Scenarios for Energy and Resource Development on the North Slope and Adjacent Seas

Research and Monitoring
Prioritization for the NSSI

Environmental Disasters | Human-caused

Summary

Terrestrial and marine oil spills have been occurring since oil production began on the North Slope and are likely to continue to occur at small scales. Regulations can reduce the magnitude and likelihood of environmental disasters, but occurrences are impossible to predict accurately. Invasive species are predicted to increase in-step with increasing trans-arctic shipping. The choices of other Arctic countries, national and international regulations, economic and political drivers and disaster response effectiveness can affect the scale of an environmental disaster's impacts on ecosystems, cultural and subsistence activities, transportation, human health and future development activity in the region.

Threats of large-scale human caused environmental disasters include oil spills, tanker spills, other pollution related to increased industrial activities, and invasive species. In addition, the cumulative effects of vessel traffic noise, ballast discharge and tundra fires can affect human and environmental health. These could drive changes in regulations, costs for clean-up and mitigation, and community views on resource extraction activities. Large scale environmental disasters may influence public support and industry decisions for expanding resource development on the North Slope.

Overview

Human-caused environmental disasters are distinct from natural disasters such as earthquakes and floods. However, the line between human-caused disasters and natural disasters can be blurry, such as in 2011 when an earthquake and tsunami caused a core meltdown of the nuclear reactors at the Fukushima power plant in Japan [2][1]. Environmental disasters are those in which the majority of direct damage occurs to the natural non-human environment, with human, material, and economic losses occurring less directly.

Oil spills

The Exxon Valdez and Selendang Ayu are examples of two large scale oil spills in Alaska's marine environment. *Exxon Valdez, an* oil tanker, ran aground in Prince William Sound, Alaska, spilling an estimated 257,000 barrels (bbl) of crude oil into the Gulf of Alaska in 1989 [3]. On December 8, 2004 Selendang Ayu released more than 335,000 gallons of fuel oil off Unalaska, Island near Dutch Harbor [11]. While oil spills from production sites may occur, oil spills are more likely to result from a vessel spill. However future expansion of oil production could include the US Outer Continental Shelf (OCS) in the Chukchi and Beaufort Seas, as well as State waters.

[1] The State of Alaska's Department of Environmental Conservations states that from Fukushima, "No levels of public health concern are expected here in Alaska" (http://dec.alaska.gov/eh/radiation/). Although there is no nuclear energy production in the US Arctic, nuclear powered ships and submarine frequently transit Arctic waters and constitute another source of a potential human-caused environmental disaster.

Considerable concern has been expressed about the ability of the oil industry to operate safely and responsibly in US Arctic waters, which exhibit extreme weather and dangerous sea ice. An oil spill in US Arctic waters could foul the marine and coastal ecosystems of NWAB & NSB. The *Deepwater Horizon* disaster in 2010 (Figure 1, *source:* US Coast Guard), which resulted in almost 5 million bbl of oil discharge into the Gulf of Mexico following a well explosion at an offshore rig [4], heightened concerns over OCS drilling in the US Arctic.

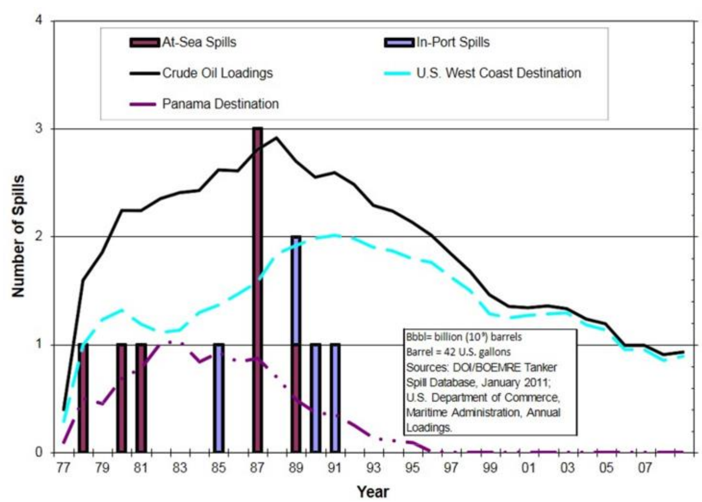

Figure 1. North Slope crude oil tanker spills ≥ 1,000 barrels vs. total crude oil loadings and crude oil shipment destinations, 1974-2008 [5].

Shell's mishaps in 2012 with their US Arctic oil exploration vessels *Noble Discoverer* (Coast Guard violations) and *Kulluk* (lost tow and grounding) furthered concerns.

Noise and vessel traffic
With expected increases in open water, increases in vessel traffic are likely. This raises the likelihood of environmental disasters from vessel spills. Increases in vessel noise, and ballast discharge may also increase the cumulative negative environmental impact of noise-related disturbance, pollutants, and introduction of invasive species.

Invasive species: Currently the incidence of terrestrial invasive species in the Arctic is low, but may increase as temperatures increase. In the marine environment there is a possibility of an influx of invasive marine species in the ballast water of transiting vessels. Invasive species can spread naturally, but then can be transported to new areas by humans, potentially causing extensive harm. Invasive species can reduce native biodiversity, increase competition of resources and alter habitats with subsequently large economic and ecosystem impacts [9].

Fires: Large scale fires affect biodiversity, ecosystems, and potentially human health and safety. While lightning is the primary source of fires in the study region, increasing human presence may also increase the risk of human-caused fires, particularly in the proximity of roads and settlements.

Trends

One source of marine oil spills in Alaska is tanker vessels that transport oil loaded at the port of Valdez, at the end of the Trans-Alaska Pipeline Systems (TAPS). While such spills do not directly affect the local environment of the Beaufort and Chukchi Seas, they are important to consider as it may affect how oil that originates from the North Slope is distributed.

A decrease in spills that have occurred since the early nineties can be attributed to improved safety regulations. In addition to tankers, sources of marine oil spills include drill platforms and offshore pipelines. A recent estimate suggests that for platforms on the US OCS between 1964 and 2010 such spills ≥ 1,000 bbl occur at a rate of .32 per billion of barrels produced (Bbbl) and at a rate of .06 spills ≥ 10,000 bbl per Bbbl produced (these numbers include the *Deepwater Horizon* spill) [5]. To put these numbers in perspective, the Prudhoe Bay oil field alone has produced over 12 Bbbl as of 2012. Very large (>= 150,000 bbl) oil spills from offshore production facilities are low probability, high impact events.

While marine spills pose perhaps the greatest risk for causing a major disaster, terrestrial spills should also be considered. A recent report initiated finds that between 1971 and 2011 on Alaska's North Slope there were 1,577 oil spills larger than one bbl from onshore and nearshore production facilities [6]. Over 80% of the spills were between 1-10 bbl, 10 spills were larger than 500 bbl, and two spills were larger than 1,000 bbl (these numbers exclude spills from TAPS).

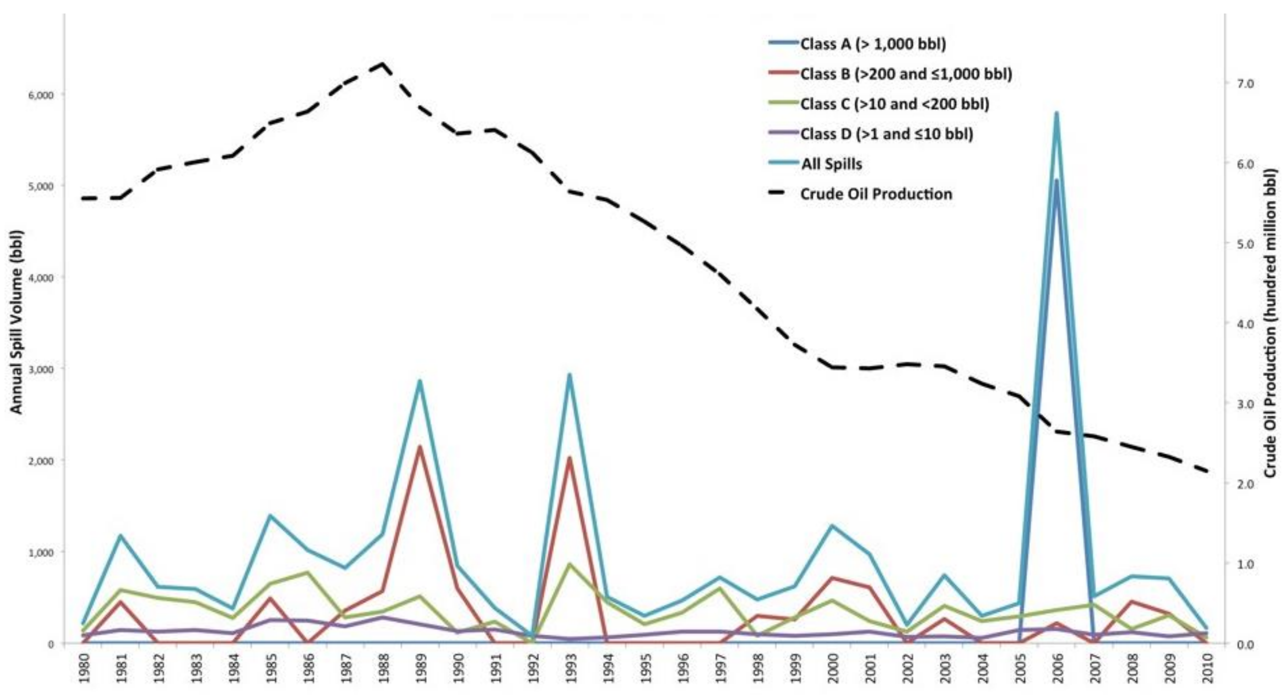

Figure 2. Annual volume of Alaska North Slope industry spills by spill size class compared to total crude oil production for the years 1980-2010 [6].

The 2006 spill (the large spike in Figure 2) is the largest to have occurred on the North Slope and was related to a corroded pipe that fed into TAPS. Approximately 5,054 bbl of oil were deposited under the snow before an industry employee detected the spill. The pipeline was built in the 1970s and the spill raised concerns about the state of current infrastructure.

Uncertainties

Oil spill sources: The threat of a marine oil spill disaster in the US Arctic motivated the National Research Council to conduct a recent study that assesses response capacity across sectors [7]. The study identified extreme weather and environmental conditions, limited communication, logistical and information infrastructure and large geographic distances as factors that contributed to the challenges in oil spill response that could affect the vulnerability of species, ecosystems and cultures in the Arctic [7].

The study offered recommendations based on the evaluation of seven scenarios: a passenger cruise ship accident; a large tanker spill; a bulk ore carrier driven onshore in bad weather; a tug and barge accident; a break in a subsea pipeline from nearshore production; a well blowout; and structural failure of an oil storage tank. These scenarios expanded the scope of potential threats from oil production to include more general maritime activities, acknowledging an increasingly wide array of potential environmental impacts from industry in the US Arctic.

Modeling spill trajectories: The presence of seasonal sea ice in the waters presents challenges for modeling the behavior of oil in the marine environment and predicting the spread of a major spill. Sea ice would also provide a physical obstacle to response vessels in the case of a marine spill. Additionally, oil trapped in ice is more difficult to clean up than oil on open water.

Despite the challenges posed by sea ice to modeling the movement of an Arctic marine oil spill, efforts are underway to assess the potential impact of spills across international borders. A recent study analyzed four types of oil spills in the Canadian Beaufort Sea and found that modeled surface oil trajectories commonly followed a westward pattern, often moving west of Point Barrow [8].

An important takeaway message from this study is that what happens in foreign Arctic waters with regards to future offshore oil spills is likely to affect the US Arctic. An offshore oil spill in the waters of the Russian Federation also poses a potential threat to the study region.

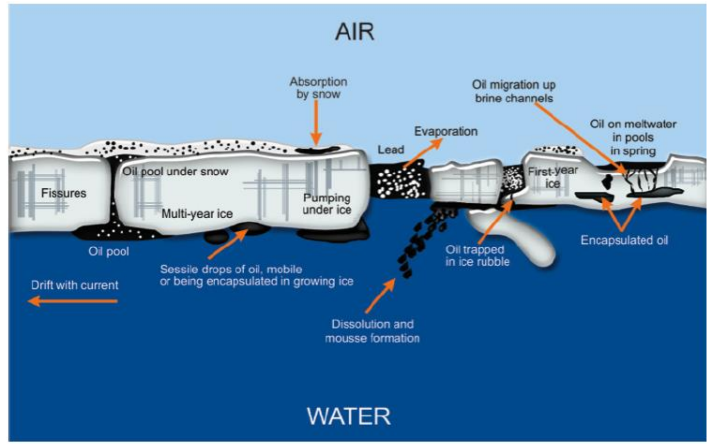

Figure 3. General dynamics and characteristics of sea ice and oil interaction [8] (Original figure by Alan A. Allen).

Impacts of increased vessel traffic: Some ecologists predict that the rise of trans-Arctic shipping will increase the presence of invasive species in the Arctic, especially in coastal zones as species are transported into the region through the ballast water of ships and on their hulls.

Possible outcomes may include greater opportunities to move species large distances over relatively short periods of time and substantial increases in invasive species introductions that increases the vulnerability of native species and not previously exposed to new competitors [10]. Research in this area is just beginning, so there is little data on which species may invade the Arctic or how quickly new species may become established after being introduced.

The cumulative impacts of pollutants discharged in ballast water and noise-related disturbances are also difficult to assess.

Developing unconventional oil resources: In addition to current resource extraction activities there is some potential for pursuing commercial extraction of oil from North Slope shale. Fracking activities have been related to environmental issues such as groundwater contamination and increased frequency of small magnitude earthquakes.

Driver interactions

Human-caused environmental disasters in the form of oil spills and invasive species are linked to multiple other drivers. An offshore oil spill, in the magnitude of *Deepwater Horizon*, could only occur in the US Arctic if oil production expands into the offshore environment of the OCS. This expansion, in turn, is a function of multiple other drivers, such as economic incentives and the political regulatory environment. The damage caused by an oil spill is related to the disaster response effectiveness of the responsible parties. Similarly, the spread of invasive species is a result of increased shipping, which is facilitated by decreasing sea ice (see Sea Ice fact sheet) and global economics.

The results of potential human-caused environmental disasters also interact with multiple drivers. Perhaps most importantly are the potential effects of a marine oil spill on subsistence species, like the bowhead whale and multiple other Arctic marine, terrestrial, and avian species. Degraded ecosystems, either covered in oil or transformed by invasive species, affect the cultural activities of North Slope residents.

Advances in new technology to reduce the threat of oil spills during production and transportation, and improvements in technology for recovery and containment of oil in the event of a spill also affect the potential environmental impact. Research on for spill response include improving methods and technology for mechanical clean up, in-situ burning, and effects of use of dispersants. The challenges of responding to offshore oil spills in sea ice has not been extensively tested in field conditions. Even with technology advances the time and resources needed to implement and coordinate the spill response effort remains an important factor in response effectiveness.

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