Effects of Industrial Activities: Oil and Gas Exploration, Tourism and Shipping on the Arctic Environment; Biotic and Abiotic

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Introduction

Industrialization in the Arctic began towards the waning periods of the 19th century and the waxing periods of the 20th century. This paper seeks to examine the effects of increased industrial activities in the Arctic observing the fact that there have been increased developments in the Arctic region in recent times. Various industrial activities particularly oil and gas exploration, tourism and even shipping has gone on an increase in this region, and likewise have triggered a chain reaction a lot of other effects in the region particularly environmental. The paper will also examine some brief case studies concerning the effects of these hiked developmental activities on an already fragile environment.

The Arctic is a particularly unique region on the earth well known for its delicate nature when plagued with external environmental factors due to the workings of feedback mechanisms. It consists of a large ocean surrounded by land and is the region that surrounds what scientists call the Arctic Circle at about $66^0$34'N.

This region is heavily endowed with untapped resources which has the capability of generating a fortune for any province or nation. With respect to hydrocarbons, this region has potential amounting to about 90 billion barrels of oil and up to 50 trillion cubic meters of natural gas and 44 billion barrels of natural gas liquids, this represents 13% of the undiscovered oil in the world, per a 2008 estimate by the US Geological Survey (Schiermeier, 2012). The Arctic is also blessed with a good number of metallogenic minerals including iron ore, bauxite, phosphate and nickel and has a relatively rich variety of fish stocks and about 10% of the world's reserves for fresh water is contained in Greenland. Finally, due to the nature of the geographic location of the region, it is packed with picturesque-like landforms ranging from mountains to valleys, waterfalls, glaciers and a host of many others making the region a hotspot for tourism and adventure.

Oil and Gas exploration in the Arctic

The exploration of oil and gas in the Arctic is extremely difficult and meets a lot of challenges. This statement is a paradox as the interest of exploration in this region is on a steady increase probably since high oil prices and recent technological developments have emerged all favouring greater exploration. Only half of the nineteen geological basins that make up the Arctic region have been explored including areas like the Barents Sea in Norway and Russia and the Beaufort Sea. The Alaska North Slope was the first area in the Arctic were oil was produced in 1968 from Prudhoe Bay.

In the Canadian Arctic, rigorous drilling activities was done by companies like Petro Canada in the 1970s and 80s but ran into road block when the quantity of oil wells drilled did not match the cost of drilling resulting in the abandonment of the wells. Interesting to know that unlike oil regions like the Gulf of Mexico, the oil in the Canadian Arctic has been transformed by geological processes and is gas prone rather than oil prone; meaning that most of the oil has been transformed into natural gas. Greenland is believed to have perhaps the largest remaining oil resources while Russia has approximately 10 billion tons of oil and gas deposits in the Lomonosov Ridge region and are also involved in offshore oil drilling on the Prirazlomnaya Platform in the Pechora Sea. The largest oil field in North America is in Alaska (Prudhoe Bay Oil Field) and has begun to see the likes of Shell since 2012. In Norway, oil deals have been signed by companies like Rosneft and Statoil.

With all these exploratory activities, the environmental challenges that make exploration difficult still stands, some of these challenges include; extreme temperatures Sea Ice, Ice bergs, whirlpools, and permafrost thaw. Icy conditions in the Arctic greatly reduces the authenticity of spill response for most of the year.

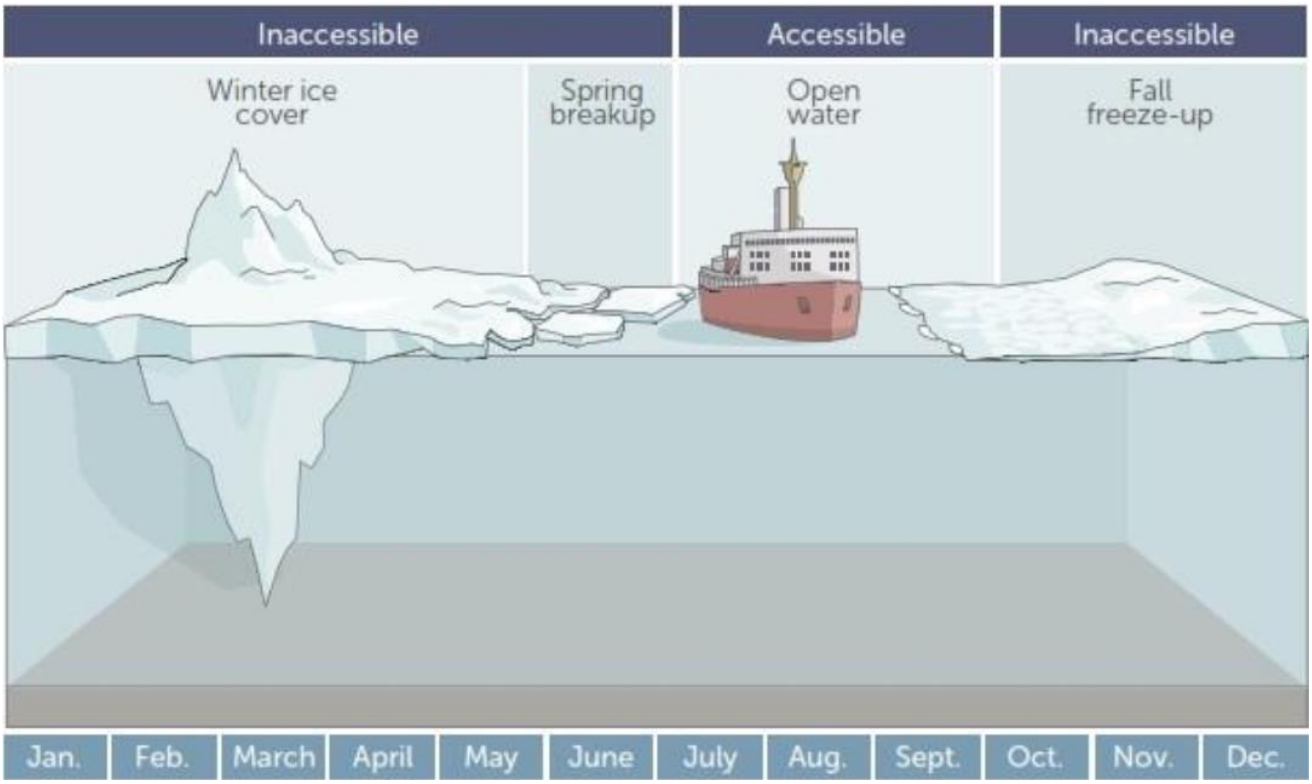

Fig 0.1: Icy conditions reduces effective oil spill response feasibility

Negative Effects of Oil and Gas Exploration in the Arctic

As stated the Arctic environment is quite a sensitive one and of course various issue arise from the activities of oil and gas exploration in this region. Let's talk about its effects on marine life. Recent reviews have been given on the effects of this activity on the benthic organisms of the North Sea. Kingston 1992) says that during the early days of exploration, it was generally believed that the major input of oil would be in water from platform drainage and production. This was found to be incorrect and the greatest source of oil until now has been in discharged drill-cuttings, which are disposed of during drilling operations (Kingston 1992). Drill-cuttings were in the form of water based solution but was changed to oil based as it was preferred in the drilling process but as toxic effects were beginning to be observed there has been a switch back to the water-based muds. The composition of his drilling muds used is of great concern, in addition to a couple of other chemicals contained is barite ($BaSO_4$), which is used vey in large quantities and contains impurities like heavy metals. This barite is of an

insoluble nature and has high density making it to settle at the seabed thus affecting sediment-living benthos. Million cubic metres of drill cuttings and its associated discharges over the years have been pilled up on the seabed. These cuttings are super imposed over smother seabed life and remain toxic for extended periods of years because of the hydrocarbons they contain. The Arctic seabed species such as the Bivalves and Snails are in great danger by this effect.

Another major effect is from distillation of toxic heavy metals and a host of other pollutants which ae emitted into the atmosphere during drilling process These pollutants and heavy metals are then deposited through condensation. Bioconcentration in both marine and terrestrial organisms as well as biomagnification in the different trophic levels of the food chain makes this effect more horrific in the Arctic.

The Arctic is such a hostile and remote region therefore making logistical operation of drilling a hassle. Coupled to that; oil rigs face a constant risk from huge icebergs and are forced to mobilize fleets of ships to drag them out of the way. Most of these icebergs are big enough to put a halt to drilling. To ad to this, because of the limited and slim window of only as few months during the summer from Arctic drilling, it is quite logistically unfeasible to complete response needed to contain a leaking well. In case of a spill, the successful drilling of a relief well to contain the hazard cannot be guaranteed before the winter ice returns and if this relief wells are left undone over the winter, oil can continue to flow out for quite some time.

Fig 0.2: Obstructing Icebergs (Green Space, 2010)

Fig 0.3: Oil spill out on ice (Green Space, 2010)

Positive Effects of Oil and Gas Exploration in the Arctic

One major positive of oil and gas exploration in the Arctic is the enrichment of local and indigenous communities but at the cost of environmental deterioration. These communities can be enriched by the influx of jobs and consequently money as companies come in to explore. This provides for an improved local economy and advancement of even other economic sectors in such communities such as retail and development.

Another major positive will be the advancement and improvement of science and conservation attempts. Even though this activity is highly detrimental to the Arctic environment, it can also act as a boost to make drilling companies such as Exxon for example to conduct numerous scientific studies and assist in the conservation in the surrounding area. Commercial activities such as oil exploration serves as a catalyst to great discovery of scientific knowledge, take for example the Arctic Sea has previously been rarely explored, bringing commerce into the area will have big benefits for the scientific community.

These activities also bring population to the Arctic. The Arctic region is known for its solitary nature due to its harsh climatic conditions, however, as more commercial activities begin to bloom in the Arctic, this could be a major pull-factor of people to this region and thereby bettering the economy of the region.

Case Study: Petroleum Activities in the Norwegian Barents Sea

Petroleum activities in Norway began around the end of the 1960s and ever since then a lot of development has taken gone forth in the oil and gas production sector. Oil production peaked in the year 2000 and declined by about 25% between 2000 and 2006, however, gas production continues to increase. One thing that the development in oil and gas exploration in the region has done and will in the future do is foster employment and value creation in the industry which is the booster to the Norwegian economy, however this industry is facing major challenges finding of new petroleum reserves does not necessarily equate the ever-rising demand. To add to this malady politics has crept in as National Oil Companies (NOCs) are favoured to operate as opposed to the Independent Oil Companies (IOCs) probably due to political insecurity.

Due to an upward twist in oil prices in recent times, Independent Oil Companies have begun to shift focus to Arctic offshore as 30% of the undiscovered Norwegian petroleum resources are expected to lie in the Barents Sea. However, the thought of expansion into the Barents Sea causes an uproar and is a horror scene to environmentalist and stakeholders in the region. This area is the “Last Wilderness”, considered for its clean undisturbed nature not to talk of the amount of fishery and hunting activities that take place here which brings heavy economic benefits for the population in the region which includes indigenous people like the Eskimos and the Nenets. NGOs challenge even the thought of this expansion into the valuable and vulnerable Arctic Sea.

There is a risk of large oil spills from blow outs as seen in Alaska in 1988, also unfavourable environmental conditions such as long periods of darkness, very low temperatures, sea ice and insufficient oil spill readiness resources shows the difficulties that can arise from drilling offshore in the Barents. The consequences of this may be irreversible and permanently plague Arctic marine life especially benthic organisms form drill cuttings. The fate of this region is at stake if the IOCs prevail.

Case Study: Impacts of Oil and Gas Exploration on Key Zooplankton Species

Due to the precarious condition of hydrocarbon exploration in the Arctic and the low feasibility of containment plan, a huge threat is posed to the marine ecosystem. Oil spills especially from the Polycyclic aromatic hydrocarbons (PAHs) will eventually enter the marine ecosystems, after which attach itself to organic matter in the water. The dominant zooplankton species that dominates the Arctic waters during spring is the Copepods of the genus Calanus, of which a couple of Arctic marine animals depend on for prey. The Calanus exhibit good amount of lipid content.

PAHs bind strongly to lipids due to their lipophilic nature and can result in effects such as immobilization and reduced grazing activity. However, the different Calanus species show different level of tolerance to PAH exposure and thus strengthens competition between them and likewise the energy source available for to higher organisms on the food chain (will also strengthen competition among the predators).

Shipping on Arctic Waters: Cause

A major cause of the rise of shipping activities in the Arctic is due to the melting of Arctic sea-ice which effectively unlocks greater parts of the Ocean. A potential increase in maritime activates in the Arctic region if very much expected and this could create a chain reaction of environmental problems for this region.

Negative Effects of Shipping Activities in the Arctic

One of the major problems of increased shipping activity in the Arctic is emissions of black carbon. Black carbon is particularly very detrimental to the Arctic environment; it contributes to diminish air quality and drives climate change. It acts as a greenhouse gas and when deposited on snow

or ice reduces albedo and thereby creating a positive feedback mechanism that will accelerate more melting.

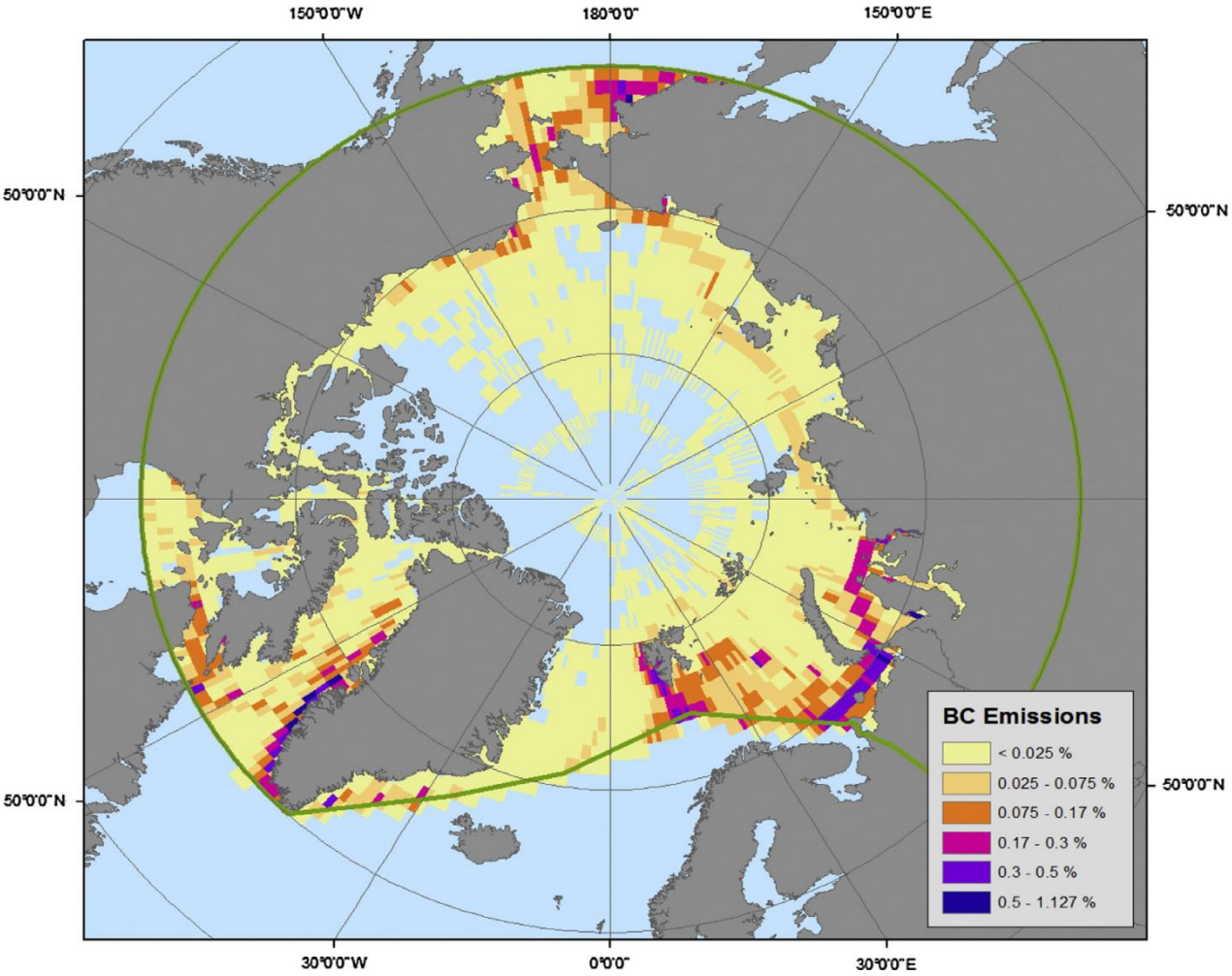

Fig 0.3: Distribution of BC emissions for Arctic region (Mjelde, Martinsen, Eide & Endresen, 2014)

This black carbon will lead to the destruction of Arctic flora and fauna in both the marine and terrestrial spheres however; emissions reduction can be attained through application of feasible available technologies through techniques and implementation of regulations. Lastly, Arctic shipping will increase the threat of invasive species as ships take in water from one location in their ballast tanks and discharge it in another thus contributing to concerns about invasive species. This ballast tanks are compartments that hold water, to weigh a ship down and lower its center of gravity to provide stability. Zebra mussel species is believed to have been introduced by this process from ships coming from

Western European ports. It is an invasive species that has dominated the Great Lakes and has cause major spending.

Fig 0.4: Cargo ship releases ballast water (Geiling - Smithsonian.com, 2014)

Some Positives of Arctic Shipping

Arctic shipping serves as a major economic booster to local communities and nation sin the Arctic as tons of goods are shipped into the region due to the opening of the sea route. Goods can now easily be shipped into this region. Another positive is empowerment of the local indigenous community who can now be employed to work at ports and even go as far as being involved in the whole commercial process.

These communities now how a high chance of getting accesses to goods that they not necessarily had access to before in the past. Although, they few positives, they are heavily outweighed by the negatives.

Tourism in the Arctic

Opening of the Arctic sea route, invention of new transport technologies and personal explorations has greatly increased awareness of Arctic tourism potential. Several cities located near the edge of the polar boundaries provide vital transportation gateways to the region. The gateways such as Vancouver and Winnipeg in Canada and many Scandinavian cities, provide key transportation linkages as well as other amenities that provide services needed to conduct tourism.

Negative Effects of Tourism in the Arctic

Because of tourism activities irreversible environmental impacts have been perpetuated in the Arctic region. Emissions which is one of them has been discussed in the shipping section of this paper, this ongoing phenomenon continues to cause a constant deterioration of the Arctic environment.

Because of tourism many species have been exterminated including the entire species of the Steller's Sea Cow which were exterminated by sealers. In the Alaskan region, vast watersheds has been transformed beyond repair. Some of the human induced effects include commercial fishing as opposed to previous substantial fishing, extraction of minerals (ores and hydrocarbons) and fur trapping for non-indigenous markets.

Some Positives of Tourism in the Arctic

Tourism in the Arctic helps to boost the economy of the region, tourism generate its own revenue as well as opens doors for small businesses to start and flourish. It also helps to increase the awareness of the region. As tourism increases, the popularity of the Arctic increases thereby giving it global recognition.

Summary

The Arctic is truly a special place on the face of the earth, known for its calm, serene and undisturbed environment. It is only in recent years' major interference with this region begun. The catalyst of course was the discovery of large quantities of hydrocarbon locked up in the region. And the exploration of these resources has created a chain-reaction of effects that have proved to be very detrimental to the Arctic environment. It is very evident from the paper that the negative effects outweigh the positives, and if we continue business as usual, we may not have this special place existing in the coming years.

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