCIOECONOMIC INDICATORS

The Socioeconomic Indicator Variables consist of the *Total Number of Households*, *Average Household Income (NOK)*, *Number of Households with an Annual Income of Less than 150,000 NOK*, and *Households with an Annual Income of greater than 750,000 NOK*. From these results, Blocks 1 and 3 have higher scores than Block 2 for the Total Number of Households variable. This follows the trend in the Population Indicator Scores, displaying that higher areas of human populations will have a greater number of households. However, among the *Average Household Income (NOK)* scores, Block 2 scores the highest, followed by Block 1 and then Block 3. Block 2 scores the highest in this category due to the fact that this geographical block contains the lowest average household income, and thus carries with it a higher Social Vulnerability score. Block 3 has the lowest score due to its overall higher average household incomes. Thus, a higher average household income decreases the level of Social Vulnerabilty in regards to this variable. Additionally, Block 3 has the highest levels of low income households and high income households, where Blocks 2 and 3 stay relatively stable in respect to this variable. Therefore, one can conclude that Block 2 is relatively the most socially vulnerable region when it comes to socioeconomic status.



	BLOCK 1	BLOCK 2	BLOCK 3
TOTAL # OF HOUSEHOLDS	0.35	0.19	0.46
AVERAGE HOUSEHOLD INCOME (NOK)	0.57	1.00	0.00
NUMBER OF HOUSEHOLDS < 150.000 NOK	0.32	0.22	0.46
NUMBER OF HOUSEHOLDS > 750.000 NOK	-0.33	-0.16	-0.51

Figure 7: Socioeconomic Indicators

5.4.3 EMPOLYMENT INDICATORS

The Employment Indicator variables serve as an overview of the levels of employed and unemployed populations within each geographical block. Additionally, four vulnerable industries related to the use of marine resources were selected for analysis. Looking at the results, Block 1 has a relatively good score for its employed population with a score of -0.34. The unemployed population score, however, is relatively high. Combined, Block 1 has a net employment score of –0.1 thus lowering its Composite Social Vulnerability Score. Block 3 has a relatively high employed population and low unemployed population compared to the other 2 geographical blocks. Combined, it scores a net of -0.17, reducing its composite Social Vulnerability Score. Block 2 on the other hand has a relatively low employed population score with a high-unemployed population score. Combined, Block 2 has a net score 0.19, increasing its Composite Social Vulnerability Score. Therefore, it could be interpreted that a hazardous event within this geographical region may induce devastating effects to its already low percentage of employed population. In terms of vulnerable industries, Blocks 1 and 3 score relatively high in these areas. Therefore, a hazardous event that affects these industries' resource base may induce serious harm to those employed in these industries within these regions.

Figure 8: Employment Indicators

5.4.4 FAMILY STRUCTURE INDICATORS

Family Structure Indicator variables reflect the potential for limited or restricted financial resources or the inability to provide for dependents during a hazardous event. According to the SoVI, Block 1 scores extremely high with regards to the number of single-parent households and relatively high with regards to large family households. Block 2 scores relatively low compared to the other two geographical blocks within this category. Block 3 scores relatively high in regards to both variables and thus is the most socially vulnerable region among this category of variables.

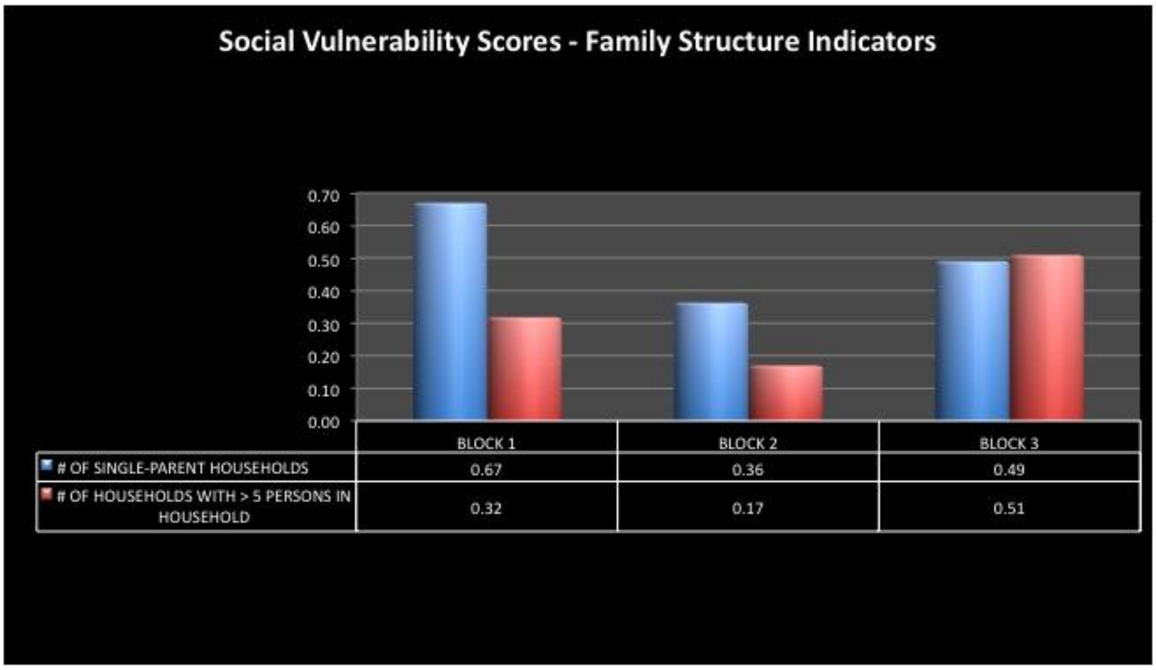
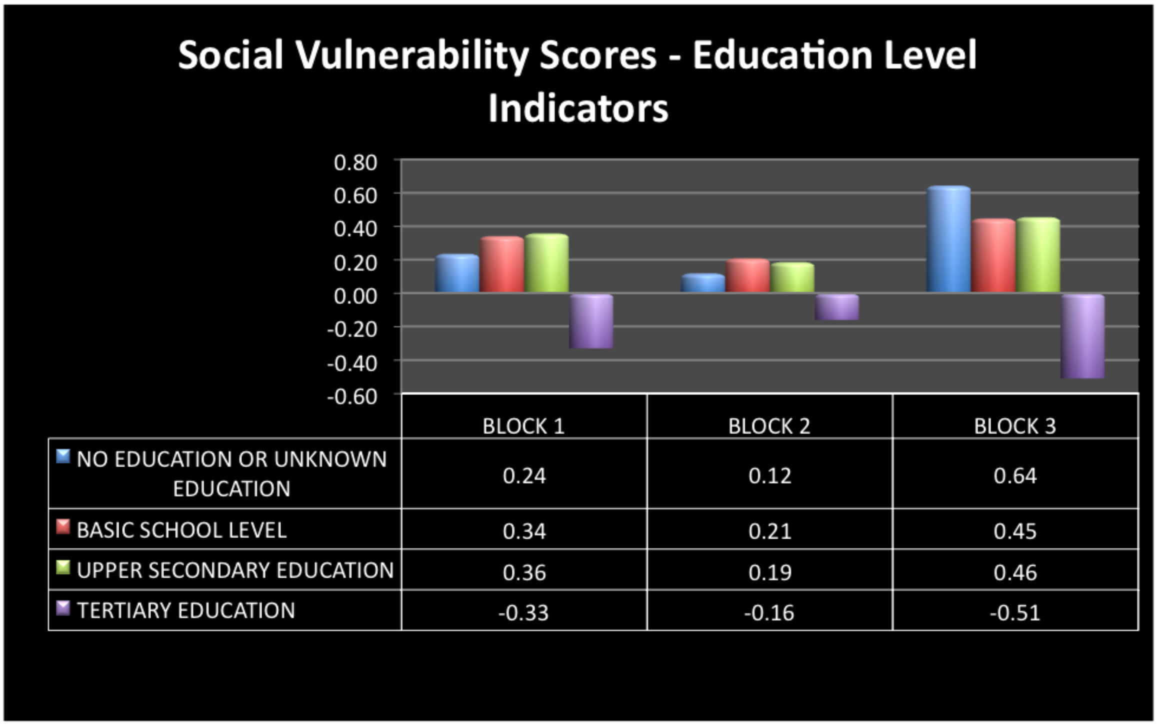


Figure 9: Family Structure Indicators

5.4.5 EDUCATION LEVEL INDICATORS

Education levels are linked to both levels of socioeconomic status and the ability to interpret warning information (Cutter 2003, 248). Both of these may have an impact towards constraining access to the recovery process before or after a hazardous event (Cutter 2003, 248). When the scores across the various levels of achieved education are summed, Block 3 has a net score of 1.04 that dramatically adds to its Composite Social Vulnerability Score. Block 1 also has a high score at 0.61, where Block 2 has a relatively low score at 0.36. Therefore, education level variables contribute towards a higher Social Vulnerability across all geographical blocks in Finnmark.



	BLOCK 1	BLOCK 2	BLOCK 3
NO EDUCATION OR UNKNOWN EDUCATION	0.24	0.12	0.64
BASIC SCHOOL LEVEL	0.34	0.21	0.45
UPPER SECONDARY EDUCATION	0.36	0.19	0.46
TERTIARY EDUCATION	-0.33	-0.16	-0.51

Figure 10: Education Level Indicators

5.4.6 SOCIALLY DEPENDENT POPULATION INDICATORS

Socially Dependent Population Indicator variables are focused on determining the extent of the number of people who may require extra assistance in the event of a hazard. These types of populations are classified into those receiving social assistance benefits, and those living in assisted living households (dwellings) or institutions. According to the results in the index, Block 3 scores the highest, followed by Block 1 and then Block 2. This category of variables may too reflect the *population trend* as there is a larger human population in both Blocks 1 and 3 than there are in Block 2, suggesting that a higher overall population contributes to the probability of more people receiving benefits or living in these types of assisted living settings. Nonetheless, Block 3 appears to be quite socially vulnerable when it comes to this particular set of indicators.

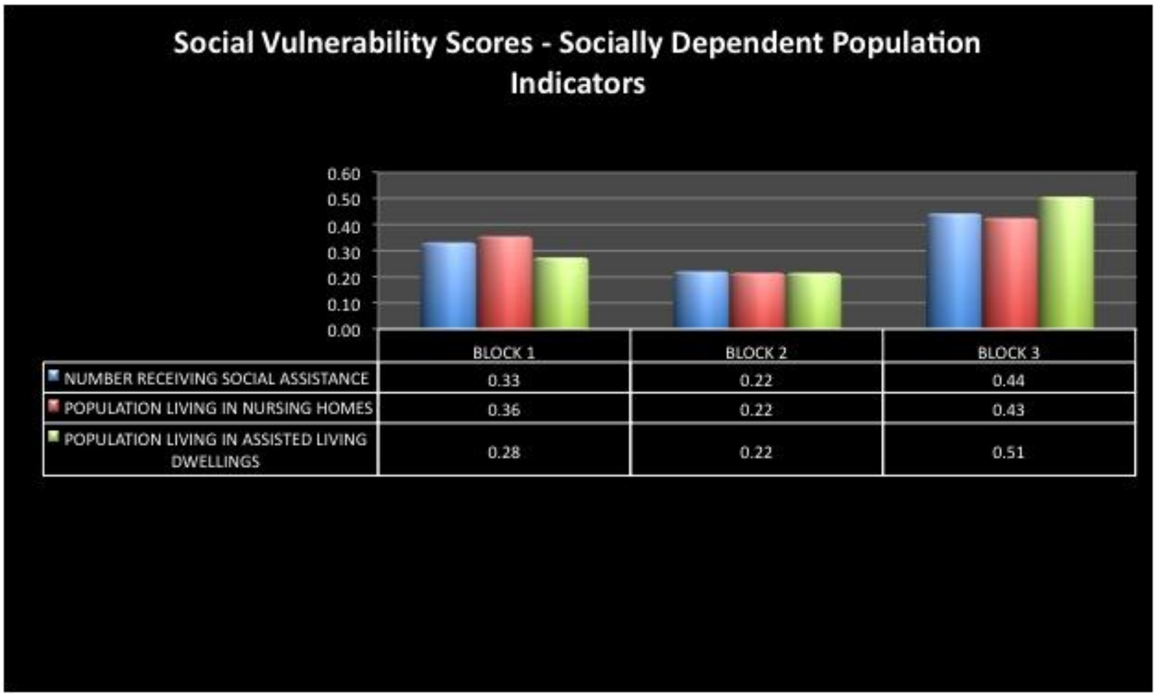


Figure 11: Socially Dependent Population Indicators

5.4.7 AVAILABLE MEDICAL PROFESSIONALS INDICATORS

According to the *Hazards-of-Place* model, a higher concentration of available medical professionals, whether physicians or nurses, decreases the overall Social Vulnerability of a place. Having these types of medical professionals on hand during and after a hazard event are pertinent sources of relief for a community. Conversely, the lack thereof of these resources contributes towards a higher level of Social Vulnerability (Cutter 2003, 248). This category of variables again may reflect the *population trend* in that it makes sense that there is a higher concentration of these resources in areas with larger populations. Therefore, this set of variables decreases the Social Vulnerability across all three geographical blocks, but it occurs most in Block 3, the region with the largest overall population. Block 2, however, may have a shortage of available physicians and nurses.

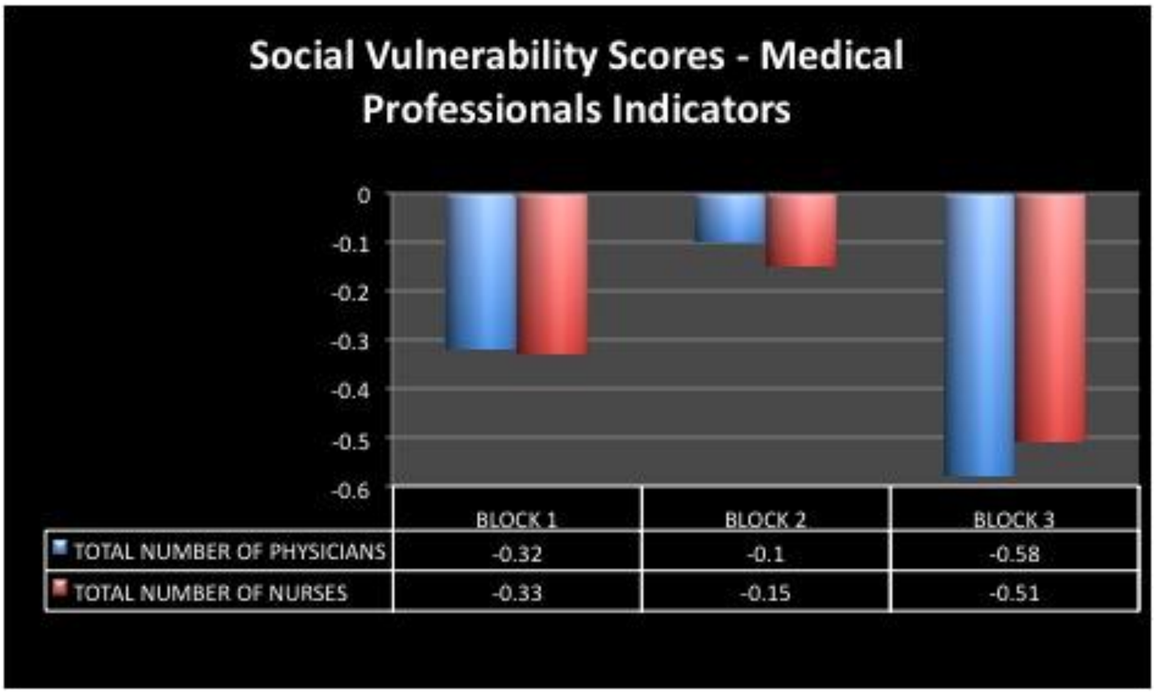


Figure 12: Available Medical Professionals Indicators

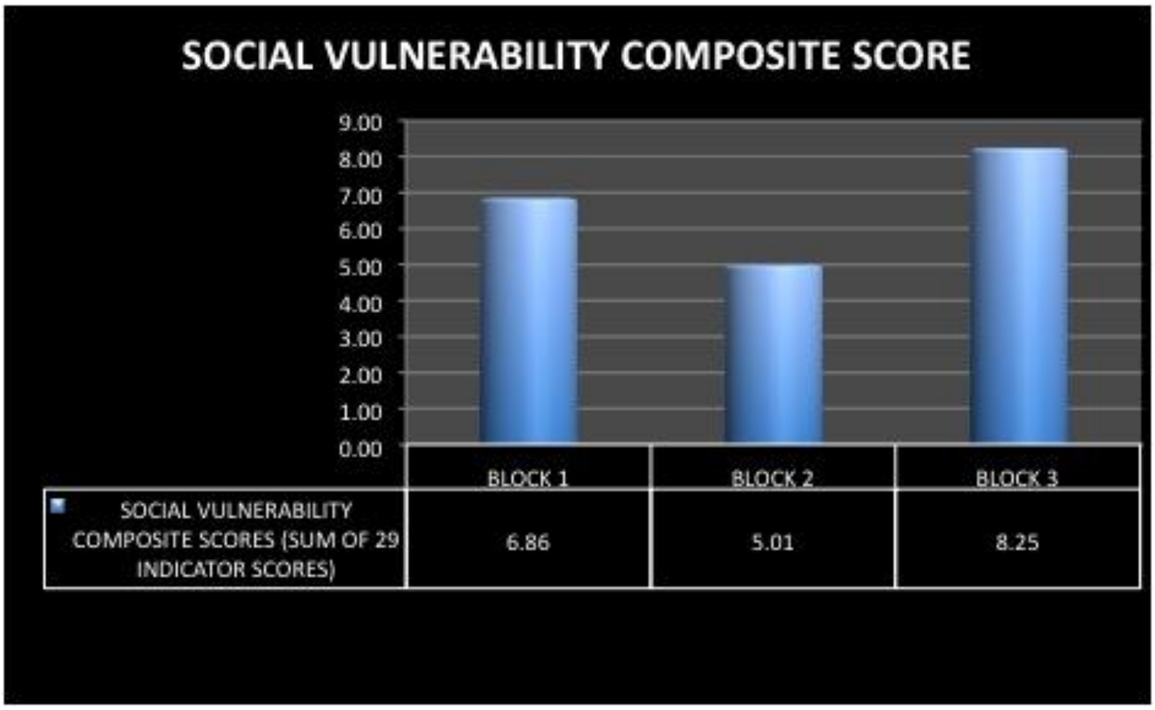


Figure 13: Social Vulnerability Composite Scores

5.4.8 SOCIAL VULNERABILITY COMPOSITE SCORES

Figure 14 is a visual representation of the Composite Social Vulnerability Scores derived from the *Social Vulnerability Index* for all 3 geographical blocks. Here again the results show that Block 2 has the lowest composite score, followed by Block 1 and Block 3 respectively. Furthermore, Figure 10 distinguishes a geographical representation of the composite scores of each Block on a map of Finnmark County. This map is the culmination for demonstrating the varying levels of Social Vulnerability and it forms the first layer in determining the overall Place-Vulnerability of Finnmark County. We now know where Social Vulnerability exists within the county and must now continue to determine where the varying levels Biophysical/Technological Vulnerability exist. Therefore, the next step in determining Place-Vulnerability for Finnmark County is to assess Biophysical/Technological Vulnerability.

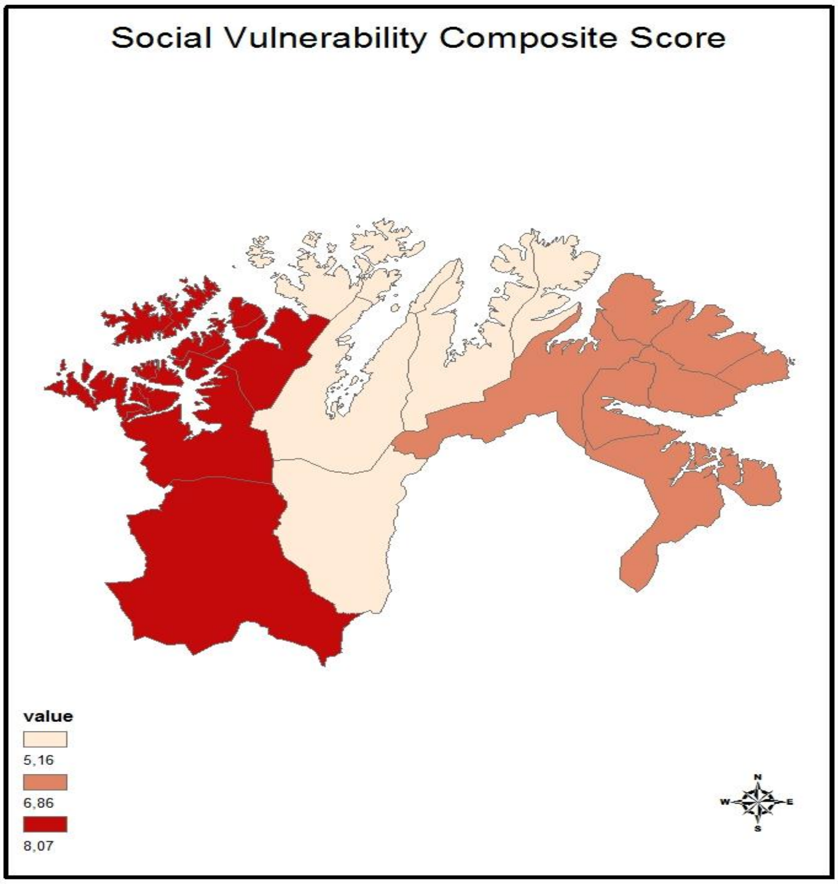


Figure 14: Map of Social Vulnerability Composite Scores – Finnmark County

5.5 ASSESSING BIOPHYSICAL/TECHNOLOGICAL VULNERABILITY

In short, Biophysical Vulnerability "is a function of the frequency and severity (or probability of occurrence) of a given type of hazard" (Brooks 2003, 4). It includes the identification of potential hazards (natural and technological), their frequency, and their locational impacts. This project is concerned, however, distinctly with the coastal geographical and environmental contexts that exist in Finnmark and how they affect or amplify the probability of Technological Hazards (or the effects towards shipping vessels) related to the transportation of Oil & Gas in the Arctic waters adjacent to the county. Therefore, the assessment of Biophysical Vulnerability in this project is focused on three areas: *Hazard Identification, Hazard Frequency,* and *Hazard Zone Delineation* in regards to the shipping lanes along the coast of Finnmark from the northeastern boarder with Barents Russia to the southern boarder at Torsvåg (See Section 4.5.7).

In order to analyze the Biophysical Vulnerability, or the hazards created from the county's geographical and environmental contexts, historical data was collected from the Norwegian Maritime Directorate's Marine Accident database. This database contains various types of shipping accidents reported to the Directorate between the years 1981 and 2011 along with a series of indicators reported for each event such as the geographical shipping area in which the accident occurred, accident date, the type of waters in which the accident occurred, wind direction and strength, wave height, darkness, visibility, and geographical constraints such as narrow corridors. A customized database was assembled using this data obtained from the Maritime Directorate and historical weather conditions obtained from the Norwegian Meteorological Institute's online database. This customized database includes the following indicators used to create and determine *Hazard Frequency*, *Hazard Recurrence*, and *Hazard Zone Delineation*:

5.5.1 HAZARD IDENTIFICATION

<u>Types of Accident Events (Shipping Hazard Identification)</u>

- Collision
- Contact Damage (Bridges, Wharf)
- Grounding
- Capsizing
- Stability Failure (without capsizing)
- Fire/Explosion
- Heavy Weather Damage
- Leakage

<u>Environmental Indicators (Environmental Hazard Identification)</u>

- Darkness
- Poor Visibility
- Severe Weather
- Geographical Constraints (Narrow Fjords, Corridors)
- Cold Operational Weather

Table 7: Hazard Identification by Accident Events and Environmental Indicators

5.5.2 HAZARD FREQUENCY RESULTS

After calculating the data from the custom database, the Hazard *Frequency* (% Chance per Year) was determined for all geographical shipping zones along the Coast of Finnmark County (See Section 4.5.7 for Calculation Methods). Figure 15 displays these results, in which the total number of the type of accident event was divided by 30 years of recorded history in the database.* From the chart below, we see that among all shipping zones there were a total of 30-recorded collisions over the 30 years of recorded information in the database. Therefore, the results display a 100% chance-per-year that a collision may occur along the total coastline of Finnmark County. Moreover, there were 86 grounding events recorded over this 30-year span, calculating into a 286.7% chance of occurrence per-year for this type of event. Contact Damage and Fire/Explosion events also have a significant *Hazard Frequency* Percentage, with 9 Contact Damage events and 10 Fire/Explosion events recorded, resulting in a 30% and 33.3% chance per year respectively.

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* All accidents in the database and their corresponding results pertain *only* to Cargo Shipping Vessels along the Coast of Finnmark County 1981 – 2011.

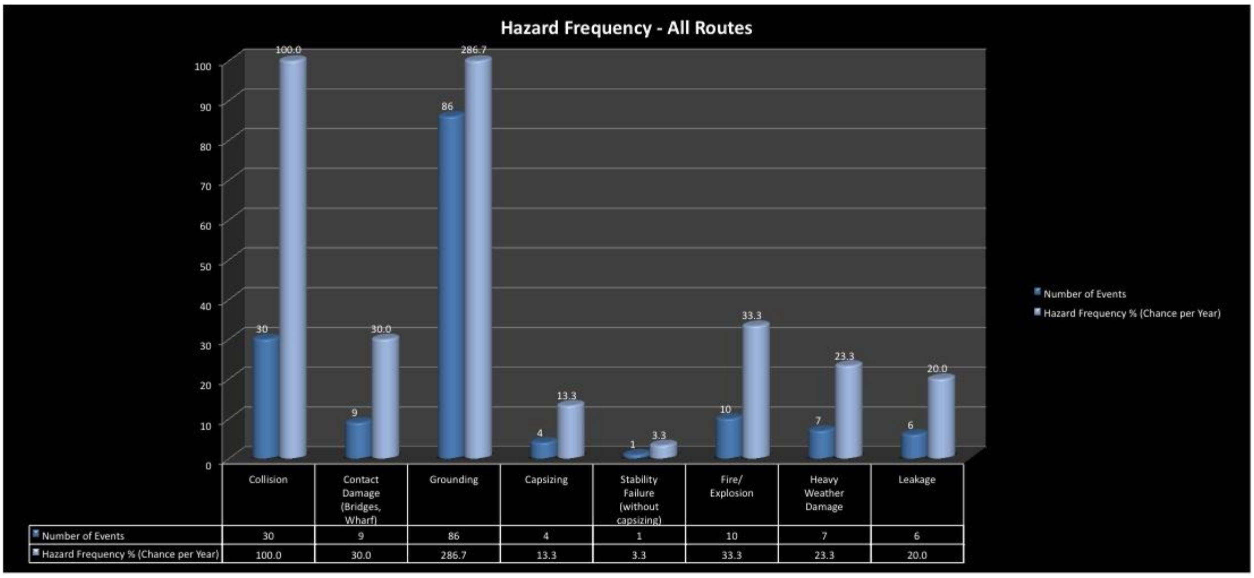


Figure 15: Hazard Frequency Chart for *All Routes* in Finnmark County

5.5.3 HAZARD RECCURENCE INTERVAL

Hazard Recurrence Intervals were additionally calculated for all routes along the Coast of Finnmark County. These results are the quotient of the total number of years on record (30) divided by the total number of events that occurred. Therefore, we see in Figure 16 that both Grounding and Collision events have a high Recurrence Interval with the recurrence of a Grounding event occurring once every 0.35 years (or nearly 3 events per year) and Collision events recurring once per every year between 1981 and 2011.

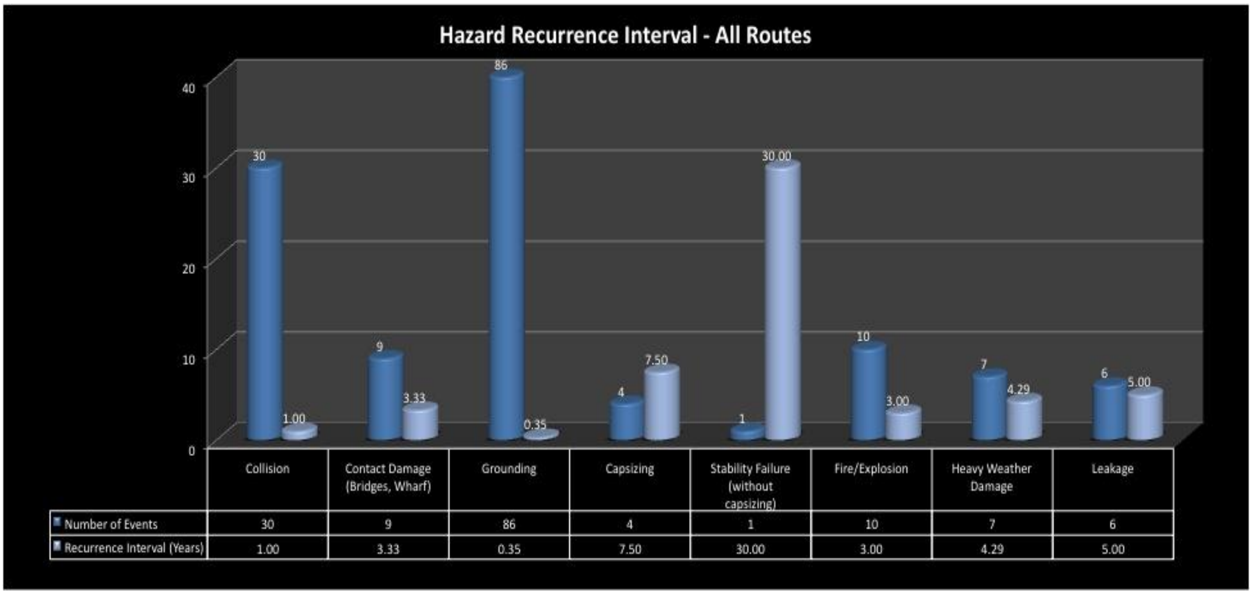


Figure 16: Hazard Recurrence Interval for *All Routes* in Finnmark County

5.5.4 HAZARD FREQUENCY AND RECURRENCE INTERVALS IN DEPTH

Data concerning *Hazard Frequency* and *Recurrence* Intervals were also analyzed more in depth pertaining to each individual geographical shipping zone. Organizing the data more specifically to reflect the type of accident, its frequency, and yearly interval rate gives a further view into the particular areas in which the events are most likely to occur, thus allowing for the identification of hazard zones.

5.5.4.1 TROMSØ – HAMMERFEST SHIPPING ZONE

Figure 17 displays the results for *Hazard Frequency* and *Hazard Recurrence* Intervals for the Tromsø to Hammerfest Shipping Zone. Within this particular zone, Grounding events represent the highest levels for both measures. According to the calculated data, a Grounding event occurred 13 times and therefore has a 43.3% annual chance of occurring and occurred approximately once every 2.3 years between 1981 and 2011. The next highest event was collisions, occurring 4 times over the 30-year record, representing a probability of 7.5% chance per year and a recurrence interval of one event approximately every 13.3 years. Other types of accident events such as Contact Damage, Capsizing, Fire/Explosion, Heavy Weather Damage, and Leakage had little to no occurrences on the record.

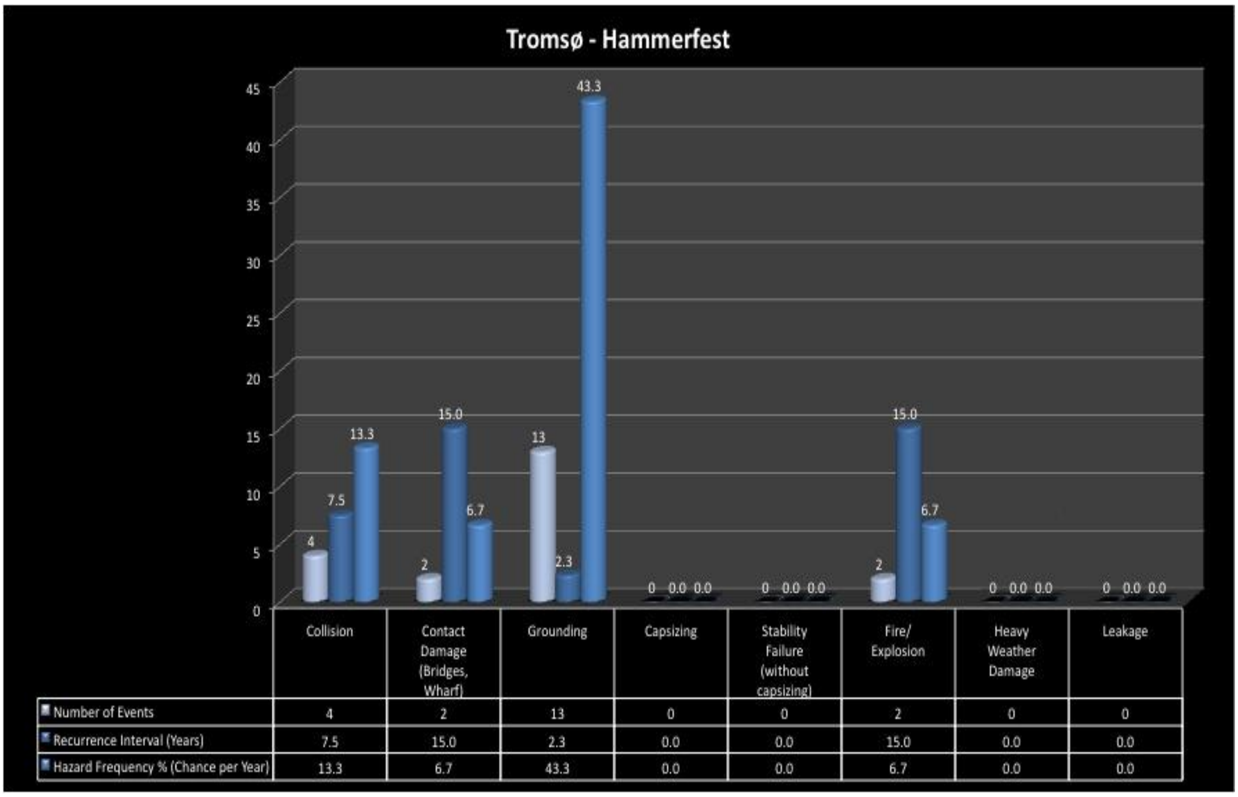


Figure 17: Hazard Frequency and Recurrence Intervals for Tromsø-Hammerfest Shipping Zone

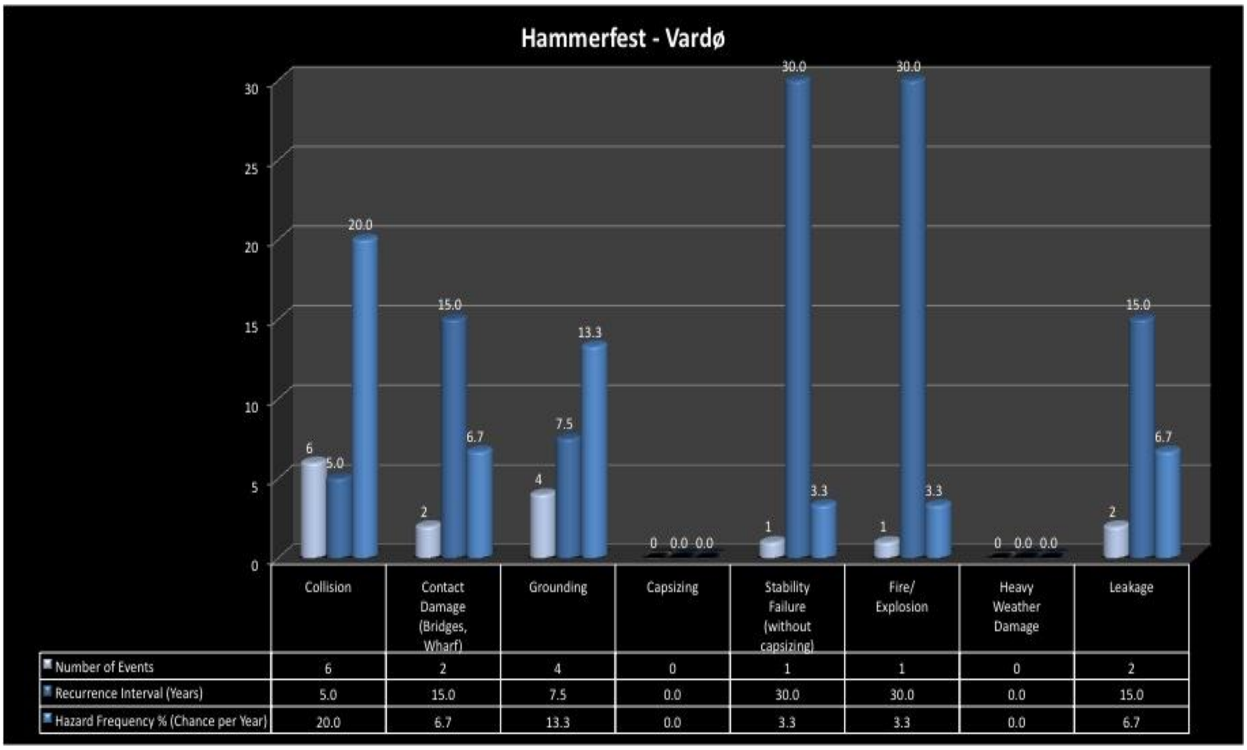


Figure 18: Hazard Frequency and Recurrence Intervals for the Hammerfest - Vardø Shipping Zone

5.5.4.2 HAMMERFEST – VARDØ SHIPPING ZONE

Figure 18 shows the results for the Hammerfest to Vardø Shipping Zone. There is little significance among the 8 different types of accident events in this zone. However, both Grounding and Collision events have a moderate Frequency percentages and Recurrence Intervals. Over the 30 recorded years in the database, there were 6 Collisions and 4 Groundings that occurred in this region. Therefore, Collisions have a *Hazard Frequency* percentage of 5% and a Recurrence Interval of once every 20 years. Groundings have a lower frequency at 13.3% and Recurrence Interval at approximately one event occurring every 13.3 years.

5.5.4.3 KORSFJORDEN – HOLMENGRÅ SHIPPING ZONE

The Korsfjorden - Holmengrå Shipping Zone (Figure 19) is significant in comparison to the other 7 geographical shipping zones in that it has the largest number of recorded Collisions and Grounding accident events. This region has, over the past 30 years, 15 records of Collision events and 39 Groundings on record. Looking specifically at Collisions, the *Hazard Frequency* for this type of event is a 50% chance of occurrence per year. Additionally, Collisions in this zone account for approximately 50% of the total recorded Collisions in all sea areas adjacent to the Coast of Finnmark. The *Hazard Recurrence* Interval for Collisions in this zone is one event every two years. The Frequency and Recurrence Interval for groundings are even greater in the Korsfjorden to Holmengrå shipping zone. The 39 events on record account for a Frequency of 130% chance per year with a Recurrence Interval of approximately one of these events occurring every 0.8 years. Moreover, Groundings in this region approximate 45% of all Groundings among all coastal areas off Finnmark County. Heavy Weather Damage is the third most event that has occurred here in the past 30 years with 6 events on record. This equates to a Frequency of 20% and a Recurrence Interval of one event per every 5 years.

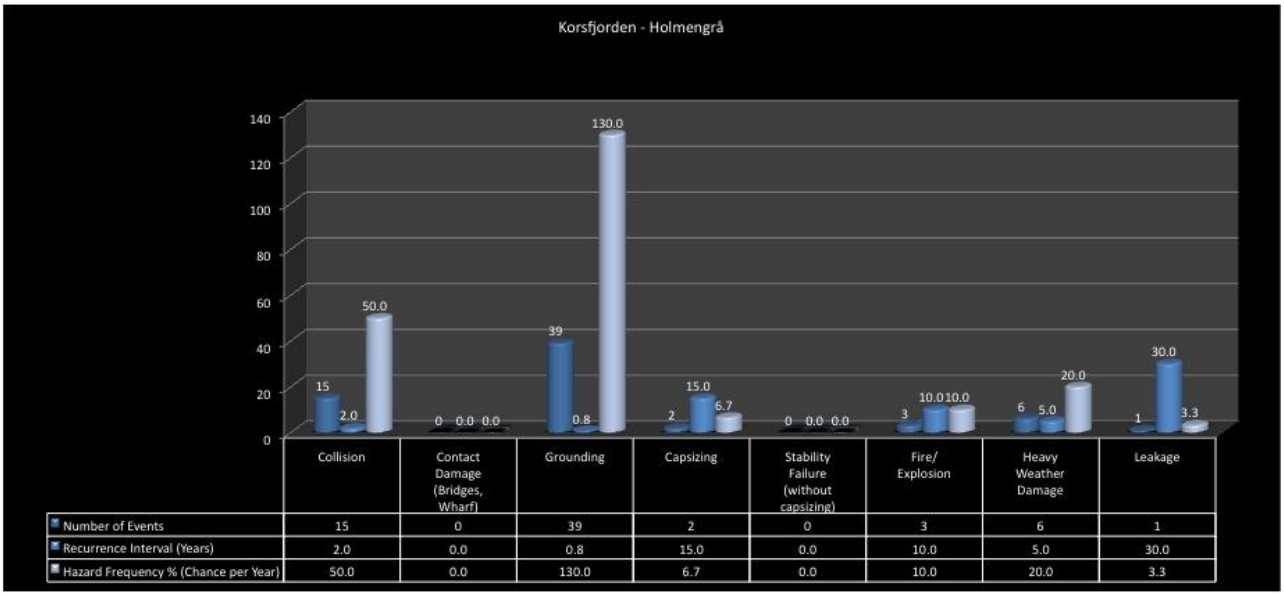


Figure 19: Hazard Frequency and Recurrence Intervals for the Korsfjorden - Holmengrå Shipping Zone

5.5.4.4 VARANGERFJORD SHIPPING ZONE

Within the Varangerfjord Shipping Zone, Grounding events occurred most often. Between 1981 and 2011 there were 7 Grounding events resulting in a 23.3% chance per year *Hazard Frequency* and a *Recurrence* Interval of approximately one event every 4.3 years. There were also three recorded events of Contact Damage and two recorded events of Collisions over the span of 30 years in this particular geographical area (See Figure 20).

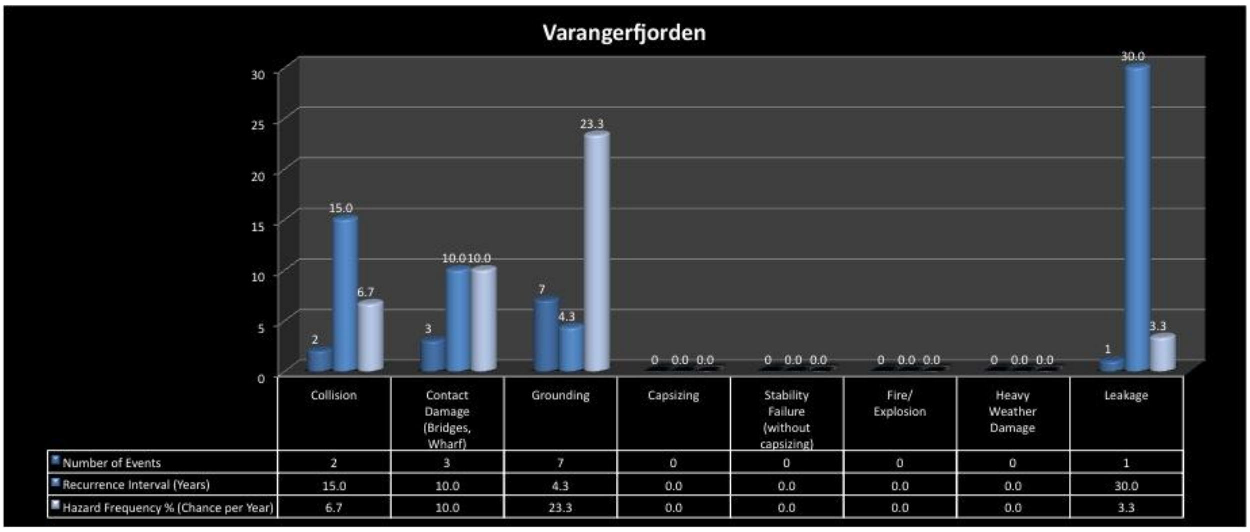


Figure 20: Hazard Frequency and Recurrence Intervals for the Varangerfjord Shipping Zone

5.5.4.5 VESTFINNMARKFJORDS SHIPPING ZONE

In the Vestfinnmarkfjords Shipping Zone (Figure 21), the accident type that occurred the most between 1981 and 2011 were Grounding events. Over the recorded time period, there were a total of 17 events of Groundings in these geographical waters. This accounts for a *Hazard Frequency* of 56.7% and a *Recurrence* Interval of one Grounding event every approximately 1.8 years. This geographical region therefore has the second highest number of recorded Grounding events in the coastal waters adjacent to Finnmark County.

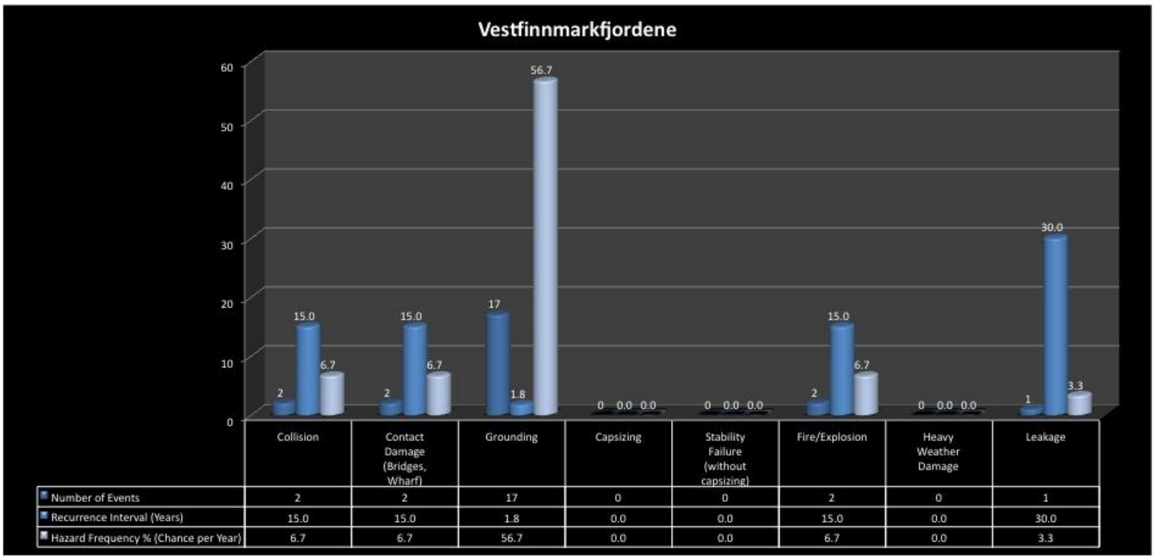


Figure 21: Hazard Frequency and Recurrence Intervals for the Vestfinnmarkfjords Shipping Zone

5.5.4.6 PORSANGER, LAKSEFJORD, AND TANAFJORD SHIPPING ZONE

Within the Porsanger, Lakesfjord, and Tanafjord Shipping Zone (Figure 22), there are a minimal total number of events across all accident types. The most Frequent type of event between 1981 and 2011 were Groundings, in which there were three on record. This translates to a Frequency of approximately 10% and a Recurrence Interval of one event every 10 years occurring in this region. There were also two records of Capsizing events over the past 30 years, according to the information from the Maritime Directorate database.

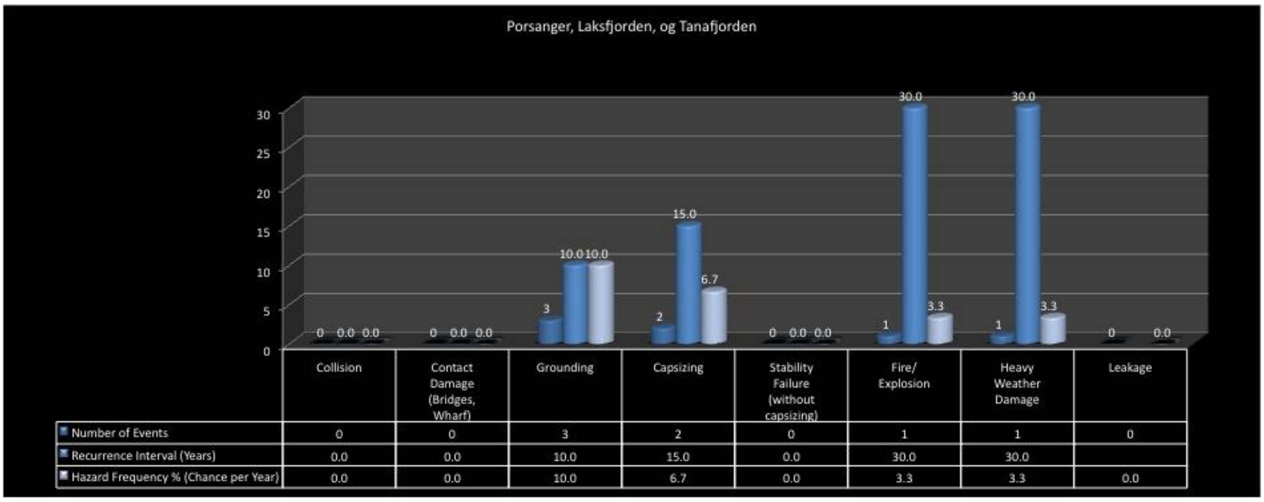


Figure 22: Hazard Frequency and Recurrence Intervals for the Porsanger, Laksefjord, and Tanafjord Shipping Zone

5.5.4.7 TORSVÅG FYR – HELNES FYR SHIPPING ZONE

The Torsvåg Fyr to Helnes Fyr Shipping Zone (Figure 23) has a relatively low number of total accident events on record. There were only three recorded events of Groundings, one Collision, one Fire/Explosion, one Heavy Weather Damage, and one Leakage event between 1981 and 2011. This geographical region therefore has the lowest number of recorded events between all 8 of the shipping zones adjacent to the Coast of Finnmark County and thus low levels of *Hazard Frequency* and *Recurrence* Intervals.

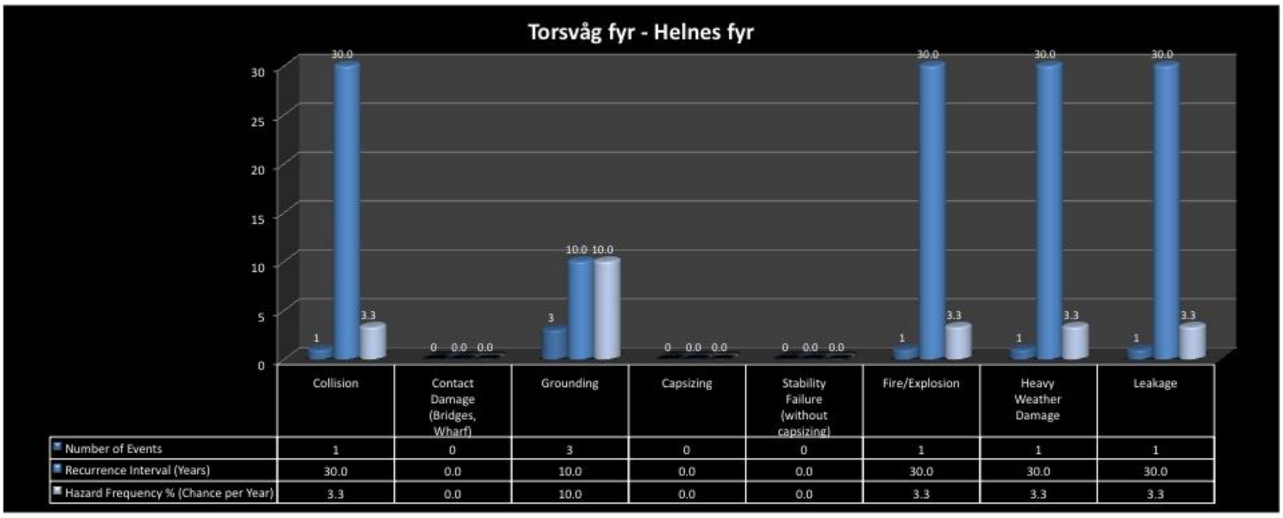


Figure 23: Hazard Frequency and Recurrence Intervals for the Torsvåg Fyr – Helnes Fyr Shipping Zone

5.5.4.8 SUMMARY OF RESULTS

From the recorded information in the Maritime Directorate database, the highest frequency for Grounding events among cargo vessels occurs within the Korsfjorden to Holmengrå shipping zone (39 events). The second most recorded Groundings occur in the Vestfinnmarkfjords zone (17 events) with the third most recorded within the Tromsø to Hammerfest region (13 events). All three of these shipping zones are located along the western coast of Finnmark County, an area with narrow shipping corridors between the fjords. Collisions also occurred most frequently in this geographical location. Further inquiry into the environmental conditions that exist in this region that may explain why these events were most likely to occur here will be the attention of the next section.

5.5.5. ACCIDENT EVENTS IN RELATION TO ENVIRONMENTAL INDICATORS

This section will assess the results derived from an inquiry into the accident events that occurred between 1981 and 2011 in relation to the environmental indicators listed in the database per individual accident report. The environmental indicators represent the following attributes:

Darkness: The number of events that occurred during twilight or nighttime.

Severe Weather: The number of events that occurred during periods with either high winds, high-recorded wave heights, or the combination of the two.

Poor Visibility: The number of events that occurred during periods of visibility less than 0.5 Nautical Miles

Geographical Constraints: The number of events that occurred in waters listed as Narrow Coastal Waters, In the Harbor, Along the Wharf, or Along Channels in the database.

Cold Weather: The number of events that occurred in periods where the temperature during operation was at or below freezing (0 Degrees Celsius).

Table 8: Definitions for Environmental Indicators

5.5.5.1 DARKNESS AS AN ENVIRONMENTAL INDICATOR

Figure 24, shown below, displays the types of accidents that occurred during periods of twilight or at nighttime for all sea areas adjacent to Finnmark County. Here we see that 53% of all Collisions, 50% of all Groundings and Capsizing, and 33% of all Leakage events occurred under the guise of darkness.

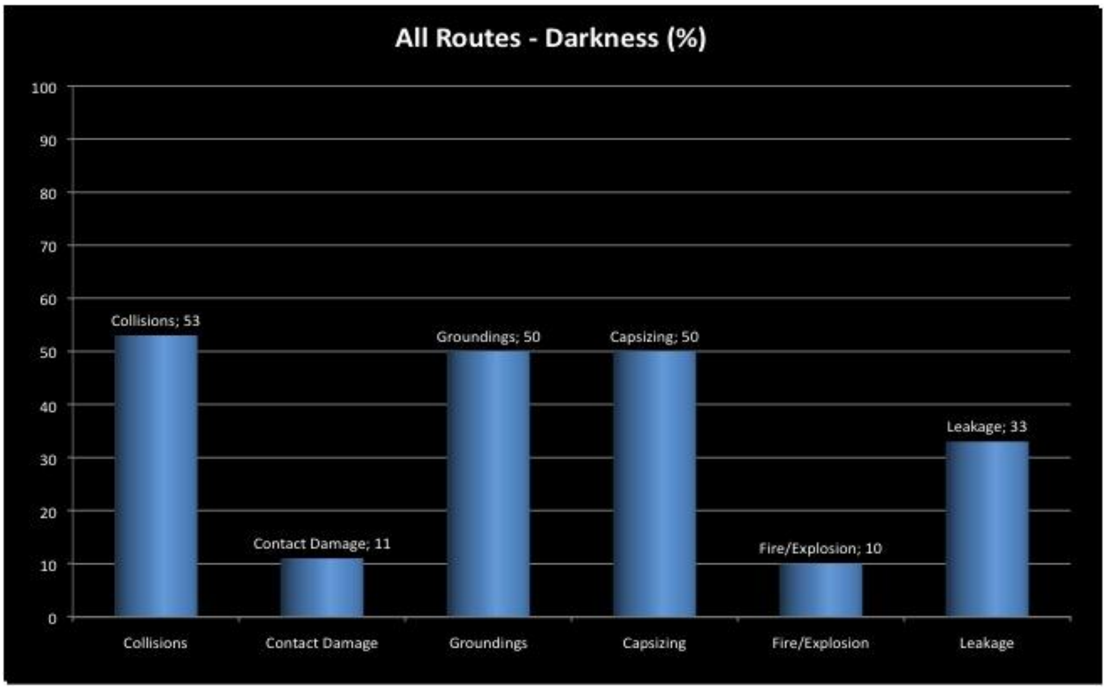


Figure 24: Percentage of All Accident Events Occurring in the Dark

5.5.5.2 SEVERE WEATHER AS AN ENVIRONMENTAL INDICATOR

Severe Weather, as Figure 25 displays, played a significant role in all the recorded accident events between 1981 and 2011. On average, approximately 50% of all accident types (except Contact Damage) occurred under such conditions where prevalent winds, waves, or the combination of the two existed.

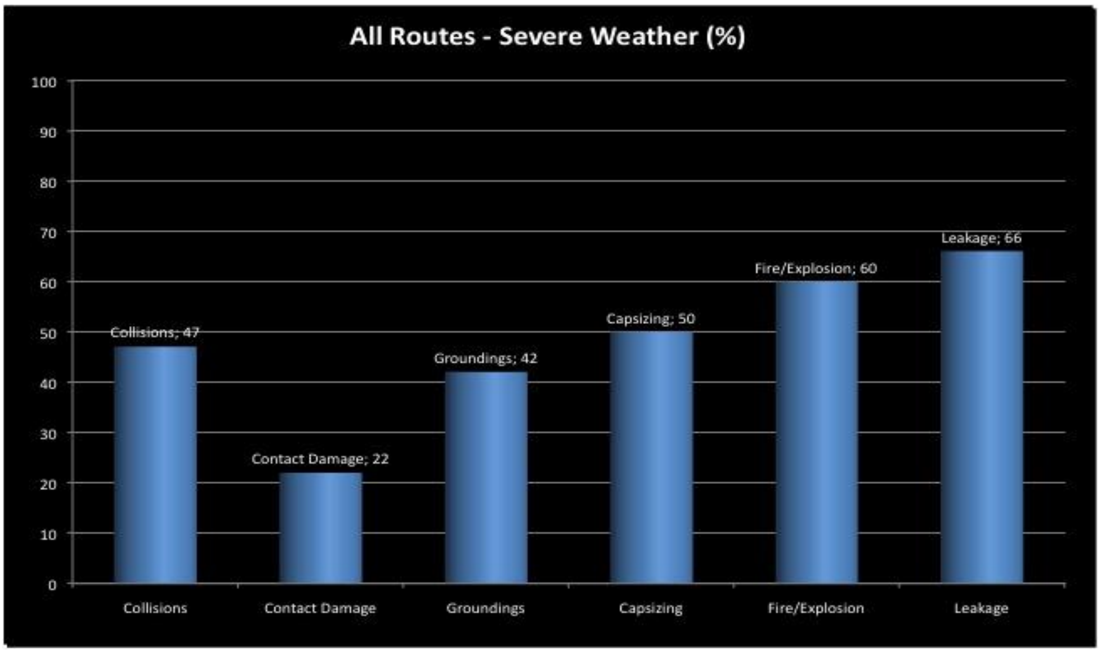


Figure 25: Percentage of All Accident Events Occurring under Severe Weather Conditions

5.5.5.3 POOR VISIBILITY AS AN ENVIRONMENTAL INDICATOR

Poor Visibility, according to the results shown in Figure 26, plays a significant role in the number of Collisions and Fire/Explosions that occurred. 30% of both of these types of accidents occurred when visibility reached levels of less than 0.5 Nautical Miles. 15% of all Groundings occurred during poor visibility conditions.

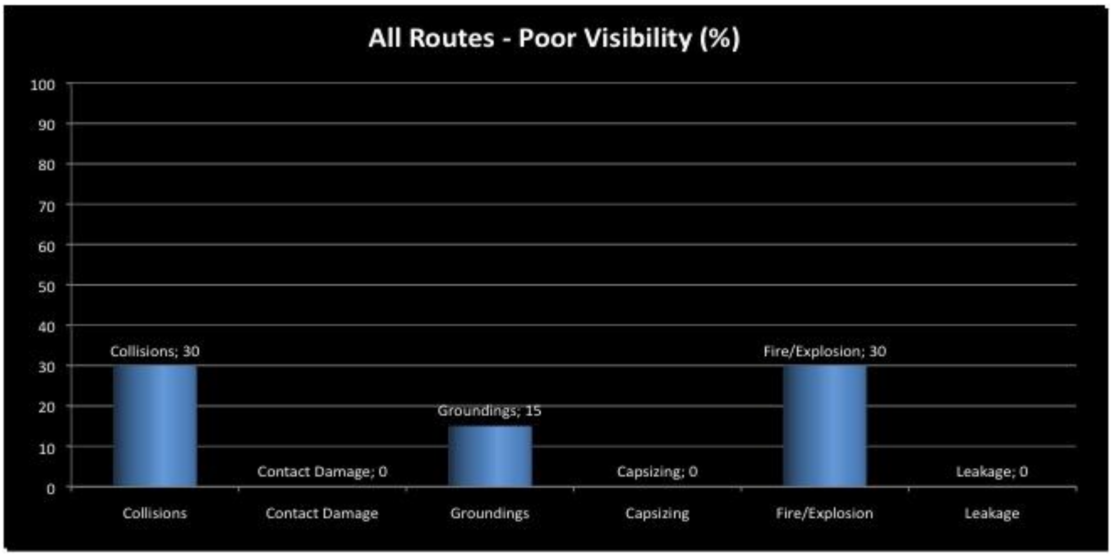


Figure 26: Percentage of all Accident Events Occurring during Periods of Poor Visibility

5.5.5.4 GEOGRAPHICAL CONSTRAINTS AS AN ENVIRONMENTAL INDICATOR

Results from the database stipulate here that geographically constraining areas such as narrow coastal waters, harbors, or channels had a large impact on both Collision and Grounding events between 1981 and 2011. Approximately 53% of all Collisions occurred in geographically constraining areas, where 48% of all Groundings accounted for occurred in the same types of waters (Figure 27).

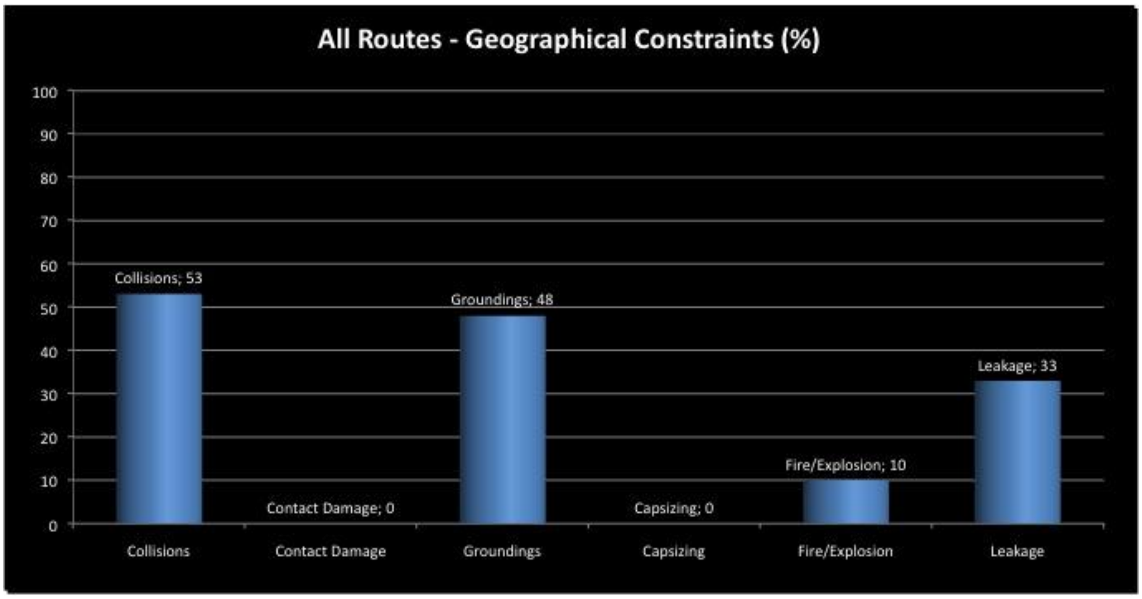


Figure 27: Percentage of all Accident Events Occurring in Geographically Constraining Areas

5.5.5.5 COLD OPERATIONAL WEATHER AS AN ENVIRONMENTAL INDICATOR

A significant amount of all types of accidents occurred when vessels were operating under temperatures at or below freezing (0 Degrees Celsius). 67% of all Leakage events, 56% of all Contact Damage events, 50% of Fire/Explosions, 44% of all Groundings, 43% of Collisions, and 25% of all Capsizing events occurred under freezing temperatures (Figure 28).

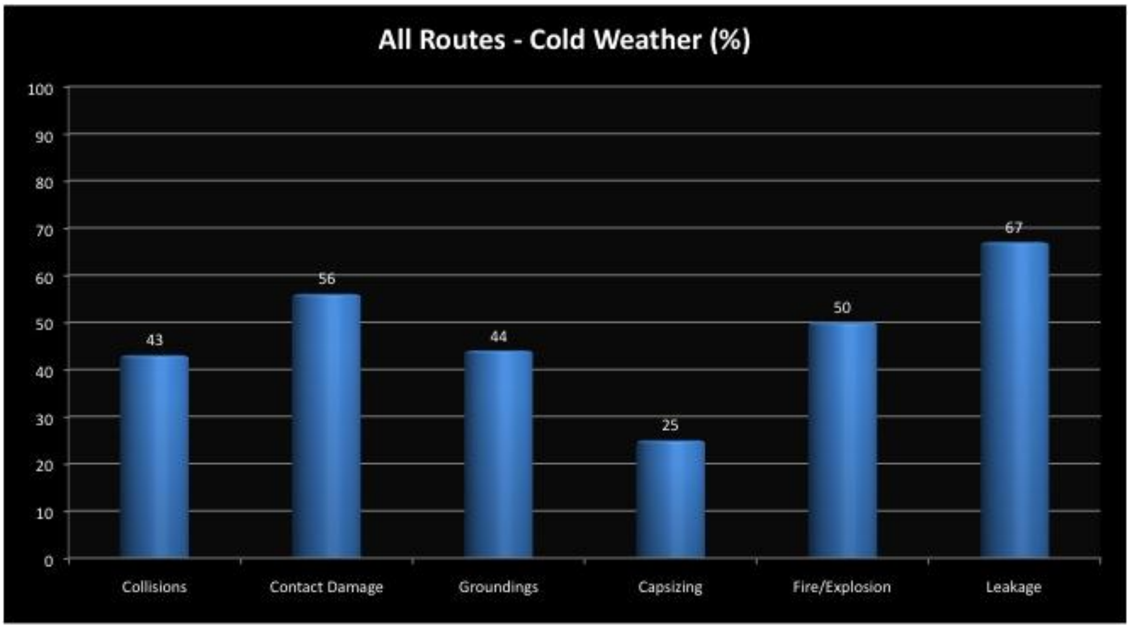


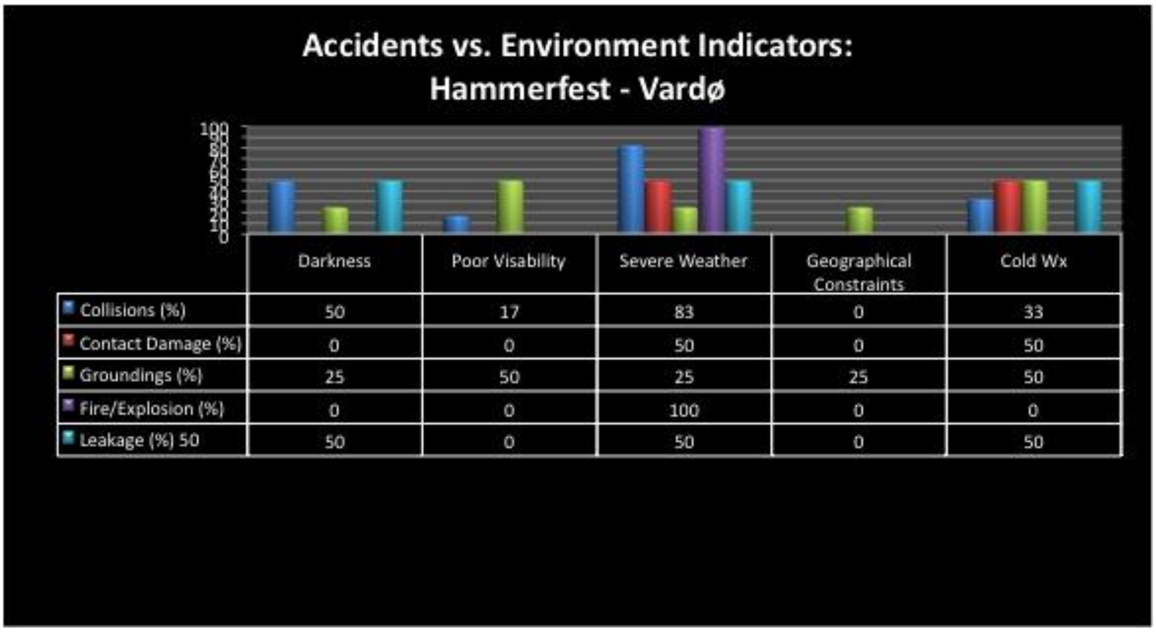
Figure 28: Percentages of all Accident Events Occurring during Cold Operational Temperatures

5.5.6 ENVIRONMENTAL INDICATORS IN DEPTH

Much like in Section 5.5.3, this section will take a more in depth view towards the effects of Environmental Indicators per specific geographical shipping zone. This allows for a more focused perspective on how the 5 types of Environmental Indicators were a factor in the reported accident types over the past 30 years by tying them specifically to a particular shipping region.

5.5.6.1 HAMMERFEST – VARDØ SHIPPING ZONE

The Arctic environment appears to play a significant role in the number of accidents reported along the Hammerfest to Vardø shipping zone (Figure 29). Approximately 83% of all reported Collisions in this region occurred where Severe Weather conditions prevailed and 100% for all Fires/Explosions along this route. Another pertinent result is that Darkness played a significant role in both Collision (50%) and Leakage events (50%). Additionally, Geographical Constraints affected approximately 25% of all Groundings and Cold Operational Temperatures were reported in a significant amount of Collisions, Contact Damage, Groundings, and Leakage events.



	Darkness	Poor Visability	Severe Weather	Geographical Constraints	Cold Wx
Collisions (%)	50	17	83	0	33
Contact Damage (%)	0	0	50	0	50
Groundings (%)	25	50	25	25	50
Fire/Explosion (%)	0	0	100	0	0
Leakage (%) 50	50	0	50	0	50

Figure 29: Accident Types and Environmental Indicators for Hammerfest – Vardø Shipping Zone

5.5.6.2 TROMSØ – HAMMERFEST SHIPPING ZONE

Along the Tromsø – Hammerfest Shipping Zone (Figure 30), Cold Operational Temperatures were reported in 50% of reported Collisions, Fire/Explosions, and Contact Damage events, where 23% of reported Groundings occurred under such conditions. Geographical Constraints were reported 50% of the time for Collisions and 31% of the time for Groundings. Severe Weather was also frequently reported in Collisions and Fire/Explosions (50%) and 23% of all Groundings along this region. Moreover, both Darkness and Poor Visibility account for 100% of all Collisions reported.

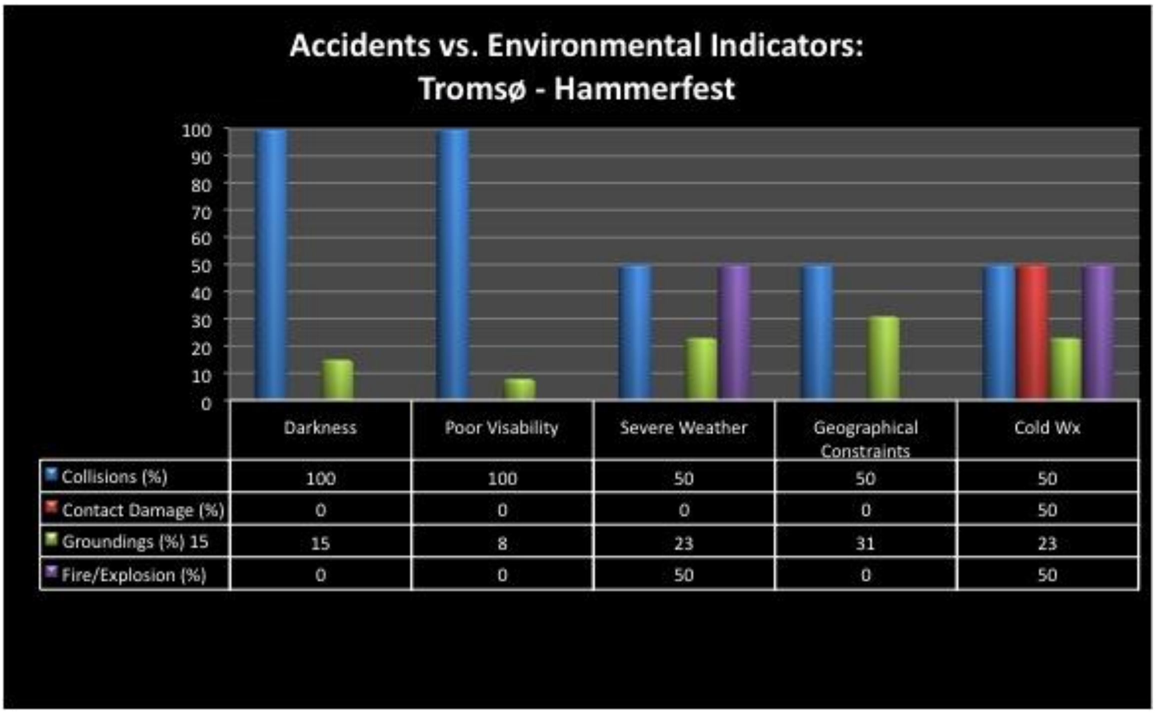


Figure 30: Accident Types and Environmental Indicators for Tromsø – Hammerfest Shipping Zone

5.5.6.3 KORSFJORDEN – HOLMENGRÅ SHIPPING ZONE

The Arctic elements were reported in many occurrences of the reported accidents within the Korsfjorden – Holmengrå Shipping Zone between 1981 and 2011. Darkness was reported as an indicator in 40% of Collisions, 56% of Groundings, and 100% of Capsizing events. Poor Visibility was a factor in 27% of occurring Collisions. Severe Weather was reported frequently as an Environmental Indicator for Fire/Explosions (66%), Groundings (56%), and in Capsizing events (50%). Geographical Constraints were another frequently observed indicator accounting for 100% of Leakage events, 92% of Groundings, and 87% of Collisions within this area. Cold Operational Temperatures also were reported 100% of the time in Leakage events, while also being reported 50% of the time in Heavy Weather Damage and Contact Damage events. 44% and 33% of Groundings and Collisions, respectively, were reported during periods of temperature at or below 0 Degrees Celsius.

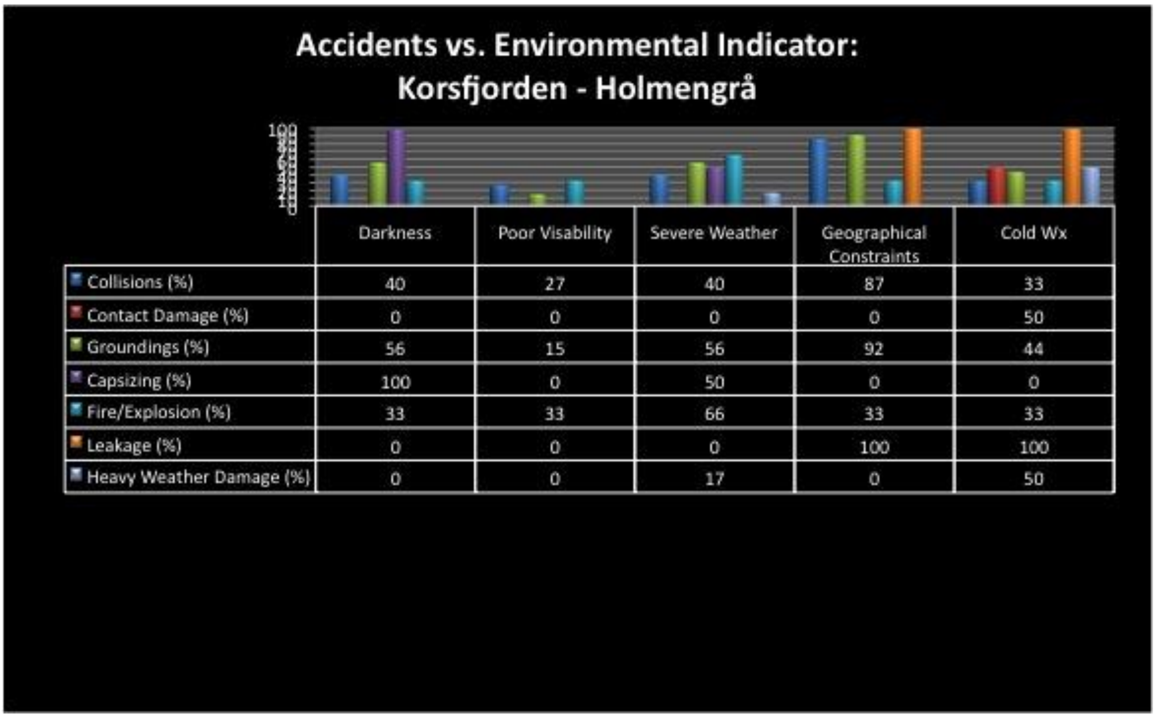


Figure 31: Accident Types and Environmental Indicators for Korsfjorden – Holmengrå Shipping Zone

5.5.6.4 VARANGERFJORD SHIPPING ZONE

Of most significance within the Varangerfjord Shipping Zone were Severe Weather, Geographical Constraints, and Cold Operational Temperatures (Figure 32). Severe Weather was reported in 100% of Leakage events and 50% of all Collisions. 42% of all Groundings occurred within this region due to Geographical Constraints. Once again, Cold Operational Temperatures were frequently reported, accounting for 100% of all Collisions and Contact Damage events and 42% of all reported Groundings.

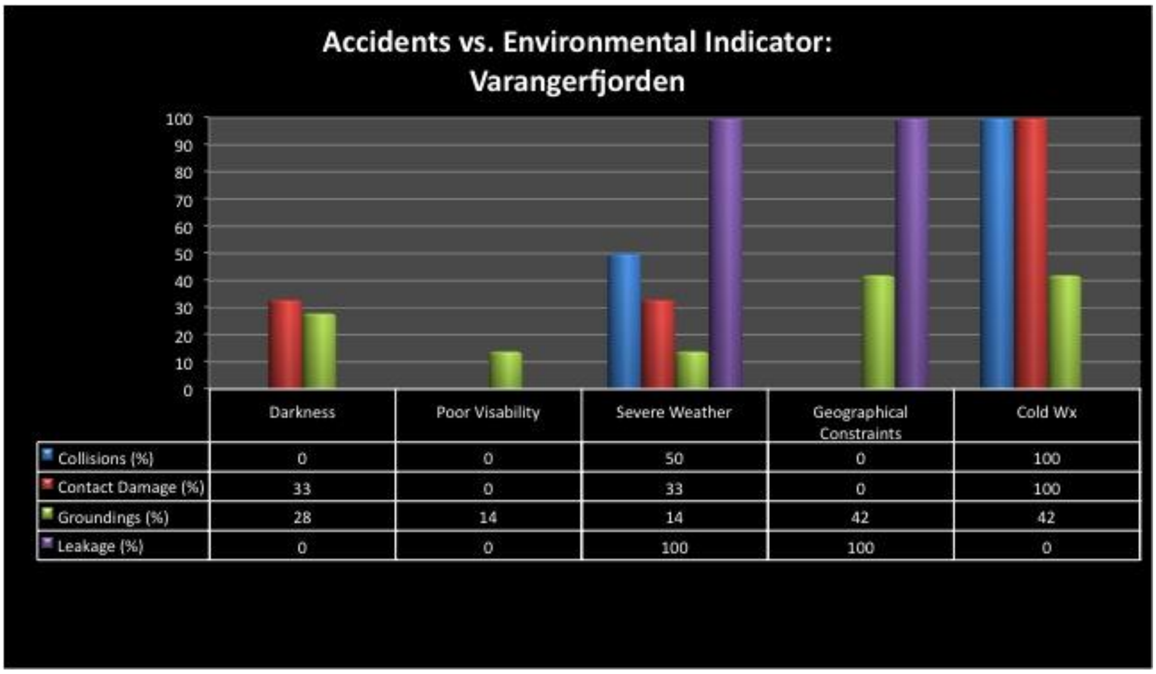


Figure 32: Accident Types and Environmental Indicators for Varangerfjord Shipping Zone

5.5.6.5 VESTFINNMARKFJORDS SHIPPING ZONE

Darkness was indicated in 71% of Groundings and 50% of Collisions within the Vestfinnmarkfjords Shipping Zone (Figure 33). Cold Operational Temperatures were reported in 100% of both Fire/Explosions and Leakage events, and 53% and 50% respectively in Groundings and Collisions. Geographical Constraints also were indicated in 50% of all Collisions within this region.

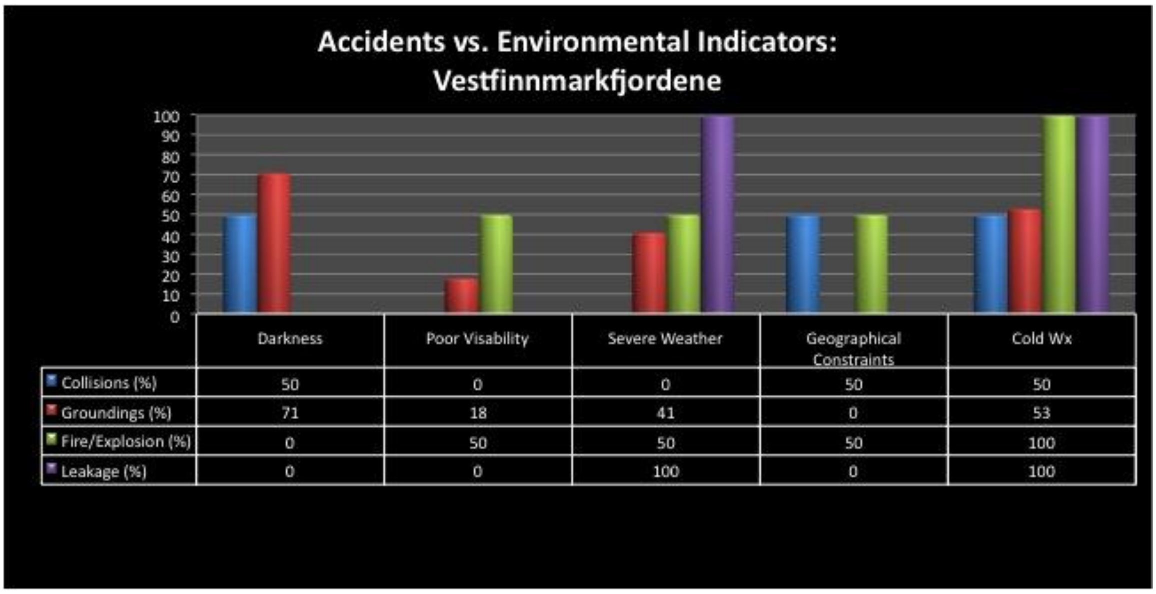


Figure 33: Accident Types and Environmental Indicators for the Vestfinnmarkfjords Shipping Zone

5.5.6.6 PORSANGER, LAKSEFJORD, AND TANAFJORD SHIPPING ZONE

Comparatively, out of all 7 shipping zones, the Porsanger, Laksefjord, and Tanafjord region faired relatively low in terms of reported environmental indicators (Figure 34). Nearly 1/3 of all Groundings occurred under Darkness, Poor Visibility, Severe Weather, and Geographical Constraints. Cold Operational Temperatures were reported in 66% of Groundings and 50% of all Capsizing events.

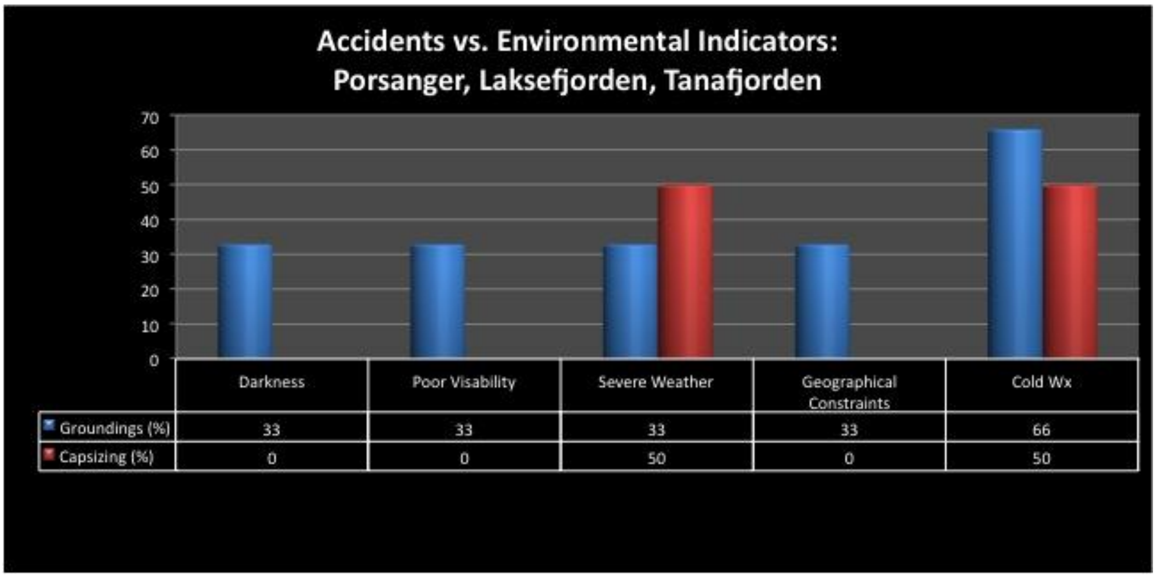


Figure 34: Accident Types and Environmental Indicators for Porsanger, Laksefjord, and Tanafjord Shipping Zone

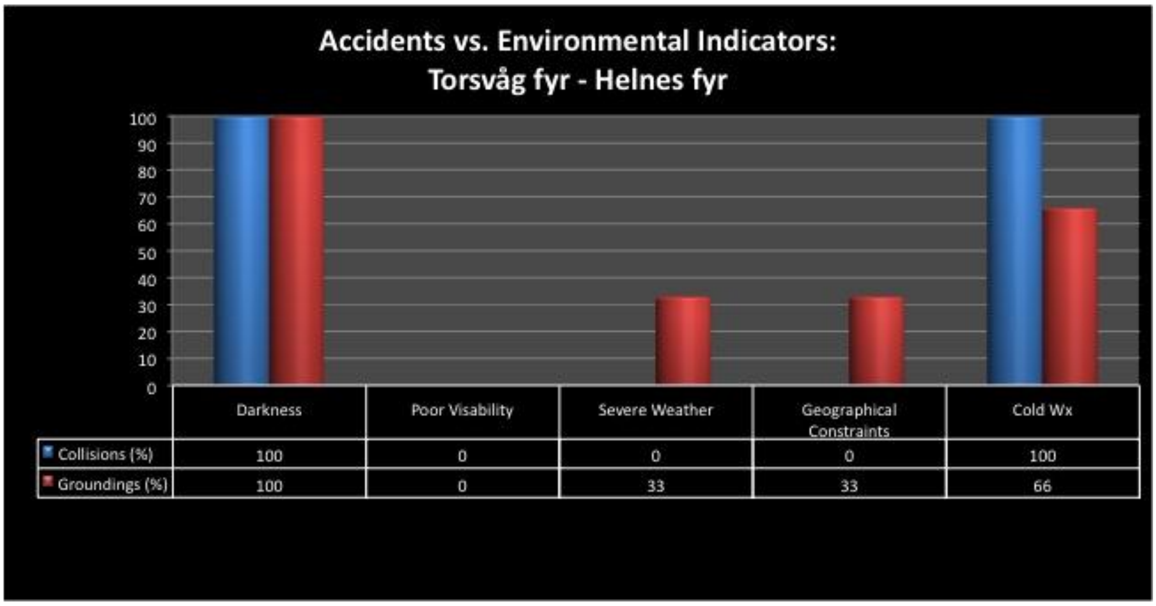


Figure 35: Accident Types and Environmental Indicators for Torsvåg Fyr – Helnes Fyr Shipping Zone

5.5.6.7 TORSVÅG FYR – HELNES FYR SHIPPING ZONE

Cold Operational Temperatures and Darkness were the two largest Environmental Indicators reported along the Torsvåg fyr to Helnes fyr Shipping Zone. Darkness accounted for 100% of Collisions and Groundings, where Cold Operational Temperatures were indicated 100% of the time in Collisions and in 66% of all reported Groundings among this region (Figure 35).

5.5.6.8 SUMMARY OF RESULTS

Analyzing the recorded data of Environmental Indicators per each Geographical Shipping Zone allows for determining the extent to which Arctic environmental conditions play a role in each type of shipping accident. The results show that the 5 identified Environmental Indicators had the largest impact along the Korsfjorden – Holmengrå Shipping Zone, followed by the Hammerfest – Vardø Shipping Zone and within the Vestfinnmarkfjords. Environmental Indicators were reported as the least significant among the accidents that occurred within the Porsanger, Laksefjord, and Tanafjord Shipping Zone and the Torsvåg Fyr – Helnes Fyr Shipping Zone. Environmental Indicators were moderate in the Tromsø – Hammerfest and Varangerfjord Shipping Zones.

5.5.7 HAZARD ZONE DELINEATION

Hazard Zone Delineation can now be determined through analyzing the *Hazard Frequency*, *Hazard Recurrence* Intervals, and *Environmental Indicators*. In Table 11, each Geographical Shipping Lane has been assigned a Risk Level (Low, Medium, High) based on its *Hazard Frequency* Percentage over all types of Accident Events, where 0-20% represents Low Risk, 21-49% represents Medium Risk, and 50^{+}% represents High Risk. Furthermore, each Risk Level is given a code, where Low Risk equals 1, Medium Risk equals 2, and High Risk equals 3. Therefore, from these results, each Geographical Shipping Zone can be ranked from Low to High Risk.[*] The results display that the Korsfjorden – Holmengrå Shipping Zone has the highest level of risk, where the Torsvåg Fyr – Helnes Fyr Shipping Zone has the lowest level of risk.

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[*] In the event where there is a Risk Level point tie, the highest Hazard Frequency Percentage for the highest Risk Level category is factored in.

5.5.8 ASSESSMENT OF BIOPHYSICAL/TECHNOLOGICAL VULNERABILITY

Given that the Geographical Shipping Lanes do not directly correspond with the boarders of each Geographical Block, each Block was assigned a corresponding number of Shipping Lanes (See Table 9). The cumulative score of the Risk Level Coding, shown in Table 12, then determines the identification of the most to least hazardous, or Technologically Vulnerable Geographical Block. These results show that Block 3 has the highest level of Risk (62 points), followed by Block 2 (59 Points) and Block 1 (51 Points) based on the accident event database from 1981 – 2011. Biophysical Vulnerability is constructed when Environmental Indicators are also considered. Based on the environmental indicator data from Sections 5.5.6.1 – 5.5.6.7, we can conclude that Blocks 2 and 3 are also the regions where the effects of the Arctic environment play the most significant role in each accident type that occurred over the 30 years of recorded data. It is therefore determined that the most Biophysically Vulnerable Geographical Block in Finnmark County is Block 3, followed by Block 2 and Block 1.

Geographical Shipping Zone	*Geographical Blocks Covered in Zone*
Hammerfest – Vardø	Blocks 1, 2, 3
Tromsø – Hammerfest	Block 3
Korsfjorden – Holmengrå	Blocks 1, 2, 3
Varangerfjorden	Block 1
Vestfinnmarkfjordene	Blocks 2, 3
Porsanger, Laksefjord, Tanafjord	Blocks 1, 2
Torsvåg – Helnes fyr	Blocks 2, 3

Table 9: Geographical Shipping Areas and Corresponding Geographical Block Assignments

Geographical Shipping Zone	*Total Risk Level*	*Rank*
Korsfjorden – Holmengrå	15	1
Vestfinnmarkfjords	13	2
Tromsø – Hammerfest	13	3
Hammerfest – Vardø	12	4
Varangerfjord	12	5
Porsanger, Laksefjord, Tanafjord	10	6
Torsvåg Fyr – Helnes Fyr	9	7

Table 10: Hazard Zone Delineation by Total Risk Level, Rank

Tromsø - Hammerfest (B3)			
Accident Type	Hazard Frequency (% Chance per Year)	Risk Level	CODE
Collision	13.3%	MEDIUM	2
Contact Damage	6.7%	MEDIUM	2
Grounding	43.3%	HIGH	3
Capsizing	0.0%	LOW	1
Stability Failure	0.0%	LOW	1
Fire/Explosion	6.7%	MEDIUM	2
Heavy Weather Damage	0.0%	LOW	1
Leakage	0.0%	LOW	1
Hammerfest - Vardø (B1, B2, B3)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	20%	MEDIUM	2
Contact Damage	6.7%	MEDIUM	2
Grounding	13.3%	MEDIUM	2
Capsizing	0%	LOW	1
Stability Failure	3.3%	LOW	1
Fire/Explosion	3.3%	LOW	1
Heavy Weather Damage	0%	LOW	1
Leakage	6.7%	MEDIUM	2
Korsfjorden - Holmengrå (B1, B2, B3)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	50%	HIGH	3
Contact Damage	0%	LOW	1
Grounding	130%	HIGH	3
Capsizing	6.7%	MEDIUM	2
Stability Failure	0%	LOW	1
Fire/Explosion	10%	MEDIUM	2
Heavy Weather Damage	20%	MEDIUM	2
Leakage	3.3%	LOW	1
Varangerfjorden (B1)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	6.7%	MEDIUM	2
Contact Damage	10%	MEDIUM	2
Grounding	23.3%	HIGH	3
Capsizing	0%	LOW	1
Stability Failure	0%	LOW	1
Fire/Explosion	0%	LOW	1
Heavy Weather Damage	0%	LOW	1
Leakage	3.3%	LOW	1
Vestfinnmarkfjordene (B2, B3)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	6.7%	MEDIUM	2
Contact Damage	6.7%	MEDIUM	2
Grounding	56.7%	HIGH	3
Capsizing	0%	LOW	1
Stability Failure	0%	LOW	1
Fire/Explosion	7%	MEDIUM	2
Heavy Weather Damage	0%	LOW	1
Leakage	3.3%	LOW	1
Porsanger, Laksfjorden, and Tanafjorden (B1, B2)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	0%	LOW	1
Contact Damage	0%	LOW	1
Grounding	10%	MEDIUM	2
Capsizing	6.7%	MEDIUM	2
Stability Failure	0%	LOW	1
Fire/Explosion	3.3%	LOW	1
Heavy Weather Damage	3.3%	LOW	1
Leakage	0%	LOW	1
Torsvåg fyr - Helnes fyr (B2, B3)			
Accident Type	Hazard Frequency (% Chance per Year)	Code	
Collision	3.3%	LOW	1
Contact Damage	0%	LOW	1
Grounding	10%	MEDIUM	2
Capsizing	0%	LOW	1
Stability Failure	0%	LOW	1
Fire/Explosion	3.3%	LOW	1
Heavy Weather Damage	3.3%	LOW	1
Leakage	3.3%	LOW	1

Table 11: Hazard Zone Delineation by Hazard Frequency, Risk Level Assessment

Accident Type	*Block1*	*Block 2*	*Block 3*
Collision	10	9	10
Contact Damage	6	7	8
Grounding	10	12	13
Capsizing	6	7	6
Stability Failure	4	5	5
Fire/Explosion	5	7	8
Heavy Weather Damage	5	6	6
Leakage	5	6	6
TOTAL	**51**	**59**	**62**

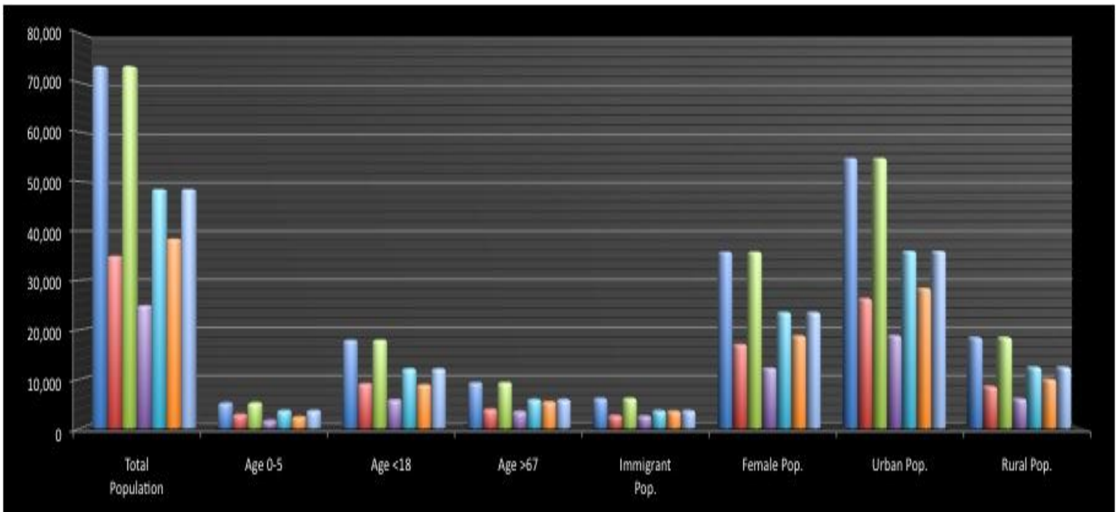
Table 12: Cumulative Geographical Shipping Zone Risk Level Scores per Geographical Block in Finnmark County

5.6 PLACE-VULNERABILITY PER SPECIFIC SHIPPING ZONE

This section analyzes the extent to which each of the Social Vulnerability Indicators is affected by a potential shipping hazard per individual Geographical Shipping Zone. Figures 36-39 depict the statistics of each *Social Vulnerability Index* Indicator per for each one of the 7 Shipping Zones along the Coast of Finnmark County. Based on the geographical Block assignments per Shipping Zone from Table 10, these statistics in the following Figures below demonstrate that Block 3 has the highest level of Social Vulnerability, followed by Block 1 and Block 2 respectively.

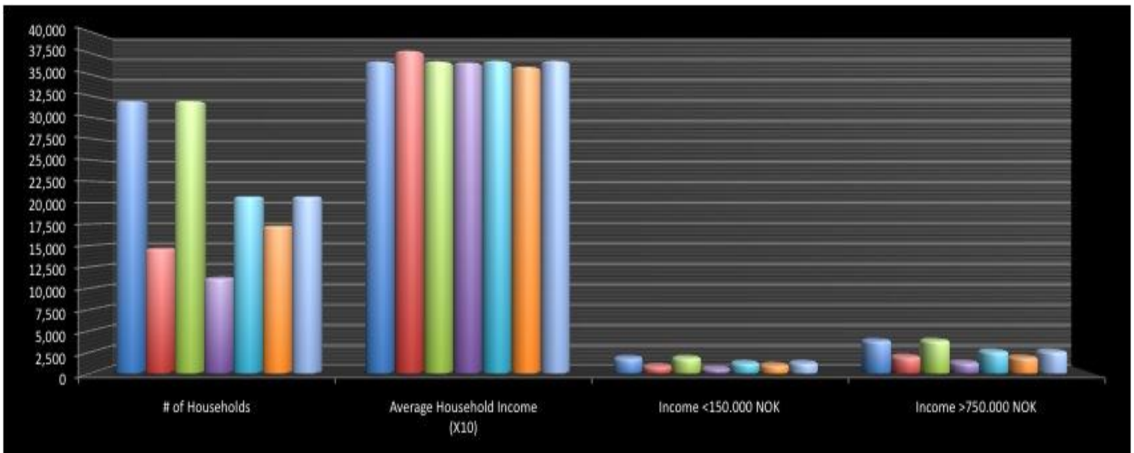
5.7 OVERALL PLACE-VULNERABILITY RESULTS

Place-Vulnerability is the intersection between where hazards exist Biophysical/Technological Vulnerability) and where the population is most susceptible (Social Vulnerability) (Cutter 2000, 733). In Section 5.5, the results from the Biophysical/Technological Vulnerability analysis show that Block 3 is the geographical region with the highest risk to physical exposure from hazard events derived from historical shipping accident records over the past 30 years. The results from *the Social Vulnerability Index* from Section 5.4 and in Figures 36 – 39 where the Indicators from the SoVI are assigned to each specific Shipping Zone suggest also that Block 3 is the most Socially Vulnerable geographical region. Combining these two elements in the *Hazards-of-Place* framework demonstrates that Block 3 has the highest level of Place-Vulnerability within Finnmark County (Dark red area in Figure 40).



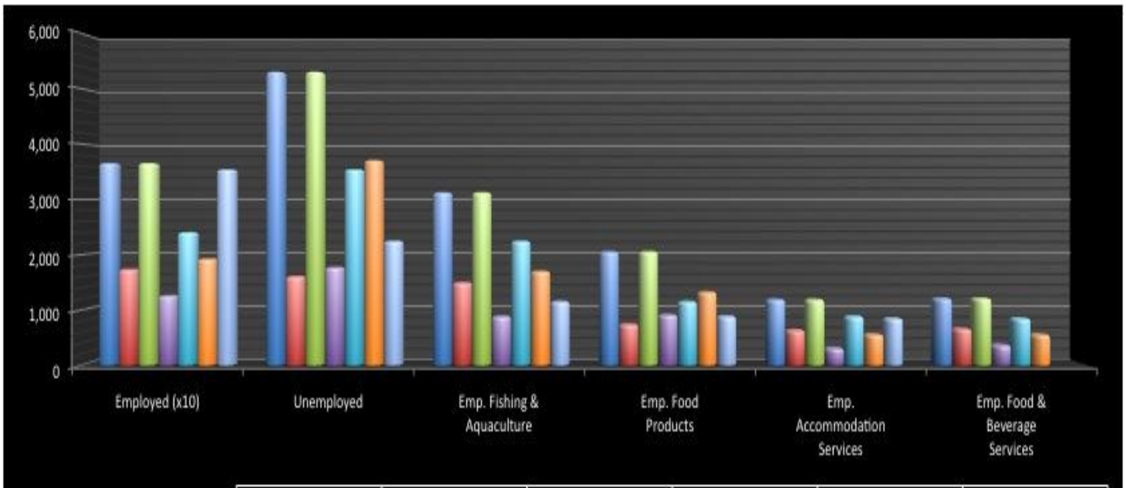
	Total Population	Age 0-5	Age <18	Age >67	Immigrant Pop.	Female Pop.	Urban Pop.	Rural Pop.
Hammerfest-Vardø	73,417	5,157	17,902	9,274	6,086	35,832	54,831	18,487
Tromsø-Hammerfest	34,966	2,812	9,068	3,867	2,589	17,048	26,396	8,529
Korsfjorden-Holmengrå (Bøkfjorden)	73,417	5,157	17,902	9,274	6,086	35,832	54,831	18,487
Varangerfjorden	24,924	1,564	5,808	3,437	2,523	12,278	18,862	6,031
Vestfinnmarkfjordene	48,493	3,593	12,094	5,837	3,563	23,554	35,969	12,456
Porsanger, Laksefjorden, Tanafjorden	38,451	2,345	8,834	5,407	3,497	18,784	28,435	9,958
Torsvåg - Helnes fyr	48,493	3,593	12,094	5,837	3,563	23,554	35,969	12,456

Figure 36: Population Indicators (SoVI) Statistics per Individual Shipping Zone



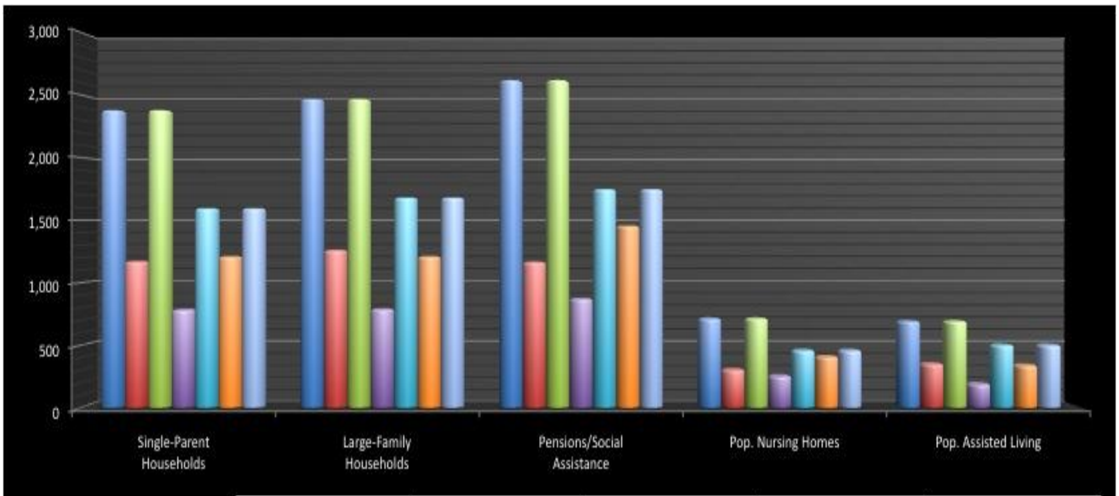
	# of Households	Average Household Income (X10)	Income <150.000 NOK	Income >750.000 NOK
Hammerfest-Vardø	31,955	36,578.9	1,836	3,871
Tromsø-Hammerfest	14,655	37,833.3	844	1,984
Korsfjorden-Holmengrå (Bøkfjorden)	31,955	36,578.9	1,836	3,871
Varangerfjorden	11,197	36,471.7	588	1,277
Vestfinnmarkfjordene	20,758	36,641.7	1,248	2,594
Porsanger, Laksefjorden, Tanafjorden	17,290	35,960.9	992	1,887
Torsvåg - Helnes fyr	20,758	36,641.7	1,248	2,594

Figure 37: Households/Annual Income Indicators (SoVI) Statistics by Individual Shipping Zone



	Employed (x10)	Unemployed	Emp. Fishing & Aquaculture	Emp. Food Products	Emp. Accommodation Services	Emp. Food & Beverage Services
Hammerfest-Vardø	3,660.7	5,318	3,129	2,058	1,187	1,211
Tromsø-Hammerfest	1,735.5	1,606	1,492	736	633	659
Korsfjorden-Holmengrå (Bøkfjorden)	3,660.7	5,318	3,129	2,058	1,187	1,211
Varangerfjorden	1,255.0	1,770	880	909	304	361
Vestfinnmarkfjordene	2,405.7	3,548	2,249	1,149	883	847
Porsanger, Laksefjorden, Tanafjorden	1,925.2	3,712	1,700	1,322	554	552
Torsvåg - Helnes fyr	3,548	2,249	1,149	883	847	

Figure 38: Employment/Industry Indicators (SoVI) Statistics by Individual Shipping Zone



	Single-Parent Households	Large-Family Households	Pensions/Social Assistance	Pop. Nursing Homes	Pop. Assisted Living
Hammerfest-Vardø	2,382	2,472	2,623	715	693
Tromsø-Hammerfest	1,171	1,261	1,166	305	352
Korsfjorden-Holmengrå (Bøkfjorden)	2,382	2,472	2,623	715	693
Varangerfjorden	785	789	873	255	191
Vestfinnmarkfjordene	1,597	1,683	1,750	460	502
Porsanger, Laksefjorden, Tanafjorden	1,211	1,211	1,457	410	341
Torsvåg - Helnes fyr	1,597	1,683	1,750	460	502

Figure 39: Family Structure/Social Assistance Indicators (SoVI) Statistics by Individual Shipping Zone

Block 3 shows results from the Biophysical/Technological Hazard Vulnerability scores as the lowest of the three geographical blocks comparatively. However, this region is the second most vulnerable in terms of Social Vulnerability. Therefore, based on Place-Vulnerability, Block 3 has a lower level of risk to exposure of shipping-based hazard events, but a higher level of vulnerability towards the affected population and its ability to resist and cope with such an event. This place can thereby be determined as the second most susceptible region within Finnmark County (Beige area in Figure 40).

Geographical Block 2 ranks second in Finnmark County according to the Biophysical/Technological Hazards Vulnerability scores. However, in regard to the *Social Vulnerability Index*, Block 2 has the lowest levels of Social Vulnerability. Combining the two elements in the theoretical framework shows that this region carries a higher risk level for the frequency of shipping accidents in its coastal waters, but affects a lower percentage of the overall population and its ability to resist and cope for a hazard event. This region can thereby be determined to have the lowest levels of overall Place-Vulnerability among the three geographical Blocks within Finnmark County (Grey area in Figure 40).

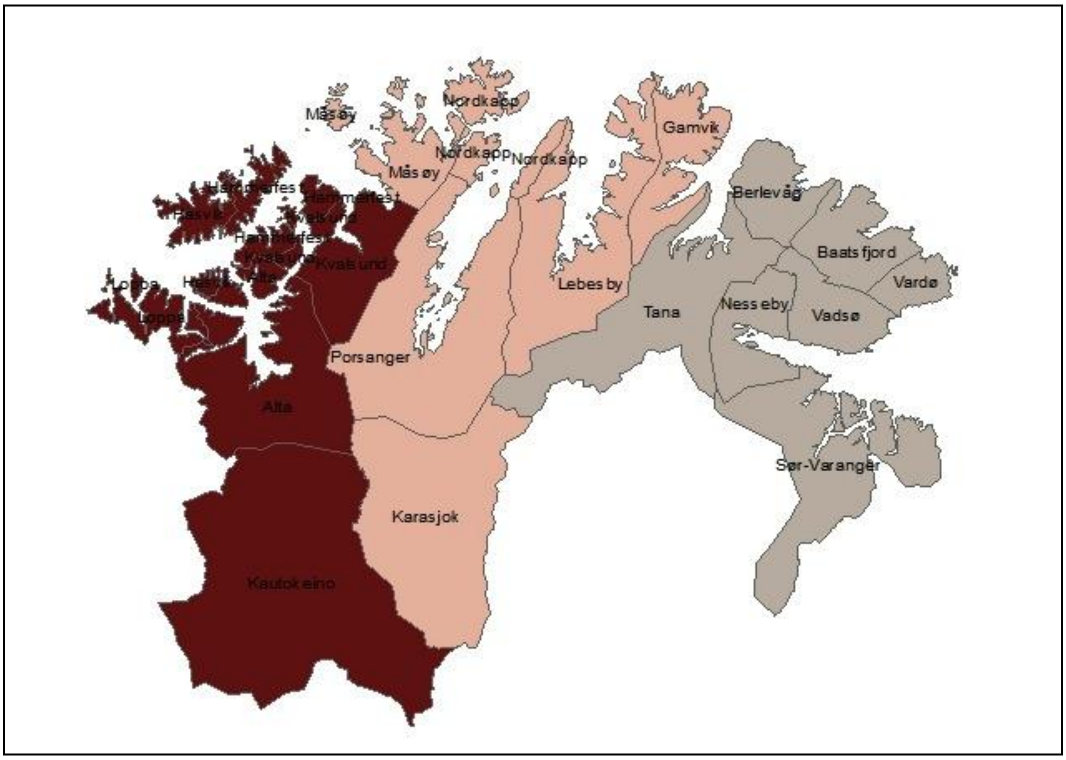


Figure 40: Place-Vulnerability Rankings by Geographical Block

6.0 QUALITATIVE ANALYSIS

Based on the results from the assessment of Place-Vulnerability (Chapter 5), there are varying levels of vulnerability within Finnmark County as a whole. The southernmost region (Block 3) is attributed with carrying the highest combined levels of Social Vulnerability and Biophysical/Technological Hazard Vulnerability. The northernmost region (Block 1) ranks as the second most vulnerable region when the results from the *Social Vulnerability Index* and the *Biophysical/Technological Hazard Table* are factored in together. The geographical area between the northernmost and southernmost regions (Block 3) had the lowest overall Place-Vulnerability scores, attributed to its lower score within the *Social Vulnerability Index*. Despite of the geographical rankings within the county, *all* areas along the Finnmark Coast are vulnerable towards geographical shipping hazards and are susceptible to the impacts of an acute oil spill.

This chapter therefore aims to answer the first part of research *Sub-Question B*. An inquiry into the policies and practices the Norwegian Government has adopted over the past decade to mitigate the levels of vulnerability (especially Biophysical/Technological Vulnerability as it relates to shipping hazards), is conducted, focusing on the historical development of pertinent framework policy documents and the subsequent practices produced as a result.

6.1 INCREASING RUSSIAN PETROLEUM EXPORTS

Further development of offshore oil and gas resources in the Barents Sea, whether on the Norwegian or Russian continental shelf, carries a higher risk as these resources are brought to market. Put simply, the more hydrocarbon resources extracted in this region directly correlates to an increased level of oil tanker traffic along the Finnmark Coast bringing these resources to receiving terminals in Europe and North America.

Figure 41 displays data concerning the annual number of Russian Oil and Gas Tankers passing along the Finnmark Coast between 2002 and 2010. From this statistical data there is a linear trend where the number of oil tanker voyages have increased over this 8-year span. In 2002, there were 166-recorded voyages originating in Russian ports and passing through the Norwegian Coastal Waters along Finnmark. By 2010, the volume of tanker traffic nearly doubled to 326 voyages. This increase is a direct result of an increased capacity among Russian ports to process and load petroleum resources over the past decade (Bambulyak 2011, 45-76).

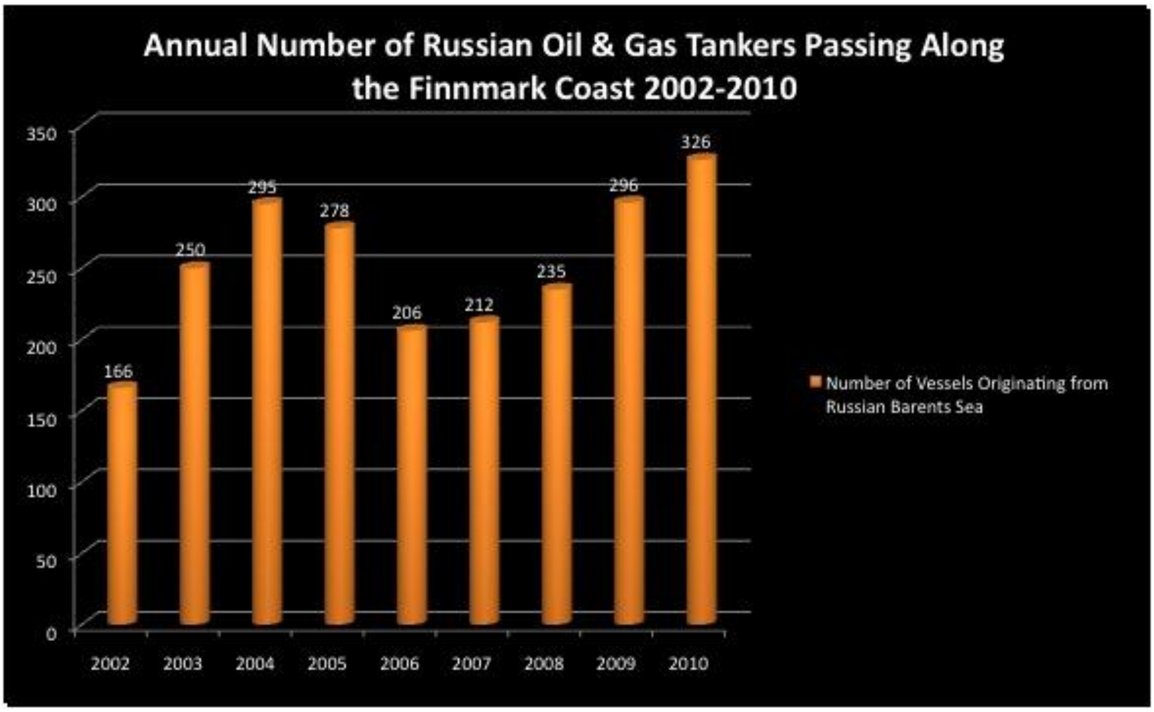


Figure 41: Annual Number of Russian Oil & Gas Tankers Passing Along the Finnmark Coast 2002-2010. Source: (Bambulyak 2011, 81)

Figure 42 displays historical records between 2002 and 2010 regarding the volume of crude oil and petroleum products that has been exported via maritime vessels along the Finnmark Coast. Here too, there is a rising linear trend towards a higher volume of exported petroleum products over the past decade. In 2002, there was an exported total of 4,226,700 tons of Oil Equivalents (O.E.). By 2010 there was a total of 18,635,181 tons of O.E. passing along the Finnmark Coast. This represents 4.4 times increase in the volume of exported petroleum products over the course of 8 years. In their report, *Oil Transport from the Russian Part of the Barents Region: Status per January 2011*, Alexei Bambulyak and Bjørn Frantzen project that there could be an increase to approximately 100 million tons O.E. being exported along the Finnmark Coast by the year 2020 – a level 5.4 times greater than 2010 levels (Nilsen 2011, 3).

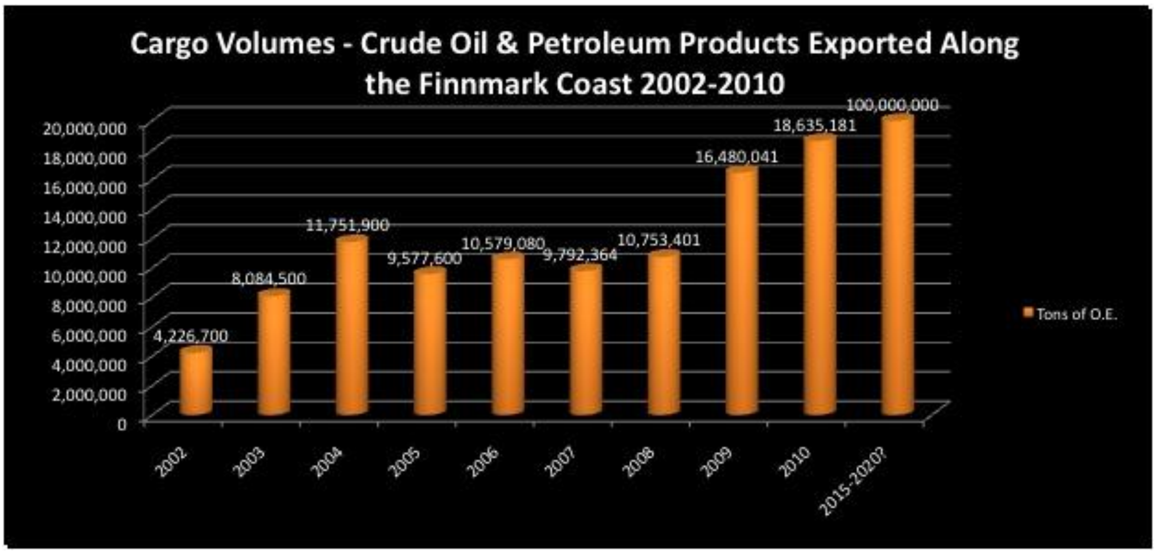


Figure 42: Cargo Volumes – Crude Oil & Petroleum Products Exported along the Finnmark Coast 2002-2010. Source: (Bambulyak 2011, 80)

6.1.2 INCREASING NORWEGIAN PETROLEUM EXPORTS

However, the volume of exported petroleum products is not limited to Russian production and transportation. There is also production occurring on the Norwegian side of the maritime boarder that must additionally be taken into account. 2007 marked the beginning of the modern era for hydrocarbon resource development for Norway in the Barents Sea with the opening of the Snøhvit and Askeladd gas fields and the Liquefied Natural Gas (LNG) processing plant at Melkøya, off the Coast of Hammerfest. Production began in 2007 and it is reported that approximately 67,000 tons of gas condensate and 155,000 tons of LNG were exported from Melkøya along the Finnmark Coast. By 2009, these figures dramatically increased to 562,000 tons of gas condensate and 3.7 million tons of LNG exported from the Melkøya production facility. These volumes will continue to increase as the Goliat and Albatross fields come online in the next few years (Bambulyak 2011, 76).

The success at Melkøya has prompted much attention towards further development on the Norwegian Continental Shelf in the Barents Sea, suggesting a new "Oljeeventyr" ("Oil Adventure") for Norway and its industries in its northernmost waters (Pettersen 2011). In recent years, there has been considerable seismic mapping occurring in the Norwegian portion of the Barents Sea with successful results (Nilsen 2011). This has prompted Ole Borten Moe, the Norwegian Minister of Petroleum and Energy, to commission an assessment study of the region to be presented to the Norwegian Parliament, beginning the formal process of oil and gas drilling in the area. Moe claims that, "the aim [of the study] is clearly to facilitate for drilling in the nearest years" (Nilsen 2011).

Most recently was the January 2012 discovery of *Havis*, an oil field north of Melkøya, projected to contain between 200 and 300 million barrels O.E. (Fouche 2012). This field is located merely 7km away from the *Skrugard* field, which was discovered only 8 months prior. *Skrugard* is considered to contain approximately 250 million barrels O.E., bringing the total recoverable oil capacity to between 400-600 million barrels O.E. among the "twin fields" of *Havis* and *Skrugard*. Furthermore, Statoil CEO, Helge Lund, directly stated that now with the discovery of the *Havis* field, this "Opens a new Oil Province in the North" (Barstad 2012). Production of these fields is anticipated by the end of this decade (Fouche 2012).

Moreover, Statoil believes that it has "cracked the code" for discovering oil fields in the Barents Sea and expects more discoveries to occur over the coming years (Fouche 2012). Therefore, between Norwegian and Russian production, there will be a sharp increase in the volume of petroleum products exported along the Finnmark Coast by the year 2020.

This dramatic rise in petroleum production will directly increase the volume of oil tanker traffic bringing these resources to market, thereby begging the question: "What specific policies and practices has the Norwegian Government adopted to mitigate these levels of vulnerability?" The answer to this question will be discussed through an assessment of past and future policies and practices implemented among and across International and National Governmental Organizations and within the Petroleum Industry.

6.2 THE GROUNDWORK FOR A NEW PETROLEUM PROVINCE

The new petroleum field discoveries in the Barents Sea only confirm the results of what has been an ongoing effort over the past 11 years among the Norwegian Government: To create a new oil province in the Barents Sea. Since the inception of the Stoltenberg II Government in 2005, there has been a concerted effort towards developing the Norwegian High North into the next energy frontier, largely to due with the fact that approximately 830 million tons O.E. await discovery on the Norwegian shelf alone in the Barents Sea (Ocean-Futures 2006, 2). Furthermore, Norway believes that it has reached peak-oil among its historical oil basins in the North Sea in 2001 (Skrebowski 2003).[*] Combined, this has seemingly spurred action among the Norwegian Government to replenish its diminishing oil supply to remain the world's 3rd largest exporter of petroleum products (Norwegian-Ministry-of-Petroleum-and-Energy 2011).

6.2.1 NORWEGIAN DOMESTIC POLICY FRAMEWORK SETS THE STAGE

The report *Opportunities and Challenges in the North* (2005), issued at the end of the Bondevik Government term, establishes a formal framework for policies areas in which the Government wishes to instigate. Here the government foremost recognizes the challenges associated with potential increased activity among the hydrocarbon production and transport industries. There are three main areas of importance in this report that the government saw as fundamental for the framework: First, that the "Government's goal is to ensure that there are strict environmental and safety requirements for petroleum activities in the whole of the Barents Sea" (Norwegian-Ministry-of-Foreign-Affairs 2005-2006, 8). It recognizes and addresses that unique environmental conditions in the Arctic inherently increase risk to exposure from petroleum activities and therefore necessitate the creation and implementation of a set of higher

[*] Not taking into account the discoveries of the Aldous and Avaldsnes oil fields in 2011. For further information on these fields see: Stigset, "Norway Sees Longer Oil Era as North Sea Find Offers Hidden Giant," *Reuters*, 2011.

environmental and safety standards for operations in this region. Second, the government emphasizes that it needs to establish the Finnmark Coast as a sensitive and vulnerable region towards the exposures of hydrocarbon activities. It therefore beckons that the Finnmark Coast needs to legally be allocated as a Particular Sensitive Sea Area. Once accomplished, this framework recommends that the Government submits a proposal to the IMO for establishing sea lanes outside of its traditional territorial waters between Vardø and Røst (Støre 2011, 26). Third, the White Paper emphasizes cooperation between Norway and Russia in the area of environmental protection in the Barents Sea. The idea is to achieve a healthier Barents Sea region as a whole through increasing Russian environmental standards and practices towards the marine environment (Norwegian-Ministry-of-Foreign-Affairs 2005-2006, 25).

The first official policy framework issued by the Stoltenberg II Government, commonly referred to as the *Soria Moria Declaration* (2005), outlined the framework for developing the Norwegian High North as the future center for energy, environment, and security politics. The claim that the Norwegian High North is the foremost strategic area to the Government has set the tone for discourse over the past six years, thus marking a new era in Norwegian domestic and international politics.

Following *Soria Moria*, there have been three pertinent publications by the Stoltenberg II Government pertaining to its High North objectives. The *Norwegian Government's High North Strategy* (2006), *New Building Blocks: The Next Step in the Government's High North Strategy* (2009), and *The High North: Visions and Strategies* (2011) fundamentally laid out the Government's action plan for developing its High North, highlighting policy areas aimed at achieving sustainable economic development through natural resources, cooperation with Russia, and overall Arctic security (Norwegian-Ministry-of-Foreign-Affairs 2006, 2009). These frameworks call out the need to achieve these objectives through addressing sustainable resource management, protection of the marine environment, and climate change, while striving for a secure Arctic through cooperation among and between the five Arctic states. At the same time, these reports send a stern message that the Norwegian Government is deeply committed towards discovering and developing the hydrocarbon resources on its seabed under the Barents Sea.

The Norwegian Government's High North Strategy (2006) framework report elaborates on the fundamental themes addressed in the previous *Opportunities and Challenges in the North* (2005) report. In this report, there is a clear indication towards developing the High North for energy production. However, it addresses some key areas in which there needs to be an increase in the knowledge base before such developments occur. Here, the government focuses on increasing petroleum-based expertise in the following areas: Operational affects in the Marginal Ice Zone, chemical beach cleaning methods, the effects of dispersants under cold conditions, and oil detection in the dark (Norwegian-Ministry-of-Foreign-Affairs 2006, 28). Furthermore, this report calls upon the establishment of an integrated monitoring system for maritime vessels operating in the High North and an integrated environmental monitoring system for the Barents Sea (Norwegian-Ministry-of-Foreign-Affairs 2006, 28, 59). The report also introduces the Barents 2020 program, established in late 2005. The focus of Barents 2020 is towards "cooperation on knowledge generation between Norwegian and foreign centers of knowledge, business interests, and public organizations" towards developing stringent environmental, safety, and operational standards for the Barents Sea region (Norwegian-Ministry-of-Foreign-Affairs 2006, 34). Much like the previous policy framework report, the *High North Strategy* report calls for setting stringent environmental standards among the petroleum and maritime shipping industries operating in this area. Of most significance is the government's aim to protect the vulnerable Arctic environment from resource development, pollution, and over-harvesting of living marine resources. The framework therefore addresses the need to create and implement an integrated management regime within the Barents Sea region to ensure the delicate balance between competing interests, resource management, and environmental stewardship (Norwegian-Ministry-of-Foreign-Affairs 2006, 45-46).

The subsequent report *New Building Blocks: The Next Step in the Government's High North Strategy*, released in 2009, serves as a summary of what has been implemented an accomplished over the past four years. More importantly, the report highlights areas for further improvement towards the development of the High North. Here the Government emphasizes improvement on pollution, oil spill, and emergency response systems in addition towards improving overall maritime safety within the Barents Sea (Norwegian-Ministry-of-Foreign-Affairs 2009, 14-15). Specifically, the report calls for improvement in maritime safety through the increased capacity of environmental and maritime traffic monitoring systems, an increased scale of response equipment and capacities, and the establishment of a satellite traffic surveillance system for the Norwegian Coast (Norwegian-Ministry-of-Foreign-Affairs 2009, 14-17). The report additionally highlights the Norwegian Government's push for implementing a binding International Maritime Organization (IMO) Polar Code – a set of guidelines for ships operating in polar waters (Norwegian-Ministry-of-Foreign-Affairs 2009, 16).

The most recent White Paper delivered by the Stoltenberg II Government, *The High North: Visions and Strategies* (2011) continues along the same areas of emphasis as the previous two strategic reports. This document, however, emphasizes the achievements in the High North since 2009, such as the implementation of a Traffic Surveillance System for the Barents Coast, updating and increasing the capacity of oil spill response equipment in the north, the recent advances in cooperation with Russia, and the creation of an Arctic Search and Rescue Treaty.

6.3 FROM FRAMEWORK TO ACTION

As a result of the *High North Strategy* reports, there have been a significant amount of official policy documents developed in the years between 2005 and the present day towards developing the Barents Sea region into a modern day energy frontier. These have been received as series of Parliament White Papers, various assessment reports, development programs, and declarations at the international level.

6.3.1 INTERNATIONAL-LEVEL POLICY DEVELOPMENT

First and foremost, the Norwegian Government recognized that in order to achieve harmonized environmental and safety standards across the Barents Sea region as a whole, it must increase cooperation with Russia. Perhaps the largest obstacle towards this increased cooperation stood as the ongoing maritime boarder dispute between the two countries. This dispute was put to rest in September 2010 with the signing of the *Treaty on Maritime Delineation and Cooperation in the Barents Sea and the Arctic Ocean*, ultimately dividing the disputed zone into two equal territories. The signing of this treaty marked a new era in cooperation, as this dispute represented the most significant outstanding foreign policy issue between the two countries (Karlsbakk 2010). The importance of this development is summed up best by Captain Lawson W. Brigham (U.S. Coast Guard, Retired) when he states, "For the Russian Federation and Norway, this agreement provides a framework of cooperation and stable political environment in which the Barents Sea's continental-shelf hydrocarbon resources can be increasingly exploited," and that, "The treaty also provides a unique and workable model for further circumpolar cooperation" (Brigham 2011, 51).

Furthermore, there has been much success at the international-level across Arctic nations. The *Ilulissat Declaration* of 2008 paved the way towards a secure Arctic, affirming adherence to territorial boundaries the laws laid forth in the United Nations Convention on the Law of the Sea (UNCLOS) for the Arctic Ocean (Arctic-Council 2008, 1). In addition, the Declaration states the Arctic states will take steps to ensure the protection and preservation of the marine environment through strengthening maritime safety and procedures (Arctic-Council 2008, 2). Additional international-level achievements have come through the apparatus of the Arctic Council (AC) in the past few years, in which Norway is a leading contributor member. The *Tromsø Declaration*, signed in 2009, affirmed the shared responsibility among the five Arctic States (Norway, Russia, USA, Canada, Denmark) towards promoting sustainability in the region and urged the IMO to complete and implement a Polar Code for operating vessels in Arctic waters (Arctic-Council 2009, 1,4). Most recently, a binding *Agreement on Cooperation on*

Aeronautical and Maritime Search and Rescue in the Arctic was signed into effect at Nuuk, Greenland in May 2011, calling upon all member nations to cooperate in, and train for Search and Rescue operations – an important step towards reducing the impacts of oil spills in the Arctic (Arctic-Council 2011, 5). The *Nuuk Declaration* additionally established a task forced charged with developing an international Arctic oil spill preparedness and response plan/agreement, to be presented at the next ministerial meeting in 2013 (Arctic-Council 2011, 4). From the international level perspective, these developments are significant towards establishing guidelines, protocols, and standards towards reducing risk of oil spills by focusing on oil spill prevention in the Arctic.

6.4 SPECIFIC ACTIONS TAKEN TO REDUCE THE RISK OF OIL SPILLS

In an effort to reduce the risks of oil spills in the Barents Sea, the Norwegian Government has presented a series of White Papers and commissioned research to identify and determine risk associated with petroleum operations. The main priority of these undertakings has been to focus on oil spill prevention under the guise of the Precautionary Approach. The results from these efforts have emphasized five priority areas among the Norwegian Government: An Ecosystem-Based Management Regime within the Barents Sea; new maritime shipping traffic standards, requirements, and surveillance; increased oil spill preparedness and response systems; advanced cooperation with Russia in the Barents Sea; and support for the creation and implementation of an IMO Polar Code. Each one of these priority areas will be further addressed in-depth in the following sections towards their effect towards reducing the overall risk of acute oil spills off the Finnmark Coast.

6.4.1 INTEGRATED MANAGEMENT PLAN

In 2005, the Norwegian Ministry of Environment delivered a White Paper to the Parliament, *Integrated Management of the Marine Environment of the Barents Sea and the Sea Areas off the Lofoten Islands*. The main aim of the plan is to "provide a framework for the sustainable use of natural resources and goods derived from the Barents Sea-Lofoten area and at the same time maintain the structure, functioning, and productivity of the ecosystems of the area," where the plan is seen as a tool to be used "both to facilitate value creation and to maintain the high environmental value of the area" (Norwegian-Ministry-of-Environment 2005-2006, 15). In this plan, the government recognizes the ecological importance of protecting these sea areas, while at the same time addressing the necessary balance in management between the fishing, petroleum, and maritime transport industries – the three most prevalent industries operating in this region. This holistic management plan thereby attempts to strike this balance by implementing an ecosystem-based approach that considers future industrial activities through an ecological perspective.

6.4.2 ECOSYSTEM-BASED OCEAN MANAGEMENT AND THE ESTABLISHMENT OF PARTICULARLY SENSITITVE SEA AREAS

The Norwegian Government sees itself as "having a direct responsibility for the protection of the Arctic and intends to be the best environmental steward of the environment and natural resources in the High North" (Norwegian-Ministry-of-Foreign-Affairs 2009, 7). Furthermore, the government recognizes that the Fishing Industry is critical to the communities of the High North as a main source of employment, and adverse affects from petroleum operations pose significant risks towards the sustainability of this industry, subsequent livelihoods, and the global marine environment (Norwegian-Ministry-of-Environment 2005-2006, 47). Therefore, the government has laid forth a series of policies aimed at reducing the impacts the petroleum industry has on the marine environment and fishing industry in the High North.

Through an ecosystem-based approach, the government has identified specific areas in the Barents Sea that are particularly vulnerable to the impacts of both petroleum and maritime transport operations. These areas have been identified based on scientific assessments conducted in the region, where they are seen as "being of great importance for biodiversity and for biological production," and "where adverse impacts might persist for many years" (Norwegian-Ministry-of-Environment 2005-2006, 27). In 2004, a technical report, commissioned by the Norwegian Maritime Directorate, evaluated the Norwegian part of the Barents

Sea and the Northern part of the Norwegian Sea. The results from this assessment identified 18 geographical areas as especially vulnerable in the region (in accordance to IMO Guidelines for Particularly Sensitive Sea Areas), including the entire Finnmark Coast from the Tromsøflaket to the eastern maritime boarder with Russia (See Figure 43) (Behrens 2004, 39-44). The coastal waters along Finnmark are considered to be rich in biodiversity and are pertinent global breeding grounds for various populations of fish stocks, sea birds, and sea mammals, while additionally containing coral reefs (Behrens 2004, 39-44). These characteristics therefore make these areas important for the entire ecosystem in the Norwegian part of the Barents Sea and particularly vulnerable with respect to acute pollution (Norwegian-Ministry-of-Environment 2005-2006, 31-32). The identification of the Finnmark Coast as a Particularly Sensitive Sea Area (PSSA) has since served as the foundation for a series of subsequent policies adopted by the Norwegian Government towards reducing the risks of oil spills in this region.

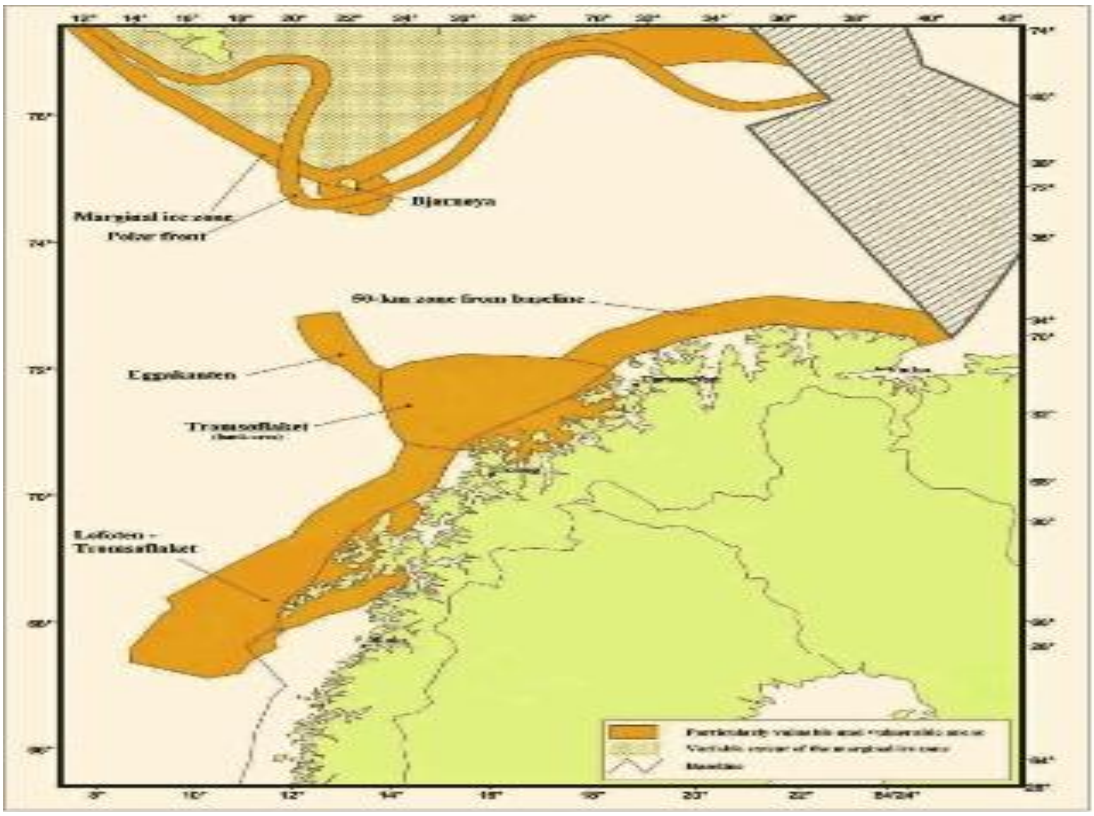


Figure 43: Particularly Vulnerable Sea Areas off the Finnmark Coast. Source: (Norwegian-Ministry-of-the-Environment 2001-2002, 28)

6.4.3 REDUCING THE IMPACTS OF PETROLEUM INDUSTRY OPERATIONS

As a result of the identification of PSSA along the Coast of Finnmark County, the Norwegian Government has strengthened a series of regulations for the petroleum industry operating in this region. These policies are aimed at reducing the potential adverse effects of the petroleum industry towards the marine environment and assuring the sustainable coexistence between the petroleum and fishing industries, by minimizing operational and accidental discharges to sea and the use and discharge of chemicals (Klaveness 2010, 5). First and foremost, the government set into place a zero-discharge policy for produced water among petroleum installations in the Barents Sea region (Norwegian-Ministry-of-Environment 2005-2006, 67). This has resulted in a 99% reduction in overall produced water discharges between 1997 and 2005 (See Figure 44) (Norwegian-Ministry-of-Environment 2005-2006, 68). It has achieved this goal by allocating discharge permits decreasingly over time to operators, as set in the regulations of the Norwegian Petroleum Act (Klaveness 2010, 5-7). Secondly, the government implemented a policy for no petroleum activity within 35km of the Finnmark Coast. Third, no exploratory drilling within 65km of the coast can be initiated during the spawning season between March 1 and August 31. And finally, no seismic surveying is permitted during times of the year that are particularly important for the Fishing Industry (Norwegian-Ministry-of-Environment 2005-2006, 137). However, the largest threat towards the marine environment of the Barents Sea does not derive from petroleum installations or their operations, but from the transport of these resources via maritime transport. In fact, according to the Norwegian Ministry of Oil and Energy, oil spill risk as a result of tanker traffic is estimated to be ten times greater than that of exploration and production activities (Dragsun 2003, 1). Therefore, the Norwegian Government has undertaken a series of actions aimed at reducing the risk of acute oil spills originating from the maritime transport industry.

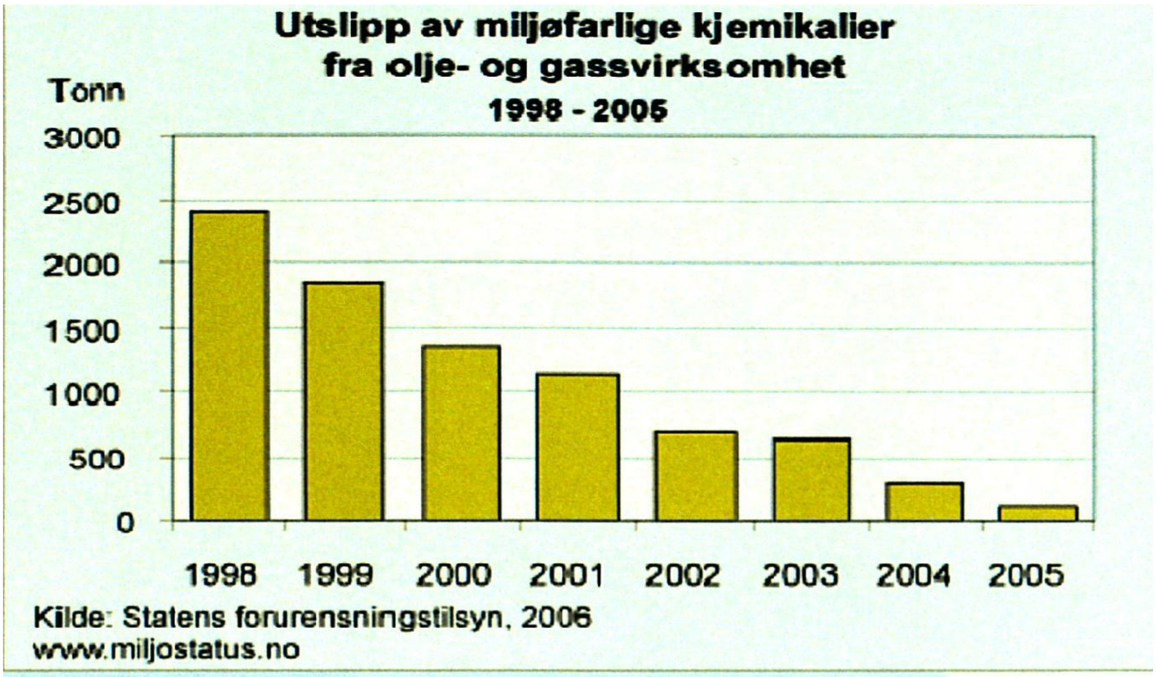


Figure 44: Emissions of Environmentally Dangerous Chemicals from the Oil and Gas Industry. Source: (Klaveness 2010)

6.4.4 REDUCING THE IMPACTS OF THE MARITIME TRANSPORT INDUSTRY

Perhaps the most effective action towards reducing the likelihood of acute oils spills in the Barents Sea is through reducing the risks associated with shipping accidents. As a result of the identification of PSSA along the Finnmark Coast, the Norwegian Government was able to lobby the International Maritime Organization to extend its control of vessels operating in its territorial waters. In January 2004, new regulations went into effect allowing Norway to extend its territorial sea boundaries from 4NM to 12NM. Additionally, the Norwegian authorities established a new mandatory re-routing and traffic separation scheme in its territorial waters between Vardø and North Cape for vessels carrying polluting cargo (Norwegian-Ministry-of-Environment 2005-2006, 54). However, in 2006, the Norwegian Government submitted a subsequent proposal to the IMO for the implementation of a mandatory routing and traffic separation scheme outside its territorial waters between Vardø and Røst. The IMO accepted the proposal and the new regulations went into effect in July 2007 (Bambulyak 2011, 83). As a result, mandatory re-routing of vessels with a gross deadweight of over 5000 tons must sail in assigned northbound or southbound shipping lanes 30NM from the coast between Vardø and Røst (Norwegian-Ministry-of-

Environment 2005-2006, 54). These assigned sea-lanes aim to reduce the risk of vessel collisions by separating the two routes by 1NM. Furthermore, these regulations thereby push large vessels (supertankers from Russia and Norway) carrying petroleum resources to the outer limits of the designated PSSA areas along the Finnmark Coast, so that Norwegian authorities are given additional time to allocate necessary response resources in the event of a technical failure or accident, thus reducing the environmental impact of an acute oil spill at sea (Bambulyak 2011, 83). It has been reported that the potential for ship grounding accidents is reduced to 36% when vessels are located 12NM from the Coast and 26% when vessels are located 30NM or more away from the coastline (Det-Norske-Veritas 2010, 38).

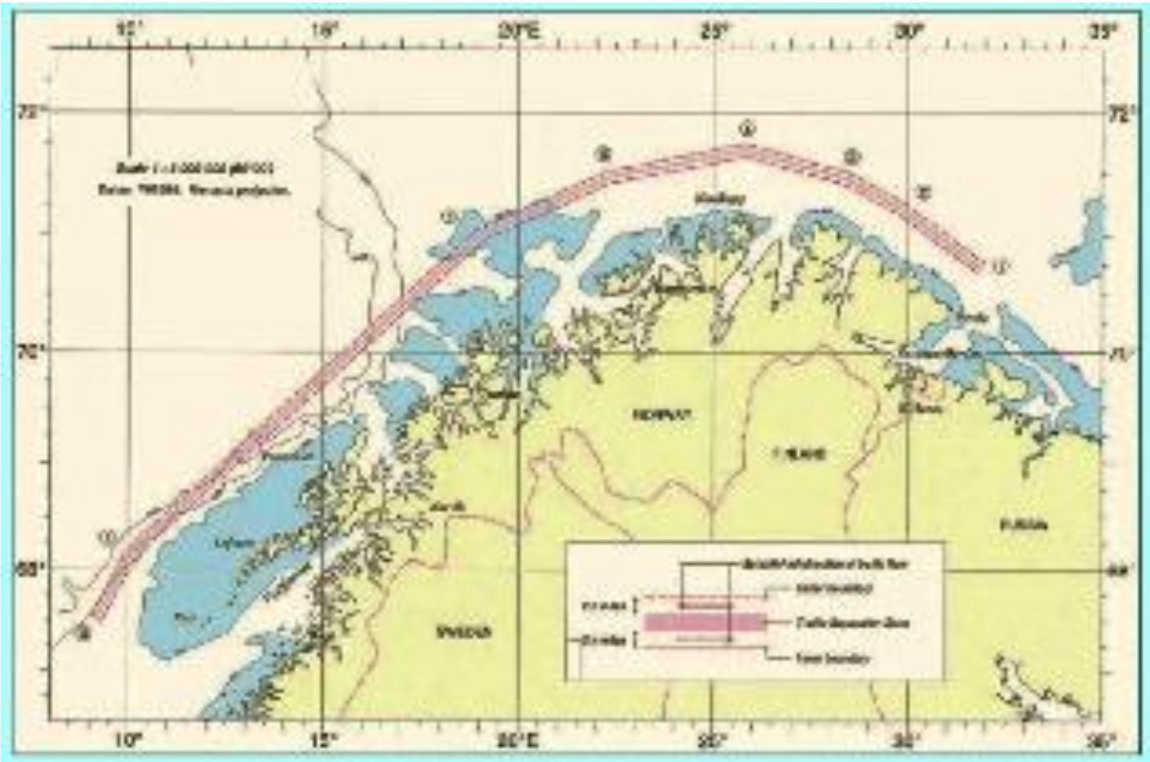


Figure 45: Mandatory Routing and Traffic Separation Scheme Outside Territorial Waters between Vardø and Røst. Source: (Norwegian-Ministry-of-Environment 2005-2006, 54)

6.4.4.1 VARDØ VTS

In addition to the new traffic routing and separation scheme, the Norwegian Government established the Vardø Vessel Traffic Service (VTS) in January 2007 to improve safety at sea and protection of the marine environment from acute pollution (Kystverket 2011, 2). Vardø VTS provides a 24-hour service for monitoring and coordinating oil tankers or other vessels carrying dangerous or polluting cargo operating in the Norwegian Exclusive Economic Zone (EEZ) (Kystverket 2011, 2). In accordance with Norwegian regulation, all operating vessels over 5000 tons gross weight must immediately report the following information upon entering the Norwegian EEZ: Ship name; IMO number; Primary telephone and fax numbers and email address; Primary Inmarsat-C number; Cargo UN reference(s) (IMDG-Code); Amount of cargo (metric tons); Amount of bunker oil (metric tons); Bunker oil UN reference(s); Number of crew and passengers on board; Port of departure; Time of departure; Port of arrival; and its estimated time of arrival (Bambulyak 2011, 79). Once a vessel enters the Norwegian EEZ, its position is consistently monitored by satellite technology via the VTS Automatic Information System (AIS) throughout its entire voyage through Norwegian waters, displaying pertinent information such as the vessel's course, route, speed, and rate-of-turn – much like that of Air Traffic Control in the airline industry (See Figure 46) (Bambulyak 2011, 79). This information allows VTS to communicate course correcting measures in real-time to ship captains, in the event of a potential collision course with geographical formations or other vessels at sea (Behrens 2004, 69). This advanced technology was implemented in the summer of 2010 when the Norwegian Government launched the AISSat1 satellite for these specific purposes (Norwegian-Ministry-of-Foreign-Affairs 2011-2012, 99).

By implementing such monitoring capacity, the Vardø VTS has the improved ability to communicate with oil tankers and provide pertinent up-to-date information regarding navigation routes and environmentally sensitive areas, potential collision courses, fishery activity, nearby emergency towing vessels, and weather conditions (Kystverket 2011, 6). The system also provides Vardø VTS with an early warning capability to coordinate preventive measures and emergency response efforts in critical conditions (Kystverket 2011, 3). According to the Norwegian Maritime Directorate, the new regulations for routing and separation schemes reduce the likelihood of vessel collisions by 40%, whereas the new AIS technologies at Vardø VTS additionally lower the risk of collisions by 20% (Behrens 2004, 71). These risk reduction measures have a significant impact, considering the projected increase in oil tanker traffic volume off the Finnmark coast in the coming years, and that currently, the hazard frequency for collisions among cargo vessels along the Finnmark Coast is approximately one event per-year (See Section 5.5.2).

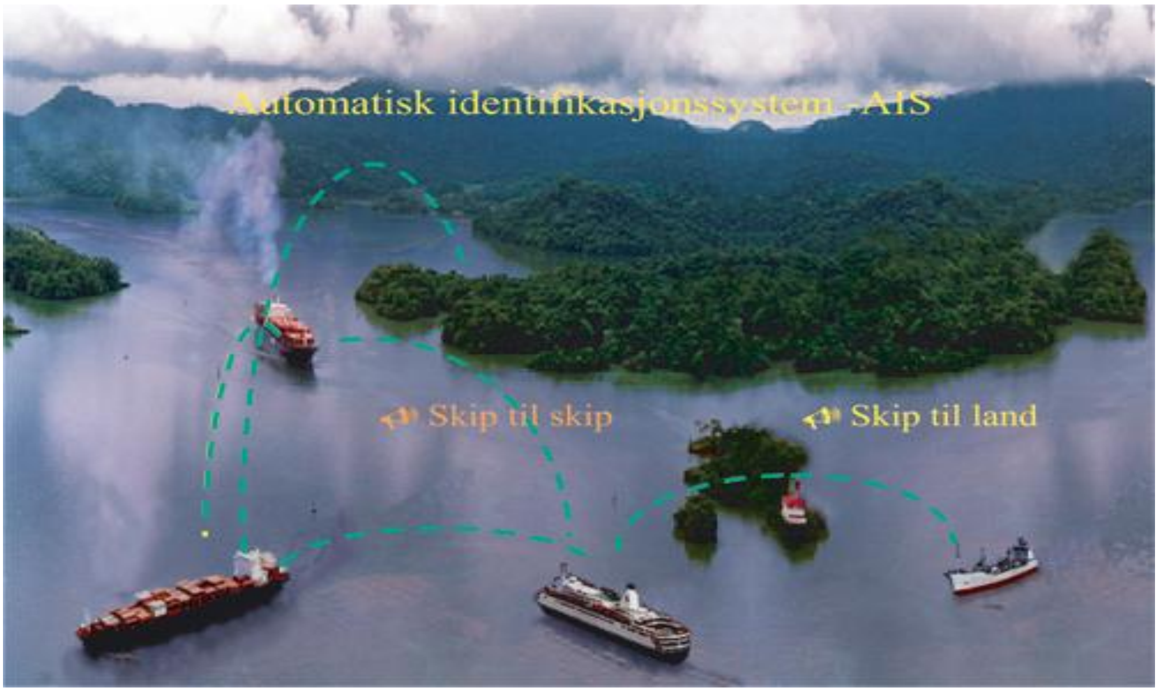


Figure 46: Automatic Identification System (AIS) for Maritime Vessels. Source: (Norwegian-Fishery-and-Coastal-Department 2004-2005, 42)

6.4.4.2 BARENTS WATCH

In 2012, the Norwegian Government plans to unveil an additional monitoring, surveillance, and warning system for the Barents Sea, called *Barents Watch* (Norwegian-Ministry-of-Foreign-Affairs 2011, 29). The overall purpose of this system is to give quality information regarding activities in the Barents Sea available to the public and among the government. *Barents Watch* will focus on five priority areas with regard to the Barents Sea Region: Climate and the Environment; Transport; Marine Resources (including fisheries); Oil and Gas Activity; and Sovereign Enforcement and Norwegian International Interests. (BarentsWatch 2011). This up-to-date database will prove to be a vital portal especially within the Maritime Transport Industry, with regards to reducing the risks involved with Arctic marine shipping for planning and operational purposes. However, this database will be crucial among the various government departments and operational authorities involved in environmental research and policy creation, monitoring, and compliance, in addition to maritime accident and acute oil spill preparedness and response. Located within the database is all pertinent information concerning the Norwegian Oil Spill Preparedness and Response System; oil spill statistics and enhanced oil drift orbit calculations; in addition to the location of geographically sensitive areas, living marine resources, and vulnerability levels (BarentsWatch 2010, 10-12). The knowledge encompassed within *Barents Watch* will ultimately assist to reduce the likelihood of acute oil spills and other pollution as it allows for an increased capacity towards prevention among industries operating in the Arctic and for greater coordination across all responsible authorities in the event of a disaster.

Figure 47: A graphical depiction of the *Barents Watch* intent and services. Source: (BarentsWatch 2010, 2011)

6.5 INCREASING THE CAPACITY OF OIL SPILL PREPAREDNESS AND RESPONSE SYSTEMS

On of the tenants of the recently published White Paper on the Government's continued *High North Strategy*, "The High North: Visions and Strategies," focuses on increasing the capacity of the Norwegian Oil Spill Preparedness and Response Systems (Norwegian-Ministry-of-Foreign-Affairs 2011, 29). The foremost aim of the Norwegian Government towards reducing the likelihood of oil spills off the Norwegian coast is on *oil spill prevention*.

6.5.1 ACTIONS PRIOR TO OPENING NEW PETROLEUM REGIONS

Before any new potential petroleum area is opened for licensing on the Norwegian Continental Shelf, the Norwegian Government must first complete an Environmental Impact Assessment (EIA) as required by the Petroleum Act. Such is the current case with the potential hydrocarbon resources located in the southeastern part of the Norwegian Barents Sea. Regarding this region, Minister of Oil and Energy, Ole Borten Moe, stated that, "…we will do an assessment study that will include environmental impact analysis, consequences for the fisheries, petroleum resource estimation and consequences for the society" (Nilsen 2011, 2). Only after the government approves the results from the EIA will such an area be considered available for licensing procedures. However, such a possibility seems likely as the Minister stated himself, "The aim is clearly to facilitate for drilling within the nearest years" (Nilsen 2011, 2). After the opening of a petroleum area, the onus therefore lies upon the industry operators to take these analyses a step further.

With regard to the Oil Industry and its operations, the emergency preparedness system within Norway is risk-based. In other words, "the design of pollution prevention and its link to emergency preparedness plans is based on a series of environmental risk analyses for acute pollution" (Det-Norske-Veritas 2010, 63). According to Statute 13 in the Pollution Act, all oil companies operating or applying for an operating license on the Norwegian Continental Shelf must conduct and submit the results of an EIA (Norwegian-Ministry-of-Environment 1981). This EIA includes the following criteria:

- Which types of pollution the activity will generate during normal operations and in the event of all conceivable types of accidents, and the likelihood of such accidents;

- What short- and long-term effects the pollution may have. If necessary, studies shall be made of natural conditions in the areas that may be affected by pollution. In particular, it shall be ascertained how pollution will affect people's use of the environment and who will suffer particular nuisance as a result of pollution;

- Alternative locations, production processes, purification measures and ways of recovering waste that have been evaluated, and reasons for the solutions chosen by the applicant;

- How the activity will be integrated into the general and local development plans for the area, and if relevant, how it will restrict future planning (Norwegian-Ministry-of-Environment 1981).

In addition, Statute 40 of the Pollution Act requires all operators to organize and submit a sufficient oil spill preparedness plan, where

- Any person engaged in any activity which may result in acute pollution shall provide the necessary emergency response system to prevent, detect, stop, remove and limit the impact of the pollution. The emergency response system shall be in reasonable proportion to the probability of acute pollution and the extent of the damage and nuisance that may arise (Norwegian-Ministry-of-Environment 1981).

Therefore, before any petroleum operations commence on the Norwegian Continental Shelf, any company wishing to operate must submit both an EIA and an emergency preparedness plan along with its license-to-operate application to the Pollution Control Authority, as required in the Pollution Control Act. From there, the Norwegian Government determines, based on a set of criteria, whether or not the applying operator's analyses and emergency plans are acceptable. In sum, the government itself must approve the petroleum region to be within the acceptable limits of environmental impact, and the subsequent operator must additionally demonstrate that it has knowledge of the involved risks to the environment and the capacity to develop and administer a coordinated oil spill response effort. This is therefore, the first step in preventing the risk of oil spills among petroleum installation operations on the Norwegian Continental Shelf.

6.5.2 THE NORWEGIAN OIL SPILL RESPONSE SYSTEM

In its effort to reduce the impact of acute oil spills on the Norwegian Continental Shelf, the Norwegian Government has implemented a national Oil Spill Response System with the purpose to prevent, reduce, or limit damage to the natural environment – in that order (Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 108). The system is divided into three parts – private, municipal, and national services.

6.5.2.1 PRIVATE INDUSTRY

First and foremost, according to Statute 7 in the Pollution Control Act, the party responsible for polluting has the primary responsibility to mitigate any damage or nuisance as a result of an event (Norwegian-Ministry-of-Environment 1981). In other words, in the event of any oil spills from offshore installations, the individual operator has the primary responsibility for combating the spill (Brekne 2005, 2). As a result, all operating companies on the Norwegian Shelf formed the Norwegian Clean Seas Association for Operating Companies (NOFO) for the purposes of "establishing and maintaining oil spill emergency preparedness and to coordinate and communicate relevant oil spill contingency issues between members and regulating authorities" (Brekne 2005, 1). This organization acts as the first line of defense in the event of an offshore oil spill and has developed five bases along the Norwegian coast (see Figure 48) along with 14 offshore systems, each consisting of a high capacity skimmer and 400m of heavy oil booms (Brekne 2005, 2). Depending on the extent of the spill, the Norwegian Coastal Administration (NCA) will also make additional oil spill response equipment available to NOFO and will share responsibility for supervision the spill relief operations (Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 106).

However, as aforementioned, the risks of acute oil spills along the Norwegian Coast are up to ten times greater with regards to the maritime transport of petroleum resources than they are with normal installation operations (Dragsun 2003, 1). In light of this, the Norwegian Government has developed an Oil Spill Contingency System. This system is subsequently subdivided into national and municipal response regimes.

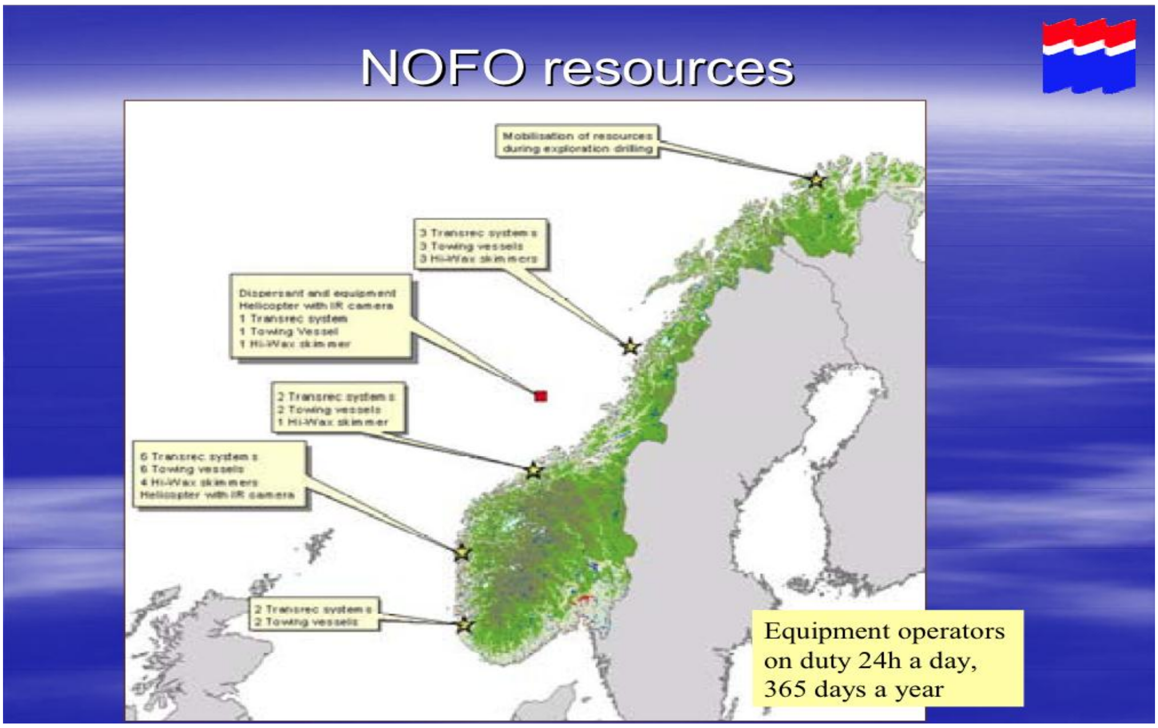


Figure 48: Location of NOFO Resource Bases along the Norwegian Coast. Source: (Brekne 2005)

6.5.2.1 NORWEGIAN NATIONAL LEVEL OIL SPILL RESPONSE

At the national level, the NCA manages and administers the Norwegian Government's response to oil spills. Primarily, the NCA assumes responsibility for oil spills that are not managed by private (NOFO) or municipal regimes. These types of events largely occur from oil tankers or unidentified sources and are determined to be acute and large in scale (Kystverket 2011). To increase the emergency preparedness at the NCA, it has developed a Department for Emergency Response in Horton, and two stations in Tromsø and Bergen. The NCA also coordinates with the Vardø VTS (Kystverket 2011). In addition, the NCA manages 15 Contingency Depots complete with oil spill equipment (booms, skimmers, workboats, pumps, and generators), trained personnel, and small boats; 4 governmental oil pollution control vessels; 8 Coast Guard vessels permanently equipped with oil recovery equipment; and a specially equipped surveillance aircraft (See Figure 49) (Kystverket 2011; Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 106).

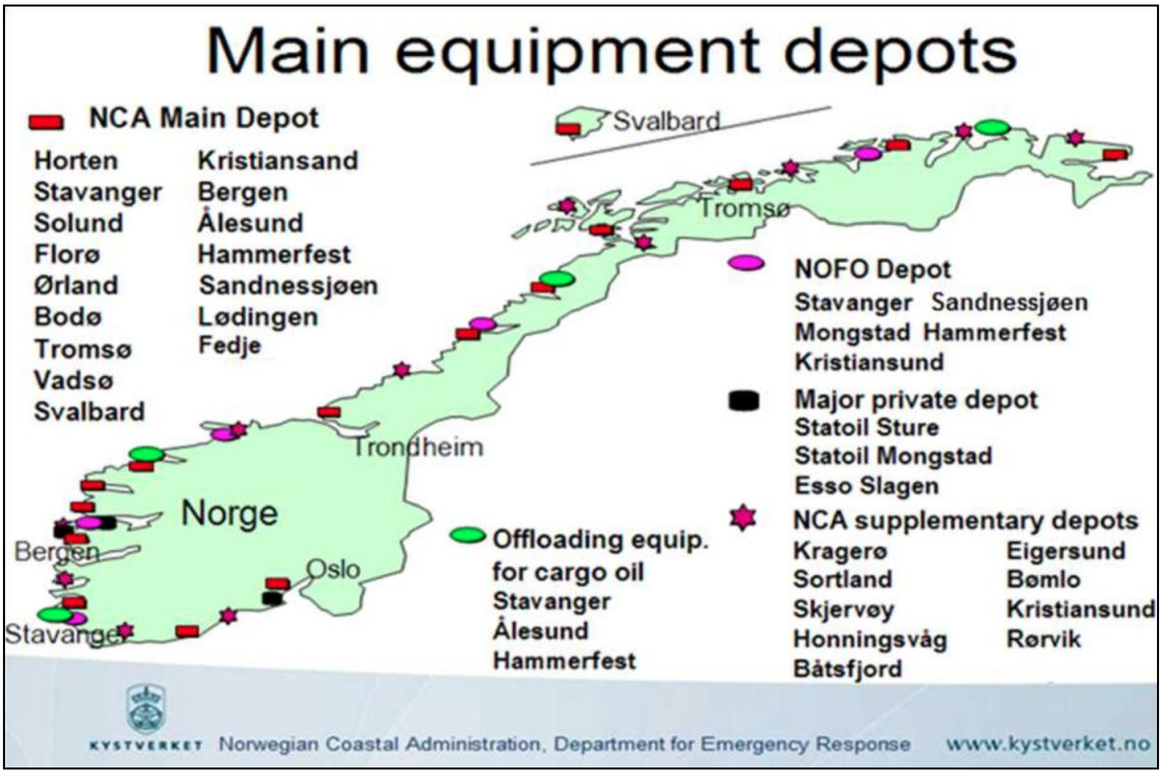


Figure 49: Main Equipment Depots (NCA, NOFO, Private). Source: (Det-Norske-Veritas 2010, 83)

As part of its *High North Strategy*, the Norwegian Government has attempted to improve maritime safety and the emergency response system in the High North region by increasing the overall amount of available oil spill response resources and equipment (Norwegian-Ministry-of-Foreign-Affairs 2011, 31). Since the scale of oil spills the NCA handles are large in nature (theoretically deriving from supertankers), the Norwegian Government placed an emphasis on preventing these types of large-scale events from occurring in the first place. Therefore, one of the largest contributions towards reducing oil spills resulting from maritime vessel accidents was when the Norwegian Government increased the capacity of emergency tugboat services in the High North. In 2003, state-run tugboat services were established for use in Troms and Finnmark Counties. From 2003 to 2009 the government provided three tugboat vessels with a towage capacity of more than 100,000 gross tones for the Troms and Finnmark Coast. In 2009, the government proposed a budget increase of NOK 112 million for tugboat services for emergency preparedness in the High North with the intent of adding to the current fleet (Directorate-for-Civil-Protection-and-Emergency-Planning 2009, 24).

Increasing the year-round capacity of tugboat services dramatically reduces the risk of acute oil spills resulting from drift-grounding* shipping accidents in the Barents Sea. In such scenarios, time is of the essence – considering that an estimated 50% of all stored oil is spilled immediately in accidents (among most oil tankers), where the remaining 50% is spilt over the following 24-hours (Dragsun 2003, 9). Figure 50 shows an estimated oil spill recovery rate as a function of elapsed time. Oil spill recovery is minimal within the first 24-hours – which coincides with the exact period in which the most oil is spilled (Dragsun 2003, 9). It is therefore crucial that emergency towing vessels are available and able to reach vessels in distress. The Vardø VTS has been allocated the responsibility for coordinating the emergency towing vessels and shall alert these vessels in critical situations (Kystverket 2011, 2). It has since been reported that these emergency towing vessels, in coordination with Vardø VTS and the new 30NM traffic routing scheme, have a 70% probability or higher of reaching a vessel in distress at any given position in the Barents Sea (Det-Norske-Veritas 2010, 71).

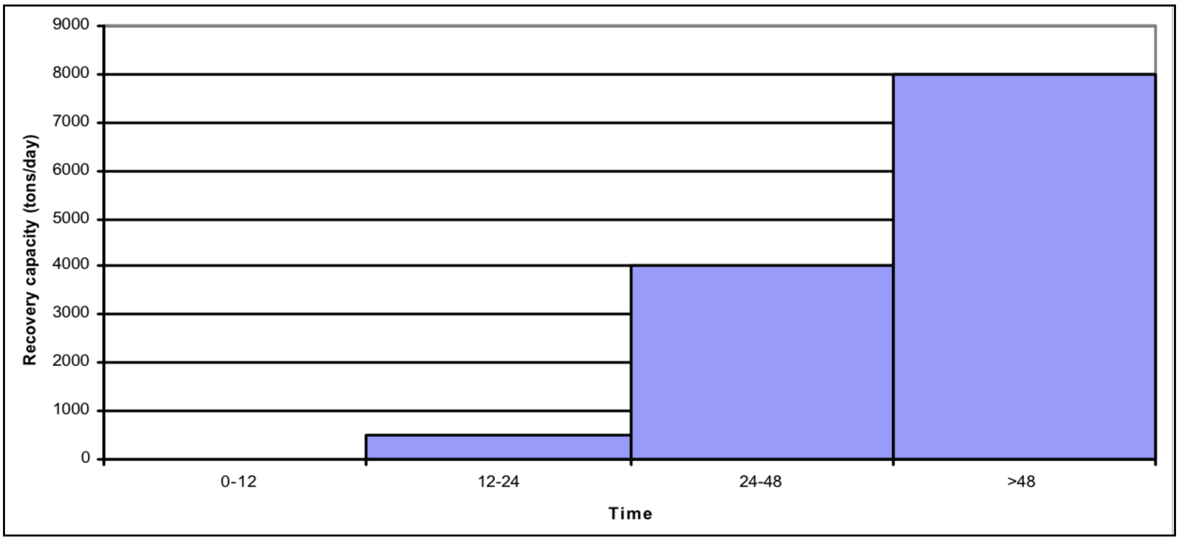


Figure 50: Spill Recovery Capacity in Responding to a Vessel Spill – as a Function of Time (Dragsun 2003, 9)

* Groundings that occur as a result of an engine failure or other technical failure and subsequent drifting

Figure 51: Current Available Towing and Salvage Vessels in 2005. Source: (Norwegian-Fishery-and-Coastal-Department 2004-2005, 63)

In addition to strengthening oil spill preventative and response measures by way of increasing the fleet and strategic location of emergency tugboat services, the Norwegian Government has also helped craft regulations in the Arctic Council aimed at preventing fuel oil spillage that occurs from Ship-to-Ship transfer. The TROOP Agreement (Guidelines for Transfer of Refined Oil and Oil Products in Arctic Waters) has set guidelines for vessels operating in Arctic waters that perform Ship-to-Ship transfers of vessel fuel or oil products. These guidelines recommend that before undergoing an operation, operating vessels must be equipped with an adequate number of well-trained personnel, possess the necessary appropriate and tested equipment, have in place an emergency contingency plan, and to promptly alert the authorities in the event of a spill, allowing for an adequate amount of time to mitigate the situation (PAME 2004, 3). Furthermore, TROOP urges that the primary consideration during Ship-to-Ship transfers shall be protection of human life and safety, and to minimize the risk of impact towards to the marine environment. Therefore, “no discharge of any oil, oily water, or any other liquids or substances that may cause pollution or discoloration of the water, whether oily or not, are allowed as a result of transfer operations" (PAME 2004, 4). Given these types of transfers tend to occur in calmer waters closer to the coast, the Norwegian Harbour Act of 1981 grants the Norwegian Costal Authority the right to mandate where, when, and whether or not these types of transfers are allowed – and additionally to intervene in situations where there may pose a threat of an acute oil spill or to marine safety (Storting 1984, 6). Such a decision was handed down to Kirkenes Transit AS and ShipCargo in 2006, when their permit for Ship-to-Ship Transfer was annulled in the Bøkfjord near Kirkenes. The Norwegian authorities cited that these transfers took place while situated in the salmon protected areas of Neiden, and where the operations represented too great of a risk of emissions that may damage the salmon stocks, and therefore prohibited these companies from operating Ship-to-Ship transfers in this area (Bambulayk 2009, 62). However, the Norwegian authorities permitted these companies to resume Ship-to-Ship transfers at Sarnesfjord, near North Cape instead, deeming it less risky towards the marine environment in this location, but have attached strict environmental regulations to accompany their permit to operate (Bambulyak 2011, 72).

Figure 52: Ship-to-Ship transfer operations of fuel, oil cargo. Source: (Bambulayk 2009, 62)

6.5.2.2 NORWEGIAN MUNICIPAL LEVEL OIL SPILL RESPONSE

For minor oil spills, the Norwegian Government has allocated the administrational responsibilities to the municipal level. Therefore, "municipalities will provide the necessary equipment and resources to combat minor oil spills within the municipality itself" (Det-Norske-Veritas 2010, 72). To combat oil spills at the inter-municipal level, the Norwegian authorities have divided its 430 individual municipalities in Norway into 34 larger sub-units called "Inter-municipal Preparedness Regions (IUA) (Det-Norske-Veritas 2010, 72). The purpose of IUAs are for combating oil spills that are determined to be too large for one municipality to handle alone, but are still designed only to deal with smaller oil spills at sea, or if oil reaches the shore (Det-Norske-Veritas 2010, 72; Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 108). However, IUAs can assist both the NCA and NOFO in the event of a large acute oil spill (Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 107-108). Figure 53 shows how Norway's individual municipalities are organized into the 34 Inter-Municipal Preparedness Regions (IUAs) units.

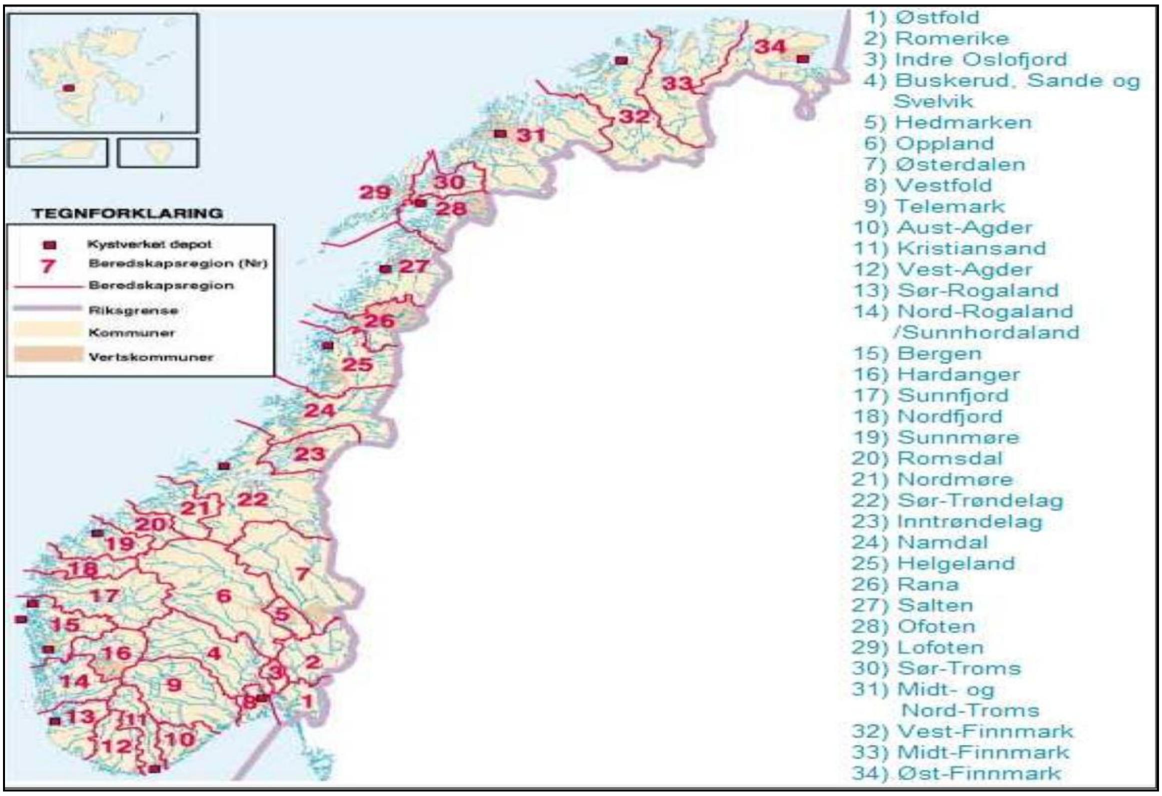


Figure 53: Norwegian Municipalities Organized into 34 IUA Units. Source: (Det-Norske-Veritas 2010, 72)

6.5.2.3 INTERNATIONAL LEVEL OIL SPILL RESPONSE

On top of the coordinated Oil Spill Preparedness and Response System developed in Norway between the private sector and the Norwegian national and municipality-levels, the Government of Norway has also entered into agreements with other international governments to help coordinate and combat against a large-scale oil spill, if necessary, on the Norwegian Continental Shelf or within its coastal waters. Under the auspices of the *Copenhagen Agreement*, the Norwegian Coastal Administration can request for assistance from other Nordic countries. The *Bonn Agreement* grants the NCA permission to ask for assistance from North Sea states. Additionally, the Norwegian Government has together with the Russian Government, developed a bilateral agreement concerning cooperation on oil spill emergency notification and response measures (Norwegian-Ministry-of-Foreign-Affairs 2008-2009, 107).

6.6 INCREASING COOPERATION WITH RUSSIA IN THE BARENTS REGION

In adherence to its *High North Strategy*, the Norwegian Government has demonstrated a concerted effort to increase its relations with Russia, it's neighboring state in the Barents Sea region. Developing cooperation with Russia stands as one of the largest foreign policy areas in the Norwegian Government, especially with relation towards the development in the High North. Perhaps the largest area of increase in cooperation was the signing of the *Treaty on Maritime Delineation and Cooperation in the Barents Sea and the Arctic Ocean* between Norway and Russia in September 2010 (See Section 6.3.1). The result from this treaty is a greater cooperation between the two states towards developing future hydrocarbon resources that may sit underneath the once disputed zone (Karlsbakk 2010). In addition, this treaty serves as a basis of trust and goodwill between the two nations, towards greater bilateral cooperation for the future of the whole Barents Sea region (Karlsbakk 2010).

The Norwegian Government seems to recognize that there will be a sharp increase in petroleum exports sailed along its coastal waters that originate from Russia. Furthermore, the Government recognizes that this increase in the volume of vessel traffic presents a higher risk of acute oil spills through its particularly sensitive sea areas along the Finnmark Coast. Therefore, the Norwegian Government is striving to reach a greater cooperation and understanding with Russia with regard to maritime safety and oil spill prevention and response measures for the entire Barents Sea region.

Currently, there are a number of bilateral agreements between the two countries revolving around these concerns. In 1994, Norway and Russia signed an agreement regarding cooperation in combating oil pollution in the Barents Sea (Norwegian-Fishery-and-Coastal-Department 2004-2005, 84-85). This agreement stipulates that "notification shall be made to the NCA and the National Sea Rescue Services at the Russian Ministry of Transport in the case of oil spill incidents or pollution that can affect the other party" (Norwegian-Fishery-and-Coastal-Department 2004-2005, 84-85). After notification, a joint-contingency plan between the two states will go into effect utilizing both Norwegian and Russian resources to combat an acute oil spill. Additionally, in 2003, the two state authorities established the *Russian-Norwegian Cooperation on Oil Spill Prevention and Response*. This agreement further seeks to ensure a higher level of maritime safety within the Barents Sea through a reciprocal exchange of information regarding petroleum and maritime transport operations in the region, and stipulates that Russian vessels will report pertinent information such as port of departure and cargo-on-board to the Norwegian authorities when traveling along the Norwegian Coast* (Norwegian-Ministry-of-Environment 2005-2006, 23).

In recent years, there have also been many policies implemented towards increasing maritime safety in the Barents Sea and reducing the risks of acute oil spills, developed through the Arctic Council (See Section 6.3.1). The focus of these international developments increase the cooperation between Norway and Russia in the areas of Arctic Search and Rescue (Nuuk Declaration), overall Arctic Security and strengthening maritime safety and preservation (Ilulissat Declaration), and the promotion of sustainable resource development (Tromsø

* These reporting requirements have increased in 2010 with the establishment of the Vardø VTS (See Section 6.4.4.1).

Declaration). The Norwegian Government has thereby achieved greater cooperation with Russia towards reducing the risks associated with petroleum and maritime transport operations through the international apparatus of the Arctic Council.

However, perhaps the area of most concern is to achieve bilateral cooperation on preserving the Barents Sea and its living marine resources in its entirety. Even though the Norwegian Government has implemented a strategic, *Integrated Management Plan* rooted in ecosystem, ocean-based management – the plan covers only Norwegian territories – an area less than half of the entirety of the Barents Sea. Therefore, the Norwegian Government has made it a priority to attempt to diffuse its environmental policies from the Norwegian side to the Russian side, to develop a holistic Integrated Management Plan for all areas in the Barents Sea region to ensure a satisfactory state of environment (Norwegian-Ministry-of-Environment 2005-2006, 11). These intentions were formalized in 2005, when a Norwegian-Russian working group on the marine environment was established. The main objective of this working group is to develop an ecosystem-based management plan for the entirety of the Barents Sea, and thus develop more stringent environmental standards within the Russian petroleum and maritime transport industries (Norwegian-Ministry-of-Environment 2005-2006, 23). In short, a healthier Barents Sea in its entirety has a significant impact towards solving the global issues rooted in the Arctic, not to mention resulting in an overall healthier sea in Norwegian waters.

In addition to attempting to strengthen Russian environmental standards in the Barents Sea, the Norwegian Government has increased its cooperation with Russia towards developing a holistic, joint-monitoring and reporting system for maritime activities within the entire Barents Sea. Norway has begun this process with the installation of the Vardø VTS (See Section 6.4.4.1), but is aiming to expand on this technology, in cooperation with Russia, to cover operations in all Barents regions. Expanding these technologies will enhance Norwegian and Russian exchanges of pertinent information regarding seafaring vessels, and allow authorities on both sides of the Barents Sea the ability to assist vessels in distress (technical failure), on a collision course or grounding path, and provide adequate time to notify emergency towing vessels in an effort to reduce the likelihood of oil spills. Greater cooperation between the two authorities will also allow for a stronger coordinated response to accident events. Therefore, the Norwegian Government aims to increase its capacity of emergency towing services and oil spill response infrastructure and resources along with Russia to focus on oil spill prevention in the Barents Sea (Bambulyak 2011, 97).

Other similar areas of priority are to expand the scale of the *Barents Watch* system to the Russian portion of the Barents Sea. Such an enhanced system would then include and make available to the authorities all resources pertaining to the Russian oil spill emergency preparedness and response system, environmental protocols, geographically constraining areas, living marine resources, risk assessments and levels of vulnerability. Such a reality would only serve to increase the Arctic knowledge base between the two states, assist towards greater coordination between operating maritime industries, and allow for a better prepared, more focused oil spill prevention and response platform and strategy for the Barents Sea.

6.7 THE PUSH FOR AN IMO "POLAR CODE"

According to the latest White Paper on the High North, *The High North: Visions and Strategies*, "Norway is committed to and is at the forefront of efforts to develop *binding* rules for shipping in Polar waters under the auspices of the International Maritime Organization (IMO)" (Norwegian-Ministry-of-Foreign-Affairs 2011, 29). While still in its developmental phase, the Norwegian Government, together with the Arctic Council is strongly urging the IMO to establish a legally binding "Polar Code," or a stringent set of regulations for ships operating in the Arctic. These regulations, upon implementation, will institute a set of formal criteria necessary for certification for maritime operations above 60°N latitude* (Jensen 2007, 11). If resolved, these new regulations will (aside from traffic surveillance systems) have the largest impact towards reducing the risk of oil spills in the Arctic, especially within the Barents Sea and along the Finnmark Coast.

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* With exception to the sea areas southeast of Greenland to Barents Russia

There are currently, however, IMO Guidelines set in place for ships operating in Polar waters, as adopted in 2009, in addition to other regulations adopted over the past decades in the IMO concerning safety at sea and environmental protection (IMO 2011). These guidelines recommend that ships operating in Polar waters contain and maintain proper certification related to its construction, equipment on board, type of operation, and environmental considerations (Deggim 2011, 8). In addition, they call for the qualification of ice-navigators to operate vessels in Polar areas (Deggim 2011, 8). This current framework set in place by the IMO, however, is not legally binding.* Therefore, there is a push to develop a mandatory, legally binding set of regulations.

Figure 54: Extent of Regulated Area under the Proposed IMO Polar Code. Source: (Jensen 2007, 23)

An IMO Polar Code would thereby include all recommended regulations in the Guidelines for Ships Operating in Arctic Ice-covered Waters and make them legally binding. According to the IMO, “In order to take account the climatic conditions of the Polar waters and to meet the appropriate standards of maritime safety and pollution prevention,” regulations will be added to the Polar

* In exception to the hard-regulations set under UNCLOS, SOLAS, MARPOL, and STCW

Code as they are “deemed necessary beyond the existing requirements of SOLAS and MARPOL” (IMO 2011). The added regulations include:

- a new classification system for Arctic seafaring ship types, based on their construction, structural integrity, function, and operational abilities;
- the inclusion of on board, certified and tested safety and rescue, fire, medical, navigation, communication, environmental, damage control and repair, and other operational equipment necessary for Arctic operations and;
- certified training, exercises, and experience among the vessel captain and its crew – in addition to the use of an onboard, trained and certified Ice-Navigator, responsible for continuous monitoring while the vessel is underway in ice-covered waters (IMO 2011)

Additional environmental concerns regarding Arctic vessel voyages are also being addressed in the formulation of the IMO Polar Code. Largely, these regulations regard fuel type allowances (bunker fuel) towards reducing black-carbon pollution in the Arctic, along with regulations concerning the vessels pollution preventing equipment and procedures, its environmental emergency contingency plan, and its available equipment necessary to remedy deck spills and small oil spills (IMO 2010).

If the Polar Code were to be adopted by the International Maritime Organization, this would serve to greatly reduce the risk of oil spills in the Arctic, especially based on the classification requirements for ships, certified and trained professionals operating the vessels, and its focus towards reducing the overall environmental impacts associated with operating in Polar waters by requiring emergency and environmental damage remedy equipment on board. The IMO Polar Code, with its stringent requirements and regulations, thereby adheres vehemently towards maritime safety and pollution prevention, based on the precautionary principle. The implementation of such measures for oil transporting vessels in the Barents Sea would certainly reduce the risks of maritime accidents and subsequent oil spills and harm to the marine and coastal environment – resulting in a healthier, less vulnerable High North.

In response to the main research question of this project – asking how, and through what specific means the Norwegian government aims to reduce vulnerability towards oil spills off the Finnmark Coast – the Norwegian Government has focused its efforts on hazard mitigation in what can be identified as five priority areas. These include: (1) A new approach to marine resource management (Integrated Management Plan, Ecosystem-Based Ocean Management, and PSSAs); (2) Developing new shipping vessel, traffic routing, and surveillance systems (Traffic Re-routing and Separation Schemes, Vardø VTS, and BarentsWatch); (3) Increasing its oil spill prevention, preparedness, and response systems both domestically and internationally – across the public and private sectors (NCA, IUAs, NOFO, Emergency Towing Services); (4) Advanced its bilateral, multilateral, and technological cooperation with Russia towards introducing higher environmental and industry standards (Maritime Boarder Treaty, Integrated Management Plan, Oil Spill Preparedness and Response Systems, Traffic Surveillance and Environmental Monitoring); and (5) lending its full support towards the creation and adoption of a new, legally-binding IMO Polar Code. The combined impact of these hazard mitigating actions serve as the fundamental basis for regulating a region on track to become the new petroleum province of the future. The extent of which these actions are sufficient, however, will be addressed in the concluding chapter.

7.0 CONCLUSION

The overall objective of this project was to provide an answer for how the Norwegian Government aims to mitigate the Place-Vulnerability of Finnmark County from oil spills imposed by the expanding maritime transport operations in the Barents Sea. To obtain this result, a quantitative analysis was first conducted to determine Place-Vulnerability levels within Finnmark. Determining Place-Vulnerability was subsequently divided into an analysis of Social Vulnerability and Biophysical/Technological Vulnerability, exposing coastal areas vulnerable to shipping accidents (the largest cause of oil spills) from the environmental hazards in the Barents Sea.

7.1 SOCIAL VULNERABILITY

Pertaining to the assessment Social Vulnerability, Finnmark County was divided into three geographical regions (North, Mid, South) (See Section 4.5.2), each containing a similar number of individual municipalities. Pertinent social data was obtained from the public database at Statistics Norway (SSB) concerning 29 social variables. Calculations were conducted to score and compare each of the three geographical regions per each variable. The results from each individual Social Vulnerability Indicator variable category were then summed to give a cumulative Social Vulnerability Score for each geographical region. From there, a *Social Vulnerability Index* was formulated to depict the results of the cumulative Social Vulnerability Scores across all three geographical regions (See Section 5.2-5.3).

The results display that the Southern Region (Block 3) had the highest overall Social Vulnerability Score, and thus is the most Socially Vulnerable geographical region within Finnmark County. The North Region (Block 1) had the second highest cumulative score, and therefore is distinguished to be the second most Socially Vulnerable geographical region. The Mid Region (Block 2) scored the lowest, and thus has the lowest present levels of Social Vulnerability within Finnmark County. However, the results display that all geographical regions within Finnmark County carry a moderate level of Social Vulnerability, and therefore can conclude that all communities within the County are susceptible to the harm imposed from technological hazards, in this case, shipping accidents.

7.2 BIOPHYSICAL/TECHNOLOGICAL VULNERABILITY

Biophysical/Technological Vulnerability was also assessed for Finnmark County as part of the *Hazards-of-Place* framework for Place-Vulnerability. This analysis focused intensely on the likelihood of shipping accidents off the Finnmark Coast as a result of environmental and geographical hazards present. Data to compile and present *Hazard Frequency* and *Hazard Recurrence* for shipping accidents off the Finnmark Coast were obtained from the Norwegian Maritime Directorate's Ships Accident Database. This database provided an historical overview of ship accident reports occurring off the Finnmark Coast between the years 1981 - 2011. From this database, there was a total of 153-cargo ship accidents reported to the authorities over this 30-year span. Among the 153 reported accidents, 86 of these were indicated as ship groundings, 30 as collisions between or among vessels, 10 as fire/explosions on board, 9 as contact damage with bridges or wharfs, 8 were reported as vessel-leakage events, 8 incidents where vessels lost stability control, 7 events occurring from severe weather damage to the vessel, and 4 were reported as vessel capsizing. The high number of total accident events suggests that the coastal wasters along Finnmark County are extremely hazardous. This is, in fact, because they are. The waters adjacent to Finnmark County are notoriously difficult to navigate, as there are filled with "innumerable small islands, scurries, and rocky shallows" (Kristoffersen 2010, 14).

Therefore, a further analysis of the accident report data was conducted to uncover what types of environmental conditions existed during each accident reported. Arctic waters are known for their abundance of unique environmental characteristics potentially imposing navigational and operational hazards for ships. Therefore, an analysis of the reported accidents in relation to environmental indicator variables was conducted. In total there were five environmental indicators selected for analysis: Darkness, Severe Weather, Visibility, Geographical Constraints, and Cold Weather. The first four environmental indicators were officially listed in the accident report database.

To determine whether the ships were operating in cold temperatures, the Norwegian Meteorological Institute's historical weather database was utilized. This database allowed for allocating the daily average temperature closest to the site of the accident on the day in which it occurred in the past.

The results from the assessment of shipping accidents in relation to the five environmental indicator variables were quite informing, and perhaps can help explain why the accidents occurred. Darkness was the first indicator analyzed. From the results, 53% of collisions and 50% of all groundings and capsizing occurred under the night sky. Severe Weather was indicated at substantial levels across all types of shipping accidents that occurred. Again, 50% of capsizing occurred during bouts of Severe Weather at sea, where as 47% and 42% of all collisions and ship groundings, respectively, occurred under similar weather conditions. Poor visibility (less than 0.5NM) was indicated in 30% of all collisions and fires/explosions, and was reported in 15% of all ship groundings. Geographical Constraints (Narrow Corridors, Steep Fjords, Shallow Waters) were indicated in 53% of all collisions and in 48% of all ship groundings. However, Cold Temperatures were the most prevalent across all types of accidents off the Finnmark Coast. Temperatures listed at 0°C or below occurred in approximately 43% - 67% of all accident types, with exception to capsizing, where cold operational temperatures were indicated at 25%.

Utilizing the recorded data for each accident location, provided by the Maritime Directorate's Database, a subsequent analysis of the geographical areas most prone to shipping accidents and marine environmental hazards was conducted. The results demonstrate that the geographical region with the most reported accidents were the shipping lanes between Korsfjorden and Holmengrå (39 accidents), between Tromsø and Hammerfest (13 accidents), and within the Vestfinnmarkfjords (17 accidents). All three of these shipping lanes are located in western Finnmark County, closest to the South Region (Block 3). Thus, the South Region has the highest level of risk towards marine shipping hazards. The Mid Region (Block 2) was assessed as carrying the second highest level of risk, whereas the North Region (Block 1) had the least level of risk of marine hazards, and thus a lower level of Biophysical/Technological Vulnerability within Finnmark County.

7.3 PLACE VULNERABILITY

Place-Vulnerability is the intersection between where hazards exist (Biophysical/Technological Vulnerability) and where the population is most susceptible (Social Vulnerability) (Cutter 2000, 733). Therefore, the results from combining these two analyses suggest that the South Region (Block 3) is attributed with the highest level of Place-Vulnerability within Finnmark County. Within this particular geographical region, there are both high levels of risk to marine shipping hazards (Biophysical/Technological Vulnerability) and high levels of Social Vulnerability, according to the results in the *Social Vulnerability Index*. The Mid Region (Block 2) has the lowest levels of Biophysical/Technological Vulnerability among the three geographical regions, but is attributed as having the second highest level of Social Vulnerability, thereby denoting it as the second most overall levels of Place-Vulnerability. Conversely, the North Region (Block 1) has the lowest distinguished levels of Social Vulnerability, but the second highest level of Biophysical/Technological Vulnerability. Therefore, in accordance to the *Hazards-of-Place* framework, this geographical region represents the area with the least overall level of Place-Vulnerability within the county.

7.4 THE HIGH NORTH STRATEGY

After determining the Place-Vulnerability within Finnmark County, an assessment of the Norwegian Government's *High North Strategy* towards mitigating these risks was conducted to successfully answer the first part of the second research question. Even with the known risks associated with offshore petroleum and maritime transport activities along the Finnmark Coast, these industrial operations are poised to dramatically increase over the coming decades (Nilsen 2011, 3). Therefore, a qualitative inquiry was conducted into the specific policies and actions undertaken by the Norwegian Government over the past decade to reduce the likelihood of oil spills subsequent to shipping and operational hazards off the Finnmark Coast.

7.4.1 PRAGMATIC ACTIONS TO REDUCE RISK OF MARITIME ACCIDENTS

Over the past decade, the Norwegian Government has presented a series of policy framework documents to address the development of its *High North*. These documents clearly state that the government is aiming to transform its northernmost areas into a strategic industrial region, with great emphasis on facilitating growth in the Petroleum and Maritime Transport Industries. However, these framework reports additionally emphasize that such developments, especially related to marine-affiliate industries, must be achieved sustainably, as they occur in the environmentally sensitive Arctic (Norwegian-Ministry-of-Foreign-Affairs 2011). This has resulted in the establishment of a management regime concentrated around environmental preservation and conservation in the Barents Sea Region. The government recognizes that increased industrial operations, especially related to petroleum extraction and marine shipping, carry great risks towards devastating consequences to the living marine resources in its coastal waters – both from an environmental and socio-economic perspective. It has therefore established a series of environmental regulations pertaining to industrial activities in this region to achieve this outcome.

A collection of technical scientific reports addressing the potential negative consequences towards the marine environment in the *High North* have identified that maritime shipping of petroleum resources present the greatest risk to the marine environment. (ACIA 2004; Bambulyak 2011; Barents-2020 2006; Den-Norske-Veritas 2009; Det-Norske-Veritas 2008, 2010; Dragsun 2003; O'Brien 2003; Sygna 2004; West 2008). In fact, it has been determined that oil spills as a result of shipping accidents are ten-times more likely to occur than oil spills deriving from offshore platform accidents (Dragsun 2003, 1). Since maritime transport represents the greatest overall risk (and this industry is projected to dramatically increase its activities in the Barents Sea), the Norwegian

Government has focused efforts towards implementing regulations to prevent the likelihood of maritime vessel accidents in its coastal waters and specifically along the vulnerable Finnmark Coast.

These oil spill prevention regulations for maritime shipping have primarily been organized around five priority areas: Implementing an ecosystem-based ocean management regime; Imposing new vessel traffic regulations and surveillance mechanisms; Increasing the capacity and functioning of oil spill prevention and response resources in the *High North*; advancing cooperation with Russia in the Barents Sea; and calling for new technical and operational requirements for vessels operating in Arctic waters. These regulations, independently, and in cooperation with one another have been assessed to be effective towards reducing the risks of maritime accidents.

Specifically, the establishment of Particularly Sensitive Sea Areas (PSSA) for the coastal waters adjacent to the Finnmark Coast has led to significant reductions in risk as it has subsequently allowed the Norwegian Government to implement a host of maritime transport regulations. Perhaps the most effective regulation is mandating that oil tankers (5000 tons gross weight or more) must sail in assigned shipping lanes 30NM from the coast. Additionally, these vessels are required to report all pertinent operational information and be subjected to continuous satellite monitoring by the Norwegian Authorities during the tenure of its voyage. These requirements are aimed at preventing both vessel collisions and grounding events – the two most frequent types of accidents. As a result, the Norwegian authorities are able to effectively coordinate and scramble their emergency response vessels in a critical situation, reducing the likelihood of collisions by 60% (Behrens 2004, 71). Additionally, the potential for grounding accidents is reduced to less than 1% when requiring vessels to sail 30NM from the coast in combination with an effective, coordinated emergency response system (Det-Norske-Veritas 2010, 38). Therefore, these specific regulations seem to effectively reduce the risk of the two most prominent types of accidents that result in oil spills. However, the overall extent of which these policies and practices are sufficient is debatable.

7.4.2 THE SUFFICIENCY OF THE HIGH NORTH STRATEGY

Even when taking into account the extent of which the policies adopted under the Norwegian Government's *High North Strategy* have a risk reducing effect, accidents do occur, even under the best prevention planning pretenses. Shipping accidents occur most often as a result of human error. The unique and unpredictable environmental conditions found in the Barents Sea only serve to exacerbate this. Therefore, it's pertinent to reflect upon whether or not the policies and practices adopted by the Norwegian Government through its *High North Strategy* are sufficient towards meeting the needs for the protection of the vulnerable Finnmark Coast.

The regulations implemented towards reducing shipping accidents and subsequent oil spills *do* meet the needs towards protecting the living marine resources affecting the Place-Vulnerability within Finnmark County. However, these policies are sufficient *only* to the effect of reducing the risks associated with the *current levels* of maritime traffic in the Barents Sea. Although they are expansive, these policies are not enough to protect the Finnmark Coast from potential oil spills and subsequent environmental and socio-economic consequences in the coming years. The *High North Strategy* is sufficient, however, in setting the foundation for managing future traffic volumes, but not for reducing the total risks involved with increasing oil tanker traffic from current levels to the volumes projected by the year 2020. In order to meet the needs for reducing the vulnerability that this project has identified in its quantitative analysis, the Norwegian Government must increase the capacity and reach of certain priority areas.

First, there needs to be a concerted effort to increase the capacity of available emergency towing vessels in the Barents Sea. Currently there are approximately 8 emergency towing vessels between the three stations located at Kirkenes, Melkøya, and Tromsø (See Figure 51). Under the current volume of maritime traffic in the Barents Sea, these resources are sufficient towards reducing the risks of collision and grounding accidents. However, the volume of oil tanker cargo in 2010 was approximately 19 million tons. This level is anticipated to dramatically increase to 100 million tons or more originating from Russia alone by the year 2020, resulting in a surge of oil tanker traffic sailing along the Finnmark Coast – especially if the Shtokman field comes online (Bambulyak 2011). The amount of available emergency towing vessels needs to reflect this sharp increase in the amount of traffic in order to reduce vulnerability.

Along the same line, there must be an increase in the capacity of oil spill prevention and response equipment to reflect the growing volume of transported petroleum resources. Furthermore, sufficient technology for oil spill recovery in cold, icy, and especially dark conditions does not yet exist to the extent required to combat an acute oil spill under these environmental conditions. The Norwegian Government must give more priority towards allocating these types of resources for the High North.

Moreover, a legally binding IMO Polar Code has to become a reality. Vessel technical and operational regulations under this code will perhaps have the largest effect towards reducing risk and vulnerability along the Finnmark Coast. The Norwegian Government has done a sufficient job in promoting these regulations – where the process and arena in which these regulations are being drafted are slow and complex. However, requiring a Polar-Class Certification for a vessel and its crew for all ships operating along the Finnmark Coast is the best means for preventing accidents at sea and subsequent oil spills.

In sum, the Norwegian Government has made positive strides towards reducing the risks and vulnerabilities associated with oil spills in the Barents Sea through its *High North Strategy*. However, the current implemented measures under this *Strategy* can only reach so far – as the future increase in maritime traffic volume is *too large* and the Finnmark Coast is *too vulnerable* to the adverse environmental and socio-economic consequences resulting from oil spills.

7.4 IMPICATIONS FOR FURTHER RESEARCH

The purpose of this project was to successfully determine Place-Vulnerability levels within Finnmark County while adhering to the *Hazards-of-Place* framework for vulnerability assessment. A secondary function of the project was to identify the existing policies and actions aimed at reducing the determined levels of Place-Vulnerability within Finnmark County (the so called "feedback loops" in the *Hazards-of-Place* framework). Now that these two research objectives have been completed, there exist multiple opportunities to take this research project further, utilizing the *Hazards-of-Place* framework.

The first area for further research would be to conduct a secondary assessment of Place-Vulnerability for Finnmark County utilizing the information regarding the Norwegian Government's mitigation strategy and priority areas for the High North in a few years time. This type of research project would focus on the quantifiable extent in which the Norwegian Government's mitigation policies and actions actually reduce the likelihood of ship accidents as a result of geological and environmental hazards. However, enough time has not passed for an effective analysis to measure the extent to which the *High North Strategy's* policies and practices actually mitigate risks and vulnerabilities. In other words, to what degree are shipping hazards (and subsequent Place-Vulnerability) reduced as a result of these new policies? Furthermore, how would these results compare to the results presented in this project?

A second area for further research would be to conduct another cycle of the *Hazards-of-Place* framework, only this time emphasizing temporal scales. In other words, what would the Place-Vulnerability of Finnmark County be in five, ten, or fifteen years from now? Has either Social or Biophysical/Technological Vulnerability increased or decreased over time and what are the root-causes? A third area for further research would be to determine the Place-Vulnerability for *all coastal counties* in Norway. This type of an analysis would involve an assessment of Place-Vulnerability for *all coastal municipalities* in Norway. Such research would help identify the exact location of vulnerable communities and geographical areas along the Norwegian Coast, which may invoke political action and the creation of new national policies.

Finally, the *Hazards-of-Place* framework could be utilized for research in any and all coastal areas worldwide. It would be worthwhile and interesting to see the results in other countries at the national, regional, or local-level.

Appendix

Figure 1

Variables, sources and table references, data included in the SoVI

Variable	Description of Variable	Data Source	Table Reference
Total Population	Population by sex, age, 1-year age groups	Statistics Norway (SSB)	Statbank02Tab07459
Population Age 0-5 Years	Population by sex, age, 1-year age groups	Statistics Norway (SSB)	Statbank02Tab07459
Population < 18 Years	Population by sex, age, 1-year age groups	Statistics Norway (SSB)	Statbank02Tab07459
Population > 67 Years	Population by sex, age, 1-year age groups	Statistics Norway (SSB)	Statbank02Tab07459
Immigrant Population	Immigrants, by country background (world region), and sex	Statistics Norway (SSB)	Statbank02Tab07110
Female Population	Population by sex, age, 1-year age groups	Statistics Norway (SSB)	Statbank02Tab07459
Urban Population	Population in densely and sparsely populated areas, by sex	Statistics Norway (SSB)	Statbank02Tab05212
Rural Population	Population in densely and sparsely populated areas, by sex	Statistics Norway (SSB)	Statbank02Tab05212
Total # of Households	Households, by size after tax income	Statistics Norway (SSB)	Statbank05Tab07182
Annual Average Household Income	Median after-tax income, by type of households, number of households, and median	Statistics Norway (SSB)	Statbank05Tab06944
Annual Household Income < 150.000 NOK	Median after-tax income, by type of households, number of households, and median	Statistics Norway (SSB)	Statbank05Tab06944
Annual Household Income > 750.000 NOK	Median after-tax income, by type of households, number of households, and median	Statistics Norway (SSB)	Statbank05Tab06944
Total Employed Population 17 – 74 Years Old	Employed Persons ages 15-74, sex, % of population	Statistics Norway (SSB)	Statbank06Tab06445
Total Registered Unemployed Population	Registered Unemployed, sex, % of population	Statistics Norway (SSB)	Statbank06Tab04471
Employed in Fishing & Aquaculture Industry	Employed persons per 4th quarter, by industry divisions, sex, and age	Statistics Norway (SSB)	Statbank06Tab07984
Employed in Food Processing Industry	Employed persons per 4th quarter, by industry divisions, sex, and age	Statistics Norway (SSB)	Statbank06Tab07984
Employed in Accommodation Services Industry	Employed persons per 4th quarter, by industry divisions, sex, and age	Statistics Norway (SSB)	Statbank06Tab07984
Employed in Food & Beverage Services Industry	Employed persons per 4th quarter, by industry divisions, sex, and age	Statistics Norway (SSB)	Statbank06Tab07984
Single-Parent Households	Private Households, by type of Household	Statistics Norway (SSB)	Statbank02Tab06070
Large-Family Households	Persons in private households, by size of household	Statistics Norway (SSB)	Statbank02Tab06079
No Education or Unknown Education	Persons 16 years and over, by gender and level of study	Statistics Norway (SSB)	Statbank04Tab06983
Basic School Education Level	Persons 16 years and over, by gender and level of study	Statistics Norway (SSB)	Statbank04Tab06983
Upper Secondary Education Level	Persons 16 years and over, by gender and level of study	Statistics Norway (SSB)	Statbank04Tab06983
Tertiary Education Level	Persons 16 years and over, by gender and level of study	Statistics Norway (SSB)	Statbank04Tab06983
Population Dependent on Pensions/Social Assistance	Recipients of social assistance, by age	Statistics Norway (SSB)	Statbank03Tab05073
Population Living in Nursing Homes (Institutions)	Residents in institutions for the aged and disabled	Statistics Norway (SSB)	Statbank03Tab04469
Population Living in Assisted Living (Dwellings)	Residents in dwellings for the aged and the disabled	Statistics Norway (SSB)	Statbank03Tab04468
Available Physicians	Employees with health care education in health care activities, by sector	Statistics Norway (SSB)	Statbank06Tab07944
Available Nurses	Employees with health care education in health care activities, by sector	Statistics Norway (SSB)	Statbank06Tab07944

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