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THE EFFECT OF WASTE MANAGEMENT OF OIL DRILLING AND GOLD MINING EXTRACTION IN THE YAKUTIA ARCTIC (RUSSIAN)

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ABSTRACT :: The Arctic region of Yakutia in Russia has witnessed significant industrial activities, particularly in the sectors of oil drilling and gold mining extraction. As a consequence of these economic endeavors, waste management has emerged as a crucial environmental concern. This research delves into investigating the effects of waste management practices associated with oil drilling and gold mining extraction on the fragile Arctic ecosystem of Yakutia. This research examines the regulatory frameworks and policies governing waste management in the Yakutia Arctic to evaluate their effectiveness in ensuring environmental protection. By identifying the gaps and challenges in the existing waste management practices, the study aims to propose sustainable solutions that can mitigate the environmental impacts and promote responsible industrial activities in the region. The findings of this research are expected to contribute to a better understanding of the environmental consequences of oil drilling and gold mining in the Yakutia Arctic, thus fostering informed decision-making and policy formulation for a greener and more sustainable future in this ecologically sensitive area.

KEY WORDS; *Drilling, Gold, Oil, Waste management, Yakutia Arctic.*

I. INTRODUCTION

The republic of Yakutia which is popularly called Sakha is the largest local unit in the Russian Federation. The region is located in the North-Eastern part of Russia, with an estimated population of one million. It has a land mass of over 3 million square kilometres, which is approximately 18% of Russian land mass. The areas stretch for almost 2,000 miles north, and 2000 miles from east to west. About half (40%) of the region is in the arctic circle with most of the town situated in the permafrost region. The Yakutia region is known to have a harsh environment, with irregular temperatures.

Yakutia was granted its sovereign status in 1922, and a State Sovereignty Declaration (Yakutia) was issued in 1990. In 1990, it was adopted. The President is the founder of the Republic and the Official Body of the Yakout Assembly is Il Tumen and the Rep. 33 percent of the Republic's majority is native Sakha (Yakuts) but the majority of the population is usually Russian, 50 percent are mainly Ukrainian, Tatar and Belarusian and indigenous.

1.1 The Yakutia Arctic

In the late 20th and early 21st centuries, anything related to Arctic was a big issue in the world. While the industry is gradually taking up its corporate share, there are limits on what companies will and can do, in particular in developing or transitional economies, where there is too frequently a lack of appropriate governmental regulations. Yakutia has a rich geology, including diamonds, gold, nickel and other valued metals as well as oil, gas and coal, and a abounding natural wealth. The extraction of mineral resources continues to play a key role in the Republic 's growth. Although the central government in Moscow traditionally sold the mined raw materials in Yakutia, only in the form of government subsidies did revenue from the profit return to Sakha.

The circumpolar system, as calculated in 2001, has three defining characteristics according to the Arctic Human Development Survey (1). The Arctic is used to support the global economy as a huge reserve of natural resources and this enormous exploitation essentially forms the majority of economic life. (2) Main transfer payments from central to regional governments are often supported by public services. (3) The traditional use of living resources in practices such as family farming, hunting and animal husbandry remains economically significant and is now inextricably The AHDR analysis also found some important characteristics in the geographical distribution of economic activity, according to Duhaime and Caron: "The Arctic exports huge quantities of raw material for processing into the southern regions, but it imports also massive finished products and finished services for end-use" [1].

In the various Arctic regions, industrial development is unequally divided; the economic prosperity of the wealthiest areas concentrates on the exploitation of natural resources on a wide scale [1]. This also applies to Yakutia. Nowadays, in Yakutia, almost every mining tool is exported to the southern regions. Yakutia has a very small population (estimated population of just 950 thousand), even though the province was Russia's largest. At the same time, according to official statistics, it ranks first in the Russian Federation with full natural reserves. The raw material market is estimated at RUR 78.4 trillion. Yakutia has the following share of the world 's reserves: – 35% diamonds; – 5% dollars tin; – 4.5% dough; – 6% uranium; – 2% iron ore. Yakutia makes up 47% of the proven coal resources, 35% of the gas and oil deposits in East Siberia and the Russian Far East .

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1.2 History of the Yakutia People

Yakut is one of the principal tribal ethnic groups of Siberia (or Sakha). The Sakha is considered too wide for the official Russian indigenous group out of more than 400,000 inhabitants. This status is confined to groups of less than 50,000, retains a traditional way of life, lives in certain remote areas of Russia and recognizes them as a distinct ethnic community [2]. The status of the Sakha people is more closely associated with classification as the 'titular' nationality of an autonomous region (Sakha Republic), but, like other indigenous populations, many Sakhs, like other indigenous groups, livelihoods such as horse- and livestock farming, fishing and hunting, etc. [2]. Sakha also echoed many indigenous people's desires including respect for their common land and rights of property, acceptance of cultural differences and acceptance of their rights of self-determination. More specifically, like many ethnic peoples, the Sakha have undergone cultural and economic marginalization in contrast to the dominant national population. The Sakha were largely excluded from the profits of extractive companies on their territory and were also disproportionately damaged by the environment due to the extraction of resources [2]. Now Russia 's main administrative unit is the Sakha Republic (formerly Yakutia). It includes one fifth of Russia's entire territory. The area is sparsely populated by approximately one million people, 45% of whom are Sakha. The Republic is of vital economic importance for the Russian Federation [2]. This region, rich in mineral resources and natural resources, is a site of crucial controversy between industrial developers and indigenous and local communities that are closely associated with industrial activity. Rare metal mining (gold , silver, copper , tin), luxury stones (diamonds, amethyst, nephritis) and energy (oil, coal, and natural gas), as well as timber working are the dominant industries [2].

1.3 Drilling and Mining Activities in the Yakutia Arctic

The link between natural resource extraction and environmental conservation is increasingly been regarded as a national priority for various government administrations in both developing and developed countries that carry out mining activities [3] [4] [5] [6]. Mining is the fifth biggest sector in the world. It plays a vital role in global economic development, with trade in minerals forming a significant portion of foreign markets. It is been reported that mining of resources contributes to the continuous damage of the natural ecosystem. These activities may lead to erosion, land destruction, ozone pollutants, surface water runoff, ground water degradation, dust, noise and occupational health and safety. With the establishment of a coal mining in the region of Verkhnekolymsky in 1936, the mining industry in the Arctic and in the northern areas began to increase.

Diamond Mining: In 1997, after the open pit mining was completed, Aikhal Deposit had been transformed into a subterranean mine. The mine's capacity exceeded 500,000 tons of ore in design. The Nizhne-Lenskoye Diamond Mining Enterprise was founded in 1994 and sold to AlmazyAnabara OJSC. The company was created in the Anabarsky, Bulunsky, Oleneksky and Zhigansky districts to produce alluvial diamond deposits [7].

Gold Mining: Gold mining is one of the biggest mining activities in Russia, offering enormous opportunities for development. According to the list of mineral reserves, Russia is one of the top three countries involved in Gold mining with about 14% of the gold reserves in the world [8].

1.3.1 Pollution of the Arctic by Drilling and Mining Activities

Drilling and mining activities have significant varying environmental impacts. These could cause irreparable damage to the land mass and the people's livelihood. The rise of environmental and social issues, enabled the exposure of the impact of mining activities. The report clearly helped to improve technology utilized in managing mineral resources with a high consideration of environmental responsibility. Environmental pollution caused by drilling and mining activities affects the livelihoods and socio-cultural heritage of the indigenous communities that host mining activities. Although the sector increasingly takes on its share of environmental obligations, there are limitations to what companies, particularly in developing countries or transitional economies. There seem to be an existing conflict of interests between economic benefits and environmental preservation for governments of developing countries that depend on mining as a vital source of income. The increase in drilling and mining activities could boost economic outlooks of the region. However, the realities in the indigenous communities are a stark contrast to the vast income generated from the drilling and mining activities. The proliferation of environmental degradation and the pollutions of natural bodies of water are just but a few of the aftermath of mining activities currently seen in many communities with an abundance of natural resources. These mining and drilling activities have greatly affected ways of life of the host communities, leaving the inhabitants with an experience of despair.

1.4 Study Justification

Roughly a quarter of the world's diamonds originates in Sakha mines [2]. However, a substantial number of local residents argue that the mining activities of the mineral companies are not environmentally. Subsequently, very small revenues have been utilized in the local communities of Sakha. For instance, in the Sakha area of Nyurba there are no water filters for the contaminated water supplies. There are accompanying poor roads and various socio-economic concerns that contrast with the revenue generated by mining activities ongoing in the communities. Moreover, many drilling and mining host communities have experienced devastating ecological repercussions from the production of natural resources in the Sakha and its smaller indigenous neighbours such as Chukchi, Evenk, and Yukagir. There is wide-spread evidence of substantial land degradation, water contamination, reduced biological diversity. The relocation of the local and indigenous communities, disturbances to the traditional economic activities of local and indigenous peoples, problems with water pollution, and degradation of water quality. In many instances the pollution caused by these drilling and mining activities in Sakha continually threatens the wellbeing of the people in the local communities [9]. A cross-sectional assessment of waste management created by mining and drilling activities is crucial in identifying likely solutions for halting environmental degradation and improving the livelihoods of the Yakutia people.

1.5 Aim of the Study

The essence of this thesis is to analyse the existing environmental challenges resulting from the dumping of waste from oil and gas drilling and the extraction of gold mine with definitive and effective ways to solve them.

Specific objectives include the following;

- Analysing the condition of drilling and extraction in the Arctic
- Indicating the impacts of human activities on the environmental
- Observing the State activities in issues on waste management in the Arctic
- Identify the main ways of reducing environmental risks in the region.

2.1 Environmental impacts of oil drilling in the Yakut region

According to a report by Sahu, the Arctic is described as one of the few unspoiled environments with minimal human activity, though offshore drilling started in the 1970s, with nearly 10,000 wells drilled to date [10] [11] and [12]. had indicated that the arctic is majorly inhabited by indigenous groups and has particular features of the climate that can be influenced by large-scale commercial activities [13]. There is a significantly high quantity of marine resources in the arctic that could be affected by oil exploration and production activities.

These could be due to the lack of appropriate technology for an environmentally-safe way of oil exploration in arctic environments.

Hydrocarbon exploration and production activities in the arctic region have led to a variety of environmental challenges. The pollution of marine bodies is the most common environmental challenge caused by oil drilling activities. These have led to poisoning of marine life, causing contamination and a significant reduction in fishing activities, a common way of life and economic survival for the Sakha people. The Offshore Exploration of oil is a risky activity, the potential risk of oil spills during exploration has led to the formation of selective emergency preparedness and response programs. The occurrence of accidental gas blow-outs and oil spills in the region have caused physical, chemical and biological changes in the water column, the seabed and the atmospheric air. Others forms on environmental contamination caused by exploratory activities include the occurrence of radioactivity, organic pollutants, heavy metal proliferation and the acidification of marine bodies.

The ice is quite dense in the arctic regions in comparison to other areas. Therefore, the management of oil spills in other environments is mostly untenable for the arctic region. The unique environmental features of the Yakut region make it challenging for the standard response to oil spill management to adequately work. The ice limits the natural cleaning potential that occurs in the event of an oil spill. While sea water is rugged with wide gaps and a large surface area, ice provides above and below water surfaces that traps the spilled oil. The encapsulation of oil in the ice causes it to linger as long as the ice is firm making the affected areas less habitable.

Table I: Sources of Petroleum Hydrocarbons in the environment

Natural sources	Oil seeps. Biogenic synthesis.
Water movements	Inflow of ocean currents. Northward flowing rivers.
Atmospheric flow and deposition	Air movements from subarctic and temperate areas.
Gas and oil production	Operational discharges. Blow-outs
Transport of crude and refined gas and oil	Accidents from tankers at sea. Tanker ballast washings. Leakage/spillage from pipelines and tanker trucks on land.
Transportation	Discharges and spills from vessels. Emissions and leakage from vehicles.
Land-based discharges and runoff	Refineries. Municipal waste water. Industrial waste water. Urban runoff. Combustion of wood and fossil fuels

Source: Arctic council (https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-counc HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"il.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"isAllowed=y" HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y" HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"isAllowed=y"isAllowed=y)

Oil spills in the arctic pose a great threat to the marine environment and aquatic life. This is mostly due to a considerably slower response time as the containment teams tend to wait for temperate seasons before they can determine the extent and impacts of the oil spill [14]. According to Almeda and colleagues, the mixture of crude oil and chemical dispersants significantly increases its toxicity and possible effects on microzooplankton and plankton species [14].

As published by Vinogradov& Azubuike; "The apparent vulnerability of the Arctic environment has led to calls for a moratorium on offshore activities in the Arctic, especially as the Gulf of Mexico oil spill has shown the difficulty of clean-up even in the significantly more favourable climate and weather conditions". It is important to note that oil spills disappear very slowly, with prevailing sub-zero temperatures and darkness impeding access to areas with oil spills. This thereby reduces the effectiveness of clean-up activities and operations [15].

Fig I: Images of oil spills in Yakutia, 2015
Source; Olga Gertcyk, via http://www.siberiantimes.com

It is quite unfortunate that a thorough assessment of the effects of the arctic pollution caused by oil exploration activities in the natural-resource rich regions of Yakutia (if any is done at all)s are not publicly published. The Russian council for international affairs (RIAC) forecasts that seismic exploration will be carried out primarily on the Arctic shelf by 2030, and that petroleum reserves in the region will be primed for future, large-scale growth [16]. There are significant technical challenges for safe environmentally-friendly exploration of oil in the arctic region. The waste generated from these exploration activities have also led to significant health challenges; these include the occurrence of respiratory illnesses and the occurrence of cancer-like illnesses among the ingenious people of the Yakut region. However, Tippee indicated that there remain significant regulatory, environmental and technical challenges facing discovery of hydrocarbons which must be properly addressed [17].

2.1.1 Discharge of drill cuttings causes environmental damage

Drilling muds used for the lubrication of drill bits controls pressures in the well. This supports the sealing of well walls carrying the drill cuts to the well's surface. These cuttings settle very quickly and accumulate in large quantities around oil rigs in areas with weak circulation. The composition of these muds includes; oils, metals and other compounds that may be toxic to aquatic life [18]. Water based muds will spread more widely in offshore environment than oil-based muds. Some conditions involve the use of environmentally harmful oils as the basis for muds. In these situations, diesel oil was used until the early 1980s but since then it has been supplemented by low-aromatic mineral oils in an effort to minimize environmental impacts [19].

"Until the mid-1990s the discharge of cuttings with oil-based drilling mud (OBM cuttings) was the main source of oil hydrocarbons entering the marine environment from the offshore petroleum industry" [20]. Exposed drilling muds have been seen to have significant impacts on marine life for up to 15 square kilometres around oil rigs. Similar studies in the Beaufort Sea showed that water-based drilling fluid discharges could alter the abundance of a variety of aquatic life. The disposal of drilling muds in land-based wells is in stark contrast to the disposal methods on oil rigs at sea. Muds used in land-based wells are usually dumped into land sumps with an efficient containment system which causes undetectable environmental changes limited to a few hundred meters from the site. In contract, the containment efficiency on water bodies contrasts largely in comparison to land-based wells. In some cases, the waste is dumped directly into landscape depressions in Russia, rather than into specially constructed dumps, resulting in damage to the environment on larger areas. In a bid to reduce the environmental effects of drill muds and cuttings, it is important to abide to strict regulation regarding waste management on drilling locations. The water generated during drilling activities in offshore wells are usually discharged back to the sea. This reinjected water to the sea bodies however include chemicals generated from the drilling activities. It is important that prior to reinjection of these water generated treatment protocols are initiated to prevent the contamination of the natural water body.

According to Kolb &Mahon, "based on oil spilled statistics in areas outside the Arctic, the probability for spills in the specified Arctic petroleum reserves may be roughly estimated over the production period. Such estimates predict between one and eight spills in the Beaufort and Chukchi Seas equal to or greater than 1000 barrels of oil (about 160 cubic metres)" [21]. However, the unique environmental conditions in the arctic region such as Yakutia are not included in these estimates. The risk of damages by oil spills is greatly increased due to the pressures of the ice of the scrubbing of icebergs. These conditions may also affect the extent of the oil spills and create challenges for the cleaning of oil spills.

Table II: Typical quantities of drilling wastes discharged during offshore oil and gas exploration and production activities.

Source	Approximate average amount, tonnes per well
Exploration sites Drilling mud -periodically -bulk at end	 200 – 2000[c] 15 – 30[a] 150 – 400[a]
Cuttings (dry mass)	200 – 1000[a] 20 – 1000[d]
Base oil on cuttings (if oil-base mud is used)	30 – 120[b] 10 – 20[d]
Production site	

Drilling mud Cuttings	900[c] 1000[c] 700[d]
Base oil on cuttings (if oil-base mud is used)	280[d]

a. GESAMP (1993).
b. Actual loss to environment may be higher (Chénard et al. 1989).
c. Neff et al. (1987).
d. Norwegian Shelf 1994 (SFT 1995b).
Source: Arctic council (https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"isAllowed=y" HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y" HYPERLINK "https://oaarchi HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"ve.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15 HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"& HYPERLINK "https://oaarchive.arctic-council.org/bitstream/handle/11374/924/AAR-Ch10.pdf.pdf?sequence=15&isAllowed=y"isAllowed=y"isAllowed=y)

2.2 Impact of Oil Pollution on the Yakutian People

The disposal of industrial waste generated from oil exploration poses a significant problem to the Yakutia people. The poorly processed wastes are released to the water bodies in the region making it difficult to swim or inhabit. Similarly, the marine life is contaminated, hence limiting the options for healthy food supply for people in the region. There have been instances where phenol contamination of fish has been detected among the inhabitants of the area. There are ecological damages caused by the environmental pollution as a result of the oil exploration activities onshore.

These damages have led to a variety of adverse effects on the lives of the indigenous people of the area. There has been a marked increase in land displacement and the destruction of traditional landmarks of the people. The socio-cultural changes caused by oil pollution have also led to a significant shift in hunting practices. In lieu of the current exploratory activities and the accompanying pollution, hunting is ideally done with the use of helicopters or snowmobiles in contrast to the traditional use of rhinestones. The pollution and contamination of ecological life has caused a shift in the availability of hunting game for feeding; hence hunter need to cover distances far than the usual to hunt. As expected, the use of helicopters and snowmobiles are quite limited as many hunters cannot afford the operational costs, despite the provisions by government agencies, they seem quite inadequate. Subsequently, reindeer herding, a common practice among the Sakha people in the 1980's reduced significantly. This is mostly affected by the degradation of approximately 90% of reindeer pastures on the north side of the of the region as reported by Shadrin [22]. This has caused great concerns for the Sakha people. According to Shadrin; "The length of the ESPO across the territory of the Republic is more than 1,500km, the pipeline is not in uninhabited lands, according to industrial companies, but directly passes through the traditional lands of Indigenous people - Indigenous peoples of the North and rural residents who have reindeer pastures and hunting lands, territories of breeding and walking the unique breed of Yakut horse, muster vegetable and non-timber natural resources, grasslands, and crosses large and small rivers with valuable species of fish" [22]. The presence of the oil pipeline led to neglect of the usual use of natural resources among the Northerners in the Yakut region. Similarly, permafrost degradation causes destruction of the arctic ecosystem, this causes changes in the traditional conditions for food storage and leads to a marked shortage in the food supply

2.3 The Impact of Gold Mining in Yakutia

Waste generated from gold mining activities poses a real threat to the environment and human health. Gold mining activities have led to a variety of disturbances of land formations and changes in the ecological life of polluted areas. This has also greatly affected the way of life of the indigenous people of Sakha. The indiscriminate disposal of wastes from gold mines have led to the contamination of native water bodies, pollution of forests and wildlife. Consequently, there have been a significant impact on the way the people live and how they survive. Sadly, there has been no record of compensations or viable alternatives to the destroyed land and water resources for the people. The increase in gold production have led to the significant increase in the emission of dust and gases into the air. This compromises the air quality of the area, corresponding with the increased morbidity and mortality caused by respiratory illness.

According to Fashola and colleagues; The infiltration of water through sulphide- containing tailings piles and ponds, surface and underground workings, waste and development rock leads to leaching of large volumes of metals like Zn^{2+}, Ni^{2+}, Pb^{2+}, AS^{2+}, Cu^{2+} and sulphate ions into stream and river ecosystems [23].

The concentration of pollutants in areas with gold mining activities contributes to the deterioration of the lithosphere. Methane and Black carbon emissions are the most common wastes generated from gold mining sites. The reprocessing of old gold dumps has led to the increase of residual air mercury concentrations. Subsequently, an expected increase in gold consumption in the energy sector of the country could worsen the negatives impacts on the climate of the region.

The tailings are radioactive sludge left behind after mining activities. On many occasions, at the end of a mine's life, the water stored in the tailing's storage facility are discharged into nearby water bodies (lakes and rivers). These increases the concentration of heavy metals in the water bodies, eventually poisoning aquatic life.

Fig II: Liquid factory waste from gold mines flows into a River
Source: (www.oc-media.org)

Gold mining is known to consume large quantities of water and has the potential to pollute the soil and nearby water supplies. This has led to shortage in water supply for farming communities. The mining activities have caused great disruption of the agricultural activities in the area. This has led to a shortage of food supply and consequent inflation of available food items in the region. The vast pollution of natural water sources has contributed to the community's poor health and sanitation. In recent years, there have been increasing cases of lung disease, cancer and renal disorders in the mining communities of the region.

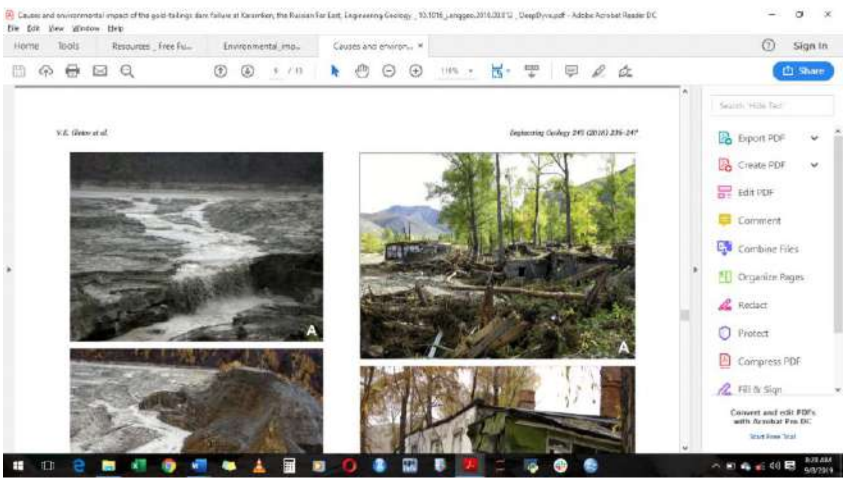

Fig IIIa: Water flow over tailings forming small caverns after release of accumulated pulp after the Karamken dam breakage, August 3th 2009.
Source (Glotov, 2009)

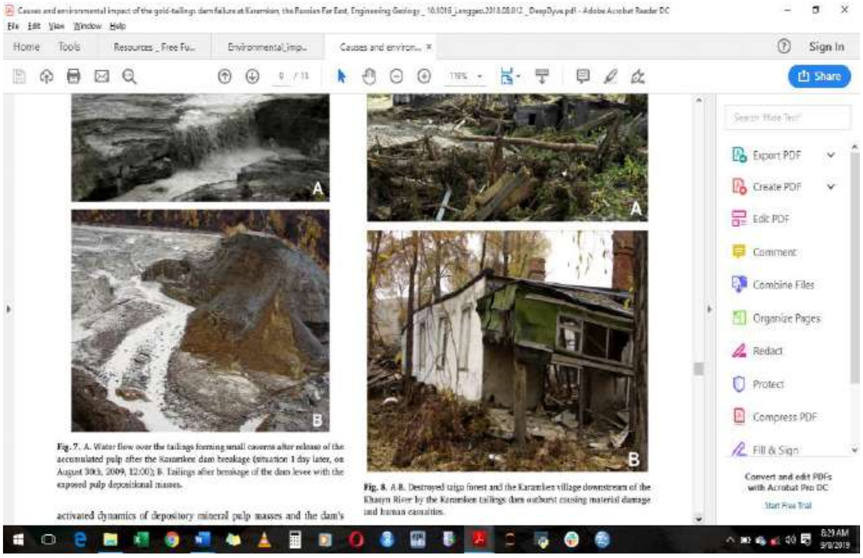

Fig IIIb: Tailings after breakage of the dam levee with the exposed pup depositional masses.
Source (Glotov, 2009)

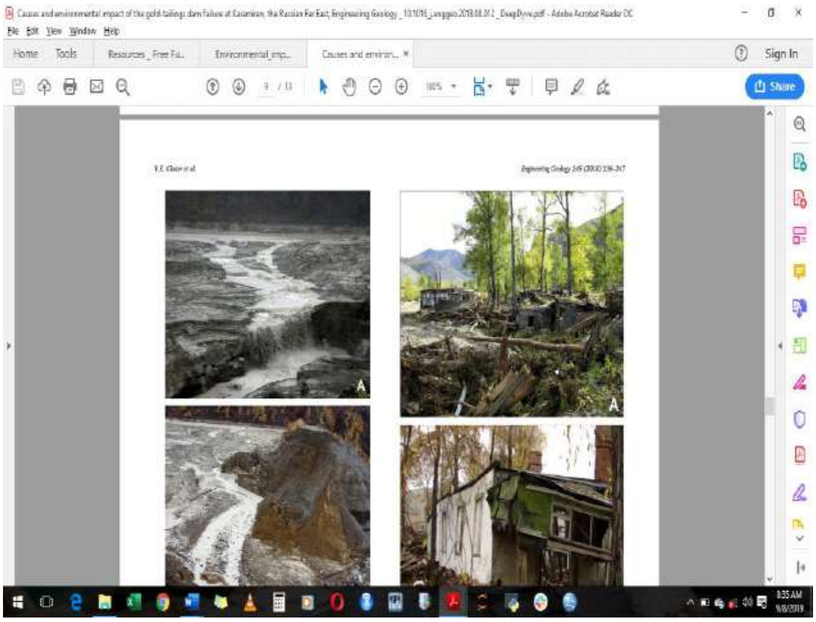

Fig IIIc: Destroyed Taiga forest and Karamken village downstream of the Khasyn River by the Karamken tailings dam outburst causing material damage and human casualties
Source (Glotov, 2009)

3.1 Methods of Managing the waste impacts caused by oil drilling

Due to the unique landscape of the arctic, there are a limited number of techniques available for the detection of oils spill and a corresponding response. Traditionally, oil spill responses are divided into three categories; mechanical recovery in which the spilled oil is removed via pumps and skimmers. The non-machinal recovery, involving the use of chemicals, burning or bioremediating agents to counteract the spilled oil. Then, the manual recovery, where oil is removed via the use of buckets, nets or shovels.

Typically, many oil operations in the arctic rely on the combination of the machinal and no-machinal processes of burning or the use of chemical dispersants at the sites of spilled oil. The mechanical methods involve deploying booms from vessels to collect the spilled oil, which is later stored and appropriately disposed. The presence of ice and snow in the arctic makes these methods of spill management more complicated, requiring a unique set of methods in a bid to rid the arctic of the spilled oil. The spilled oil may become trapped in ice and snow for long periods, therefore prolonging the period of decontamination of the affected areas.

The sequence of oil spills is mostly difficult and complex to understand as it depends on a various confounder. The intricate nature of sea water and floating ice bodies that are found in the arctic region also increases the complexities in the sequence of event after the occurrence of an oil spill.
Each season also presents with various challenges and advantages for response to oil spills, the freezing of ice, and drifting of ice have caused limited site access, restricting response [24]. Similarly, the long periods of darkness during mid-winter and the changing nature of the ice-packs during melting makes it imperative to adopt innovative ways for oil spill responses in the arctic regions of Sakha.
Typically, there are complex models based on atmospheric, oceanographic and weathering data that are usually employed in determining the trajectory of oil spills on water bodies. These models tend to be fairly accurate and helpful in curtailing the impacts of oils spills. However, these models are used in warmer climates distant from floating ice which is a typical feature of the oil drilling locations in the Yakut region. Consequently, there is a need for the development of models that are uniquely suited to regions with large volumes of floating ice as seen in the Yakut region.
The application of chaos theory in drift problems have shown that current and wind directions could aid better predictions of the direction of oil spills in arctic regions compared to early conventional oil spill models [24]. However, the efficacy in detecting oil under ice which would be more appropriate for the Sakha region seem to be a bit lacking and inadequate.
The detection of oil spills is vital in the response and control of oils spills and it subsequent effects. Generally, there has been significant improvements in the detection of oil spills from remote locations via the use of sensors. The use of these technology is somewhat limited in the arctic space, where it is vital that oil spills are detecting instantly to curtail the spread and extent of the damages. As a matter of consequence, the remote detection of oil spills in the arctic can be subdivided into; detection with sensors mounted above the ice cover, mounting sensors on the ice cover and below the ice cover [24].
The most common method of cleaning oil spills applied in the Yakut region is the in-situ burning and disposal of what remains after, which is a combination of mechanical and non-mechanical methods. Mechanically, the remainder of what is burnt is disposes using a skimming device. Typically, the deployment of the booms is done using land or fixed structures. There are a variety of skimmers used in the stripping of oil from the water surface via suction, or the application of oil-absorbing materials.

Adequate response to oil-spills in the arctic region relies heavily on planning and a flawless execution of the intricate multi-faceted plans. The plan must take into account the rehabilitation of the affected ecosystem and the adequate treatment of organisms exposed to the spill event.
The Net Environmental Benefit Analysis (NEBA) is a strategic tool used by decision-makers to assess and compare expected environmental impacts and response activities in the context of an impact [25]. This process involves the evaluation of constantly changing information for the development of appropriate strategies for the response to oil spills and the prevention of future events. The table below illustrates the elements associated with oil spill responses in challenging geographical regions like the arctic.

Table III Oil Spill Contingency Plans in Yakutia

Type of Contingency Plan	Examples
National or Regional	National Contingency Plan. Through cooperative agreements, regional plans may cover more than one jurisdiction: for example, the overarching Arctic Council Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, as well as numerous bi-lateral agreements between individual Arctic nations with shared borders
Site specific	Geographic specific: for example, oil handling terminal: storage tank site; pipeline route
Vessel specific	Apply to a ship wherever it is located

Source: EPPR, (2015)

When oil spills in a drilling location is also affected by ice, there are site-specific appropriate plans for dealing with the spills and containing the extent of the damages. The optimal spill response is formulated to ensure that the effects on the habitat and biological resources are reduced to the barest minimum. The ideal spill response should consider information on the physical characteristics, ecological characteristics and socio-ethnic ideals of the areas where oil drilling is currently ongoing. It is also important to review the events of past spills to glean understating on ways to improve response and prevent the occurrence of further spills.
Optimally, the ideal response to an oil spill event in the Yakut region must be one with minimal adverse effects on the environmental and biological resources of the affected areas. It is important to note that the livelihoods of the indigenous people of the region is intractably connected to the unique ecological geographical features of the region.

3.2 Methods of Managing the waste impacts caused by gold mine extraction

In line with established strict technical and environmental criteria for the management of wastes from gold mining, mining facilities are expected to be designed and operated in consideration of their local and neighbouring environments. It is important that the chemicals and reagents used in the mining facilities are properly stored to prevent spillage and contaminations. Treatment of waste water used in for processing the gold is vital in a bid to reduce adverse environmental effects in the event of the discharge to the land or nearby water bodies.

Mercury poisoning is the most common fallout of the pollution from gold mines. This impact of the aquatic and atmospheric areas of the surrounding areas. The adoption of both biotic and abiotic techniques has been employed in the degradation of mercury deposits in and around gold mines in the Sakha region. The photochemical decomposition and microbial detoxification are the two most common methods employed in dealing with the issue of mercury pollution [26].

As a result of the Minamata Convention on Mercury, a treaty to control mercury pollution was signed by Russia in January 2013 [27]. In recent times, a complex network of technical, environmental and planning challenges have been tackled in a bid to conform to the national and international requirements for the appropriate treatment and disposal of wastes generated from mining activities in the region. According to Alexander *et al.*, "The Minamata Convention aims to protect human health and the environment from anthropogenic emissions of mercury and its compounds. The treaty seeks to reduce mercury supply and mercury trade, to phase-out or restrict application of certain goods and processes with use of mercury, and to control mercury releases into the environment"

Traditionally, areas where unintended discharge of waste materials occurred are sealed off and, in many times, it has not been environmentally ideal for the people of the affected areas in the region. However, recently, in accordance to the recommendation of the mine waste management systems, a geographical survey of the affected areas is carried out. The survey provides information on the description of the residues and the mobility of the residues. Subsequently, there is a constant oversight of the weathering occurring and the resultant effects on ground water and the surrounding ecosystems in the environment [28];[29]. These aids in the informed decisions for remediation of the affected areas. On different occasions, wetlands have been used in the immobilization of trace elements. Also, microorganisms have been used in mitigating the reactivity of by-products of mining activities in the region. The state-of-the-art methods of managing wastes from mines would involve the adoption of mapping techniques and technologies such as hyperspectral equipment in determining the extent of mining wastes discharged into the environment [30]. Subsequently, it is expected that biochemicals are used in the dissolution of submarine tailings. In some instances, the dilution of the products generated from tailings are employed in a bid to mitigate the environmental effects in the event of discharge to water bodies [31].

As directed by The Spill Prevention, Control, and Countermeasures Plan (SPCC), it is important to maintain an up-to-date list of all major chemical reagents and their current quantities in mining sites and locations. These records help to determine the appropriate measures of decontamination and treatment of wastes required prior to disposal or storage for appropriate disposal. The management plans must ensure the records of waste management during construction, operations and closure of the mine [32]. The SPCC framework takes into account a variety of factors including the monitoring and prevention of unintended release of waste products, the storage of toxic items/waste in conjunction with the roles of responsibilities of the organizations involved in response to cleaning of areas affected by the wastes generated and released to the environment.

The implementation of the toxic chemical and mercury inventory have been instrumental in curtailing the events of contamination and also aid in the provision of a clear picture of the extent of pollution in the event of accidental discharge of toxic materials in the process of mining.

3.3 Environmental activities of non-governmental organisations in the Yakutia arctic.

There is a fair amount of non-governmental organizations (NGOs) involved in environmental activities in the Yakut region. Excerpts form the National research council in 2001 indicated that the NGOs in the Yakut region "may be divided into four groups: (1) opponents of the policies of the government, (2) prisoners of conscience, (3) educational organizations, and (4) promoters of new technologies" [33].

The first group are known for opposing government-led exploratory activities and tend to employ radical means in doing so. In recent years however, their activities have involved the use of the NGO to obtain grants from other sources for research purposes. The prisoners of conscience are a group that are concerned with the maintenance of safe environments and work towards the improvement of same. The educational organizations are involved in educating the inhabitants and advocate for environmental protection mostly among young people. This is vital in the preservation of the environment as it involves the enlightenment of a great number of the future generations for the preservation of the environment. The promoter of new technology are typically involved in the integration of environmentally friendly technology for the exploration activities in the region. There have been instances where non-governmental agencies have contributed to bettering the lives of the people by establishing a moral and psychological relationship with the inhabitants of areas affected by drilling and mining activities. In recent times, there have been instances when NGOs fiercely advocate for improved living conditions and the cultural preservation of the Sakha people via the protection of marked areas which are deemed socio-culturally important for the Yakut people.

Similarly, other NGOs are dedicated to increasing collaborations and awareness in a bid for exchange of expertise needed to bridge the gaps notices in the management of wastes generated from oil drilling and mining activities. These partnerships include the “United Nations Environment Programme (UNEP), International Solid Waste Association (ISWA) International Telecommunication Union (ITU) The Basel Convention Regional Centre for Asia and the Pacific (BCRC China)” all resultant of the Basel Convention Regional Centre for Asia and the Pacific [34].

3.4 Intergovernmental and international organisations activities of the arctic region on the management of the waste

According to the Arctic Council, “In 2015, an Arctic Council Sustainable Development Workgroup initiative was begun to document the extent of water and sanitation services in Arctic Nations, the related health indicators and climate-related vulnerabilities to WASH services” [35]. The formation of this group led to the holding of two conferences to highlight the water, sanitation and hygiene (WASH) problems and solutions peculiar to the arctic region. in the year 2019, the clean country initiative was implemented in different location of the arctic including Yakutia.

The resulting program led to the cleaning of water bodies polluted by oil spills and gold mining activities in areas such as the Ust-Yansky District. The clean-up ensures the mitigation of tailing residues generated from the dams and the reclamation of approximately 12 hectares of arable land. A series of environmental mandates were launched in the bid to curtail the impacts of oil spills and mining wastes on the aquatic ecosystems and arable lands available to the Yakut people. One of the mandates involved the provision of an Arctic-wide compensation system for regions along the shoreline, including the indigenous people affected by the pollution. The vital element of all liability and compensation programs is the compensation for environmental damage, irrespective of the origin or extent of the damages across the borders of the regions in the arctic.

Currently, the blacksmith institute leads an international group providing solutions and technical support in reducing the health risk of lead pollution resulting from drilling and mining activities in the arctic, which the Sakha region is a beneficiary.

The protection of arctic environments includes the use a combined mainstream and side-stream regulations that have led to the formation of environment-friendly treaties governing mining and exploration activities in the region. The essence of these mandates is to take necessary measures in the reduction, prevention and control of pollution in the arctic ecosystem. Certain statutes refer specifically to the emissions generated from oil installations and mines in the region, including the use of machinery for the exploratory finding and extraction of the natural resource on water or land. The obligation of these regulations ensures the regulation and enforcement of laid down regulations to control pollution of the host communities. Consequently, the national regime has managed to balance the various competing interests of different mandates and regulations to ensure prompt and adequate compensation for acts of pollution from drilling and mining activities in the region.

IV. Conclusion

The Yakut region of the arctic has unique geographical features, that are not similar to other parts of the world where drilling and mining activities occur. The region is chiefly made of ice glaciers and has a rich distribution of permafrost. Despite the seeming difficult geographical composition of the region, the people have found different ways to ensure survival, with designated fishing sites, hunting sites and agricultural farming of specific crops that thrive in such environment.

The region is also rich in natural resources especially oil and contributes to about a third of the gold and diamond mining activities of the Russian federation. However, the discharge of waste generated from drilling and mining activities in Yakutia have had immense socio-economic impact of the people. In the past the potential financial windfall from drilling and mining activities caused led to ignoring planning for the appropriate disposal of waste generated from the exploration of these natural resources.

In recent times, there have been efforts in the remediation of areas affected by the pollution caused from the discharge of wastes from mines and impacts of oil spills. However, the difficult terrain of the arctic region is a major challenge as the conventional methods of oil spill response may not be applicable. Hence, a combination of different methods (mechanical and non-mechanical) have been employed in a bid to clean up affected areas. Consequently, regulations have been established in the bid to control and prevent future occurrences of the events that may adversely affect the people of the region.

The occurrence of oil spills and the inappropriate disposal of mine tailings from mines are chief among the causes of environmental pollution in the Yakut region. These events have led to the poisoning of the aquatic environment and destruction of arable land, making it challenging for the inhabitants of the region to continue their customary ways of life Nowadays Yakutia is the one region where such norms have been adopted and indigenous communities could consider fair compensation for damage to traditional lands. They call this ethnological expertise—a comprehensive scientific research on social, economic and cultural impact of the investment project developed by Sleptsov and colleagues in 2017. This sort of initiative should be encouraged to improve the socio-economic prospects of populations suffering from environmental pollution due to exploration and mining activities in arctic regions.

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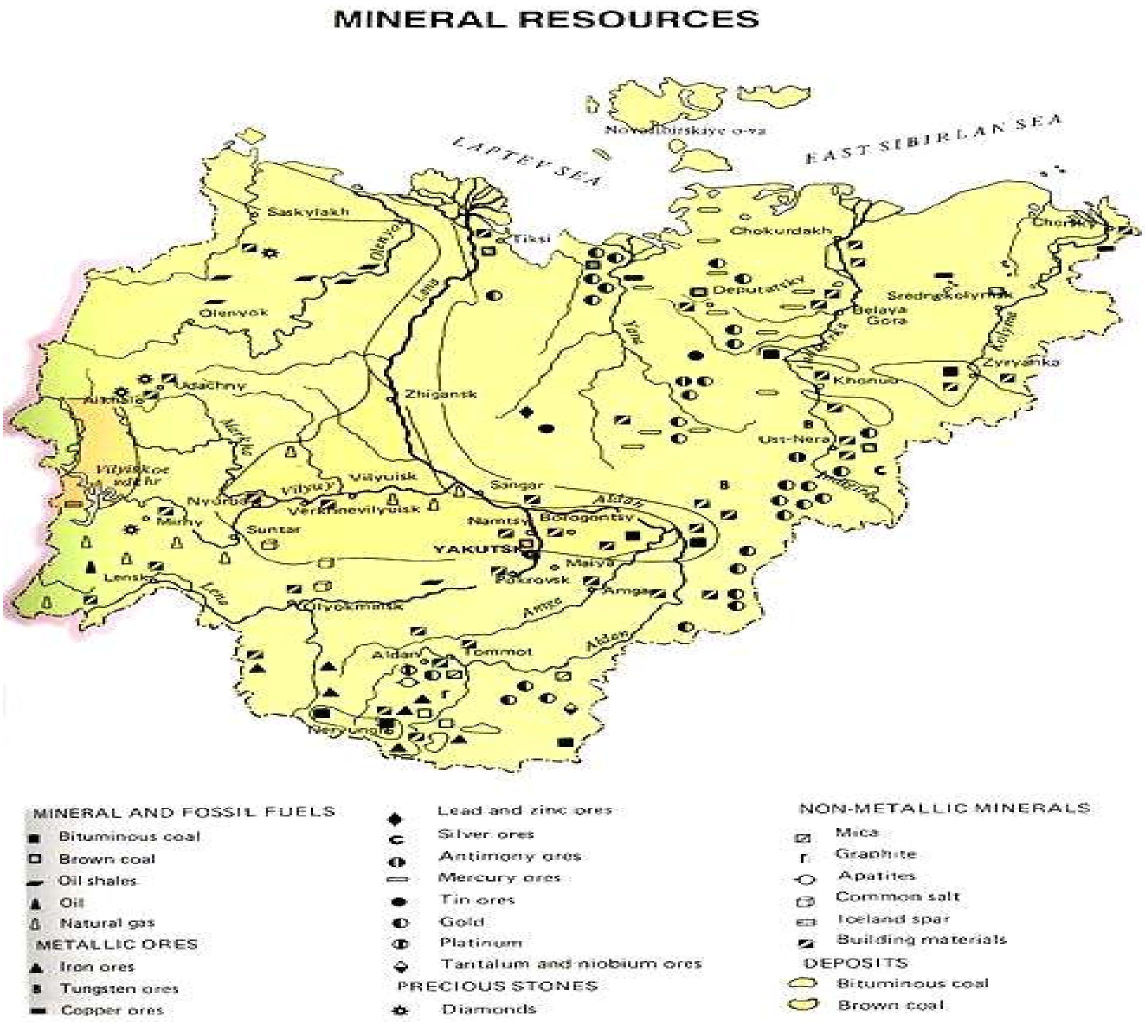
Appendix I: Mineral resources of Yakutia



Source:http://www.geocurrents.info/place/russia-ukraine-and-caucasus/siberia/sakha-yakutia-since-the-fall-of-the-soviet-union

Appendix II: Data on the condition of the raw material and mineral base of the Republic of Yakutia

Mineral deposit	Measurement unit	Reserves	Resources
1. Oil (extractable)	Million tonnes	549	1 847
2. Natural gas	Billion m³	2,716	7,577
3. Coal	Billion tonnes	9.8	121.6
4. Gold	Tonnes	1,537	512
5. Silver	Thousand tonnes	10.3	14.9
6. Iron ore	Billion tonnes	5.7	10.5
7. Rare earth metals	Million tonnes	8.0	203.5
8. Apatite	Million tonnes	85.6	235
9. Tin	Thousand tonnes	778	2,805
10. Antimony	Thousand tonnes	204	822
11. Tungsten	Thousand tonnes	132	660

Source: Deloitte, 2015