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TASK 1 FINAL REPORT

ARCTIC REGIONS AND ITS CONCERNS, THREATS AND POTENTIAL CHALLENGES

PROJECT NAME: PREPARATION FOR THREATS TO ENVIRONMENTS IN ARCTIC REGIONS (PRETEAR)

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PROJECT PARTNERS:

- NARVIK UNIVERSITY COLLEGE *(NORWAY)*
- HARSTAD UNIVERSITY COLLEGE *(NORWAY)*
- INASMET-TECNALIA *(SPAIN)*
- ICELAND FIRE AUTHORITY/UNIVERSITY OF ICELAND *(ICELAND)*
- SWEDISH CIVIL CONTINGENCIES AGENCY *(SWEDEN)*

SELF FUNDED PARTNERS:

- POMOR STATE UNIVERSITY *(RUSSIA)*
- OIL SPILL RESPONSE *(UK)*

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Executive summary and report structure

This review work has two main objectives; first to highlight the potential challenges/concerns as well as threats, and the magnitude of their possible impacts, that the Arctic region[1] is currently facing. These concerns are presented in general prospect regardless of the type of primary targets[2] of their impacts. This project is strongly expected to raise public awareness regarding existing and potential issues, leading to better cooperation between nations to address them. These threats involve environmental, ecological and Arctic vegetation related issues that need to be addressed by the world community to overcome the potential upcoming disasters due to resultant changes in the Arctic environment.

In this work we summarise only the threats that are obvious and require urgent attention. The information has been gathered from a wide range of available sources where full details of each topic can be found via the references provided in Section 10. Moreover, as this project is aimed at research concerning Civil Protection, the main focus and priority is the safety of civilians. The report hence also reviews potential harms in which human beings are more likely to be direct targets.

The report contains information gathered from four main sources;

- The preliminary report made by Narvik University College which comprises a review of published work related to the topic.
- Responses and comments from the project partners.
- A brainstorming meeting held at The Norwegian Fire Protection Training Institute.
- Interviews with current and past operators (business and individuals) in the region.

Three versions of the questionnaire for use in approaching current and past operators are shown in the following Appendices:

Appendix 1: Draft Questionnaire Document

Appendix 2: Final Questionnaire Document

Appendix 3: A suggested questionnaire document which has been successfully used in the past.

One way to represent the different strands of this report is shown in Figure 1. The report begins by gathering information about the Arctic regions as well as concerns and threats

[1] A map showing the area defined as 'the Arctic' in the context of this report can be seen in Figure 3.
[2] In the context of this report, a 'target' is defined as those being affected.

currently occurring. These general existing issues can be caused by climate change, human or others factors. The threats are then inspected from the point of view of their primary and direct targets which could be human beings, the environment or other elements. The challenges, in terms of potential harm mainly towards human beings, related to each concern or threat category, are then summarised at the end of each section. For completeness, these lists of challenges will be coupled with the information to be obtained from the fourth data source (interviews with current and past operators).

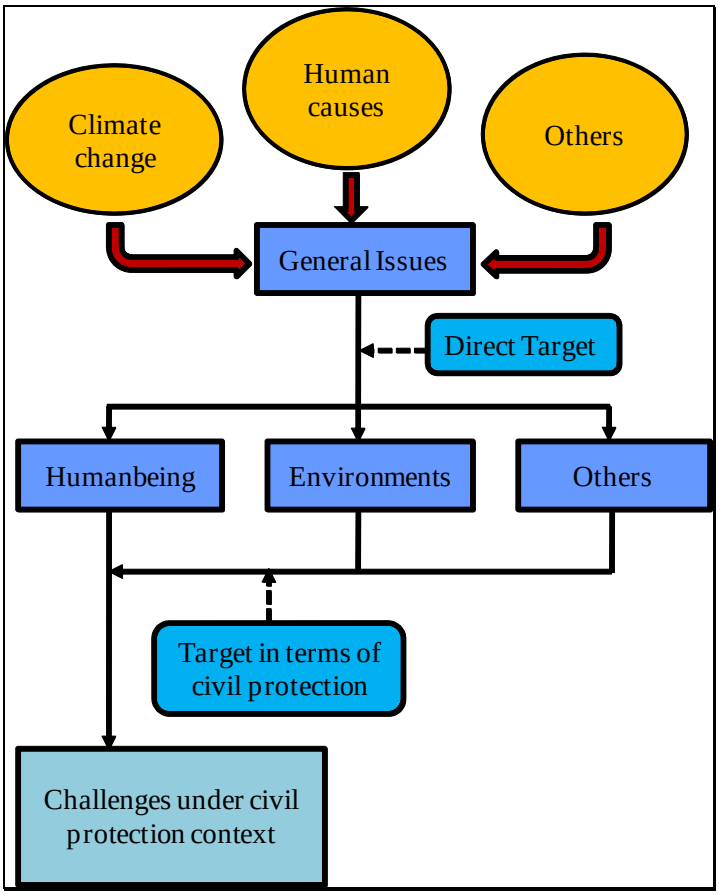

Figure 1 : *Report structure diagram*

1. Introduction

The Arctic is experiencing some of the most rapid transformations on the planet. Arctic regions maintain unique organic communities, arctic ecosystems are sensitive to environmental change and slow to recover, arctic regions have a significant effect on the global climate, global changes are first observed in arctic regions [1].

It has become common for one to pre-conceive Arctic in regard to climate change particularly when it comes to the word *'challenges'* and *'concerns/threats'*. That is whenever Arctic is referred to, climate change and its impacts seem to automatically appear to open up and carry on a conversation. This is simply because the melting of the ice in the arctic combined with the ever-increasing demand for resources and the recent advances in technological innovation are three of the main driving forces behind the growing realization that the arctic is an area the affects all nations and, as such, is an area of common interest of us all. As the Arctic warms, increased political interest in the region is occurring, driven by the belief that it will become accessible to greater commercial activity. An increased economic interest through increased access to oil and gas resources and potential changes in the distribution and dynamics of harvestable resources have brought the Arctic Ocean to the top of political agendas nationally and internationally. Obviously economics, not climate change, primarily will drive future commercial ventures in the Arctic. Warming will bring some new hazards and difficulties, and the Arctic's inaccessibility to extensive human activity will remain [2].

Alongside all the impacts resulting from climate change, ongoing concerns resulting from human activities are not to be omitted. Nevertheless, since every element involved is connected, there are always bridges linking one to another. The scale is too enormous in terms of both space and time to be completely confident to what extent and/or in what aspect they are connected. In other words, the situation is not clear enough to reach a conclusion about whether or not climate change is the only cause for all of the changes taking place in the Arctic region.

The four key words related to the story told in this report are *'challenge'*, *'concern'*, *'threat'* and *'civil protection'*. In order to avoid any confusion, we distinguish each of these based on its surrounding contexts as follows:-

- **Concern/threat:** issues that are seen as harmful to Arctic regions in general regardless of what the direct targets are.
- **Civil protection:** ensuring the protection of people from the impacts of the concerns and threats defined above.
- **Challenge:** an event, incident, accident or case scenario resulting from any concern or threat in terms of civil protection, as defined above.

From the definition of the four key words, it becomes apparent that, apart from human causes and climate change, the nature of the region itself can also be another source of concern leading to further challenges. Therefore, the concern/threats concerning the Arctic region considered in this paper cover three main categories:

- those resulting mainly from climate change, which remains the hottest topic and draws attention from all over the globe.
- those as a consequence of human activities in general, and
- those resulting directly from the uniqueness of the Arctic itself

where each may or may not be linked to one another.

2. The Arctic and its uniqueness

2.1 Landscape, habitats and climate

The Arctic as an area is essentially an ocean surrounded by the land north of the Arctic circle (66032' N) that covers a region of 33 million Km^2, larger than Africa or Asia. Altogether about 4 million people live in the Arctic parts of eight countries: Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden and United States (Alaska), Figure 3. The main portion of its entire region is oceanic of which one-third is occupied by land, another one-third consists of offshore continental shelves located in less than 500 meters or Arctic Ocean water and the other one-third is under Arctic Ocean sea water deeper than 500 meter [3]. It is a region of vast natural resources and a clean environment, compared with most areas of the world [4].

Arctic countries population consists also of native inhabitants or indigenous people. Russia, Finland, Sweden and Norway have Sami people in the Arctic parts of the country. Greenland (Denmark), Canada, USA (Alaska) and eastern parts of Russia (Siberia) has Inuit population. For all, their way of living is traditional and the overall principle is to exploit the basic elements in nature; reindeer herding, fishing and hunting. Although the native societies have been influenced by the modern world and globalization, they still fight for the possibility to sustain area management and exploitation of local natural resources. The Sami population has been estimated to be 50000-80000 people. Norway has the highest number, followed by Sweden and Finland, and Russia has the lowest. Nevertheless, an accurate number does not exists and the estimates differ [5].

The climate of the Arctic is characterized broadly by long, cold winters and short, cool summers. There is a large amount of variation in climate across the Arctic, all regions experience extremes of solar radiation in both summer and winter. Some parts of the Arctic are covered by ice (sea ice, glacial ice, or snow) year round, and nearly all parts of the Arctic experience long periods with some form of ice on the surface. Average January temperatures range from about −40 to 0 °C (−40 to +32 °F), and winter temperatures can drop below −50 °C (−58 °F) over large parts of the Arctic. Average July temperatures range from about −10 to +10 °C (14 to 50 °F), with some land areas occasionally exceeding 30 °C (86 °F) in summer [6].

The Arctic consists of ocean that is nearly surrounded by land. As such, the climate of much of the Arctic is moderated by the ocean water, which can never have a temperature below −2

°C (28 °F). The Gulf Stream plays an important part in keeping many coastal areas habitable, keeping temperatures higher than in inland areas, see Figure 2. In winter, this relatively warm water keeps the North Pole from being the coldest place in the Northern Hemisphere, and it is also part of the reason that Antarctica is so much colder than the Arctic. In summer, the presence of the near-by water keeps coastal areas from warming as much as they might otherwise, just as it does in temperate regions with maritime climates.

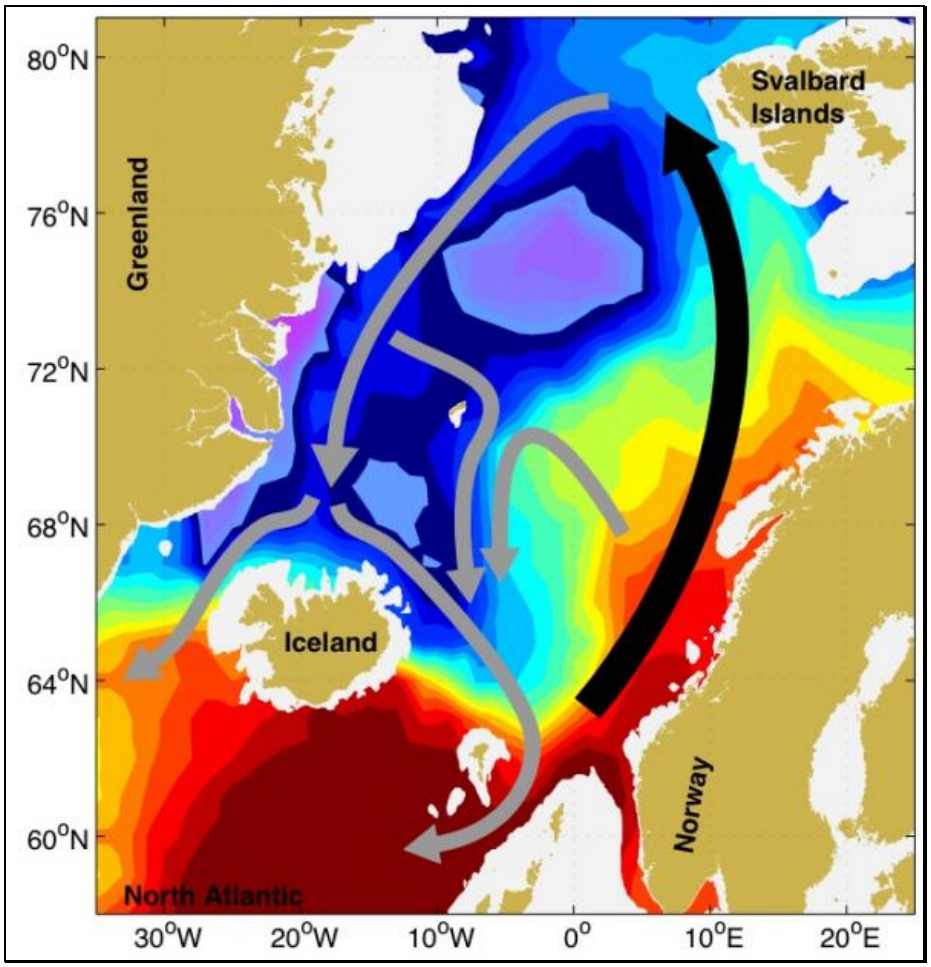

Figure 2 : *The overturning from warm (red) into cold water masses (blue) in the Nordic Seas. The black arrow indicate the extension of the Gulf Stream into the Norwegian Sea, and the grey arrows the cold return flow at depth. (Credit: Image courtesy of University of Bergen) : source [7].*

2.2 Plants

Arctic vegetation is composed of plants such as dwarf shrubs, graminoids, herbs, lichens and mosses, which all grow relatively close to the ground, forming tundra. As one moves

northward, the amount of warmth available for plant growth decreases considerably. In the northernmost areas, plants are at their metabolic limits, and small differences in the total amount of summer warmth make large differences in the amount of energy available for maintenance, growth and reproduction. Colder summer temperatures cause the size, abundance, productivity and variety of plants to decrease. Trees cannot grow in the Arctic, but in its warmest parts, shrubs are common and can reach 2 m (6 ft 7 in) in height; sedges, mosses and lichens can form thick layers. In the coldest parts of the Arctic, much of the ground is bare; nonvascular plants such as lichens and mosses predominate, along with a few scattered grasses and forbs (like the arctic poppy).

2.3 Animals

Herbivores on the tundra include the Arctic hare, lemming, muskox and caribou. They are preyed on by the Arctic fox and wolf. The polar bear is also a predator, though it prefers to hunt for marine life from the ice. There are also many birds and marine species endemic to the colder regions. Other land animals include wolverines, ermines, and arctic ground squirrels. Marine mammals include seals, walrus, and several species of cetacean—baleen whales and also narwhals, killer whales and belugas.

2.4 Natural resources

The Arctic includes sizable natural resources (oil, gas, minerals, forest—if the sub-arctic is included—and fish) to which modern technology and the economic opening-up of Russia have added significant new opportunities. The tourism industry is also on the increase because of intense interest in the region and its unique environment.

The Arctic is one of the last and most extensive continuous wilderness areas in the world, and its significance in preserving biodiversity and genotypes is considerable. The increasing presence of humans fragments vital habitats. The Arctic is particularly susceptible to the abrasion of groundcover and to the disturbance of the rare reproduction places of the animals that are characteristic to the region. The Arctic also holds 1/5 of the Earth's water supply

Amongst several, there seem to be two unique attributes about the regions that are outstanding; its remoteness and the weather conditions. The Arctic is often referred to as the region north of the tree line, the point beyond which the trees do not grow. As some measure of the isolation of the region, it is thought that more information is known about

the moon than about the Arctic. Even when only considering these two attributes, the Arctic prompts a number of challenges in terms of human protection.

Table 1: Potential Challenges - Natural Resources

Potential challenges - Natural resources	
1	Availability or lack of availability of secure infrastructure: routes of access.
2	Possible peed of access to remote locations/installations
3	Underwater pumping (in sea ice conditions) - how is access possible?
4	Access to marine fires for salvage vessels because of remote locations.
5	Icing of equipment and structures on shipping creates stability issues, and containerships are particularly vulnerable.
6	Work conditions on installations/platforms because of temperature conditions.
7	Responses in the event of loss of power lines – cold climate effects on humans.
8	Offshore rescue best practice will have to change (sea ice, more snow, etc).
9	Lack of daylight for exploration, etc.
10	Lack of signal sent and received or small vessels in shadow areas increasing risk of narcotics, weapons, dangerous chemical and illegal goods transportations in/out. More radar detecting stations and cooperation from neighbor countries required.

Figure 3 : *Arctic map identified by the area inside the highlighted red enclosed line; Source [8].*

3. Climate change and its impacts

With its high proportion of ice, the Arctic is sensitive to climate change and acts as an amplifier for the global heat engine. Climate change in the Arctic region causes major physical, ecological, sociological and economic impacts around the globe. Once triggered, they may continue for centuries, long after greenhouse gas concentrations are stabilized and cause irreversible impacts on ice sheets, global ocean circulation and sea level rise [9].

Climate change has resulted in many ways to the region as well as the rest of the world. Some direct ones are [10, 11];

- **Rising temperature:** up to approximately 3-4^{o}C in Alaska and Western Canada and up to 7^{o}C on average of entire region over the century [12]. This is projected to warm by as much as 18^{o}F by 2100 [13].
- **Increasing precipitation:** estimated to be anywhere between 8 % and 20 % on average over the past century [12].
- **Thawing permafrost:** warmed up to 3^{o}C in the recent decades since 1980s [14].
- **Declining snow cover:** about 10 % - 20 % over the past 30 years.
- **Diminishing lake and river ice:** mostly taking place at North America and Western Eurasia.
- **Melting glaciers, Greenland ice sheet and retreating summer sea ice:** reduced by 2-3 % per decade over last 50 years. Statistical data of average Arctic sea ice extent for December 2008 was 12.53 million square kilometres, which is 140,000 square kilometres less than the 1979 to 2000 December average [15, 16], see also Figure 4.
- **Rising sea level:** approximately 10 – 20 centimetres in the past 100 years and predicted to rise up to 7 metres if the Greenland ice-cap melt completely.

Table 2 : Potential Challenges – Climate Change

Potential challenges – climate change	
1	Stock management in the event of climate warming / cooling – effects on nomadic lifestyles, social outcomes.
2	Economic, education, issues in cold climate conditions.
3	Sea warming – invasion of other species colonization, effects on indigenous species.
4	Ice melt from Greenland effects on gulf stream will change climate condition.
5	Floods can contaminate drinking water for variable periods of time.
6	More fresh water gradually added to dams can result in sudden dam failure. Dam failure is also a problem in the mining industry.
7	Higher amount of precipitation and warmer climate, forest fires can occur more easily.

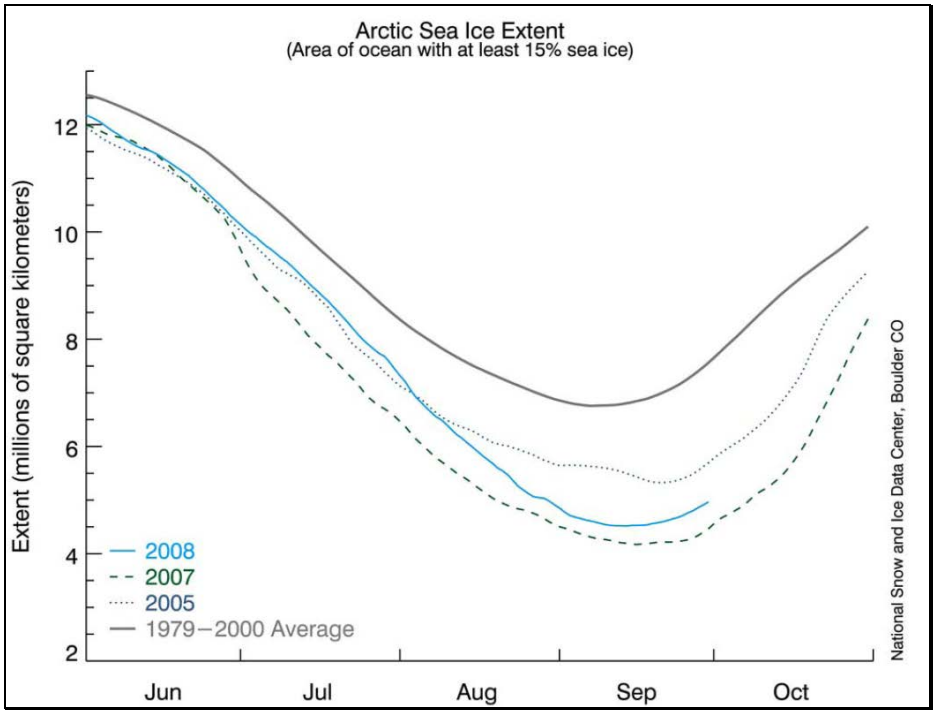

Figure 4 : *The Arctic summer's sea ice extent in 2008 (solid blue line), 2007 (dashed green line), 2005 (dotted dark blue line) and average extent from 1979 to 2000 (solid gray line) ; Source [16].*

3.1 Oil - Gas Exploration and Associated Increased Shipping Activities

The world demand for oil and gas is growing at an ever increasing rate and, as a result, there is a demand to explore new areas for potential supplies. The Arctic region is one of the remaining unexplored areas, where such exploration still can be undertaken. The Arctic contains large untapped hydrocarbon reserves. A US Geological Survey (USGS) preliminary assessment suggests that the Arctic sea bed may hold as much as 22% of the world's undiscovered conventional oil and natural gas base with an estimate of 400 billion barrels lying beneath the Arctic seabed. This is about 30% of the world's undiscovered natural gas resources, about 13% of the world's undiscovered oil resources and about 20% of the world Natural Gas Liquids (NGL) [17-19]. Melting of the Arctic ice cap is gradually making these resources more easily accessible.

The impact of oil and gas exploration in the Arctic region covers a wide range of activities such as production fields, transportation corridors, seismic trails, material sites and living camps. Infrastructure and the long roads or pipelines needed to transport oil and gas damage tundra vegetation and disrupt wide-ranging species; reindeer and caribou [2]. Associated threats could include noise pollution, water dispersal in the drilling phase and the actual drilling process which can release oil and chemicals into the water. This has highlighted the need for new regulations and standards in these areas.

The increase in ice-free regions in Arctic not only provides more opportunity for oil and gas exploration but also allows commercial vessels to travel with shorter routes. The melting of sea ice is progressively opening opportunities to navigate on routes through Arctic waters. This could considerably shorten trips from Europe to Pacific, save energy, reduce emissions, promote trade and diminish pressure in the main trans-continental navigation channels. Concerns regarding this such as drift ice, lack of infrastructure and environmental risks, nevertheless still remain [20].

Shipping activities in the Arctic Ocean are increasing day by day. There was a little transport of oil prior to 2001 through the Barents Sea, but this volume has now grown. It is expected that by 2015 the annual oil shipment along the northern coast of Norway will be around 30 million tons. This means that every day there will be a continuous stream of several tankers along the coast of Norway, raising obvious environmental concerns for this area, which is home to some of Norway's most important fisheries and has an unspoiled nature that is highly valued by both local residents and visitors [4]. The expected increase in shipping traffic in the Barents Sea and along the Norwegian coast has an associated higher risk of accidents

and associated pollution. The transport of oil and gas in Arctic region by tanker and pipeline poses severe problems of environment impacts. Moreover, Norway also has one of the longest coastline in the world, 25,148 km (includes mainland 2,650 km, as well as long fjords, numerous small islands, and minor indentations 22,498 km; length of island coastlines 58,133 km [8]), making it difficult to protect from coastal pollution.

All in all, more areas discovered give rise in impact of new activity towards exploitation of the mineral and energy resources in the north, as well as the opening of new transport routes. Benefits, however, rarely remain in the region, and permanent jobs are rare. And when jobs are retained, the result may be adverse effects such as social stratification and inequity in wealth distribution. Long-lasting consequences often persist through industrial waste, tailings, and environmental contaminations [21]. At sea, oil spills are the largest potential environmental threat. They are difficult to control and can spread over 100s – 1000s unnoticeably harming the ecosystems [22]. Another factor that can magnify the problem is the lack of emergency response capability for mitigating pollution and saving lives in the event of an accident [23]. Hence, the opening up of new opportunities is a huge challenge to the northern communities in both positive and negative ways.

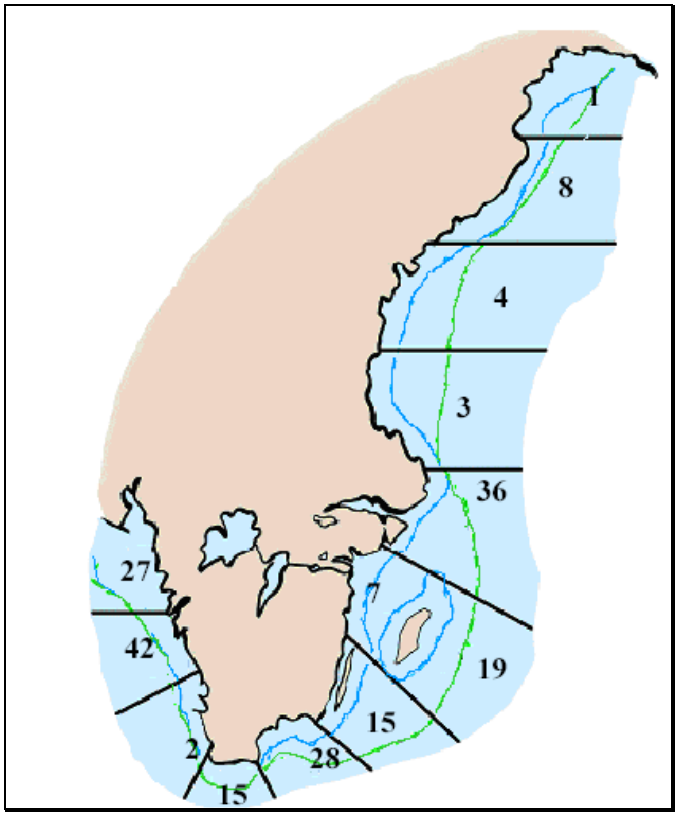

Figure 5 *The number of oil spills along the Swedish coastline in 2003: Source MSB.*

In addition to this, a possibility of conflicts amongst the Arctic countries growing and becoming serious political issues still persists. Despite the need for more responsibility from the members (as well as the rest of the world) to react to the already existing concerns and threats that the region is facing, territories claims as benefits of new resources including oil and gas continuously discovered are still taking place [24, 25]. This could eventually lead to another threat, terrorism activity, to the region, created purely as a result of human greed.

Table 3 : Potential Challenges – Oil / Gas Exploration and Associated Increased Shipping Activities.

Potential challenges – Oil / Gas Exploration and Associated Increased Shipping Activities	
1	Icing of structures on shipping (stability issues) – containerships are particularly vulnerable
2	Oil and gas explosions – deep sea issues – health and safety of all involved
3	Environmental protection with pipeline breakages or similar issues
4	Transportation from deep sea areas to mainland.
5	Corrosion/materials issues – what will be used to replace pipelines?
6	Import of structures for oil and gas industry – effects on infrastructures (road, ships, etc).
7	Terrorism – with increased resource exploitation.
8	Difficulties in managing the oil industry growth and environmental protection still remaining political issues.
9	More melting ice creating shorter routes leading to energy savings for trips and less emissions but drift ice, lack of infrastructure and environmental risks still present serious problems.
10	Effects of incidents on indigenous species – marine and land.
11	Container contents, transportation generally, ballast water issues (movement of non-indigenous organisms from one region to another).
12	More traffic, more pollution and threats, disturbing natural habitat - Laws and regulations amongst neighboring countries are desirable.

3.2 Methane Release

Methane (CH_4) is a very powerful greenhouse gas with 25 times the warming potential of carbon dioxide (CO_2) [26]. It has been estimated that there are 400 giga-tons of Methane locked in the frozen Arctic tundra and if there is a release of these reserves because of the already projected increase in Arctic temperatures, then it can be disastrous for the planet [27].

Global methane emission from all sources, both human and natural (as a result of permafrost thaws, due to increasing temperature for instance), are calculated to be about 500-600 million metric tons per year. Recent estimates put current methane emissions from the world's soils at between 150 to 250 million metric tons of methane per year. A quarter of a

third of the total is estimated from the wet soils of the Arctic, making them one of the largest sources of methane emission on earth [26].

Should the CH_4 be absorbed by sea water before reaching the atmosphere, it could contribute to the ocean acidification proportion unavoidably affecting the marine ecosystems, Figure 6. Furthermore, CH_4 is also responsible for seabed stability and could have serious impact on coastal land if the balance is broken [2].

The consequences of the significant increases in methane release, especially the additional warming, would be felt around the world. Any additional warming will lead to ice melt of glaciers, ice caps and ice sheets that will raise sea level around the globe.

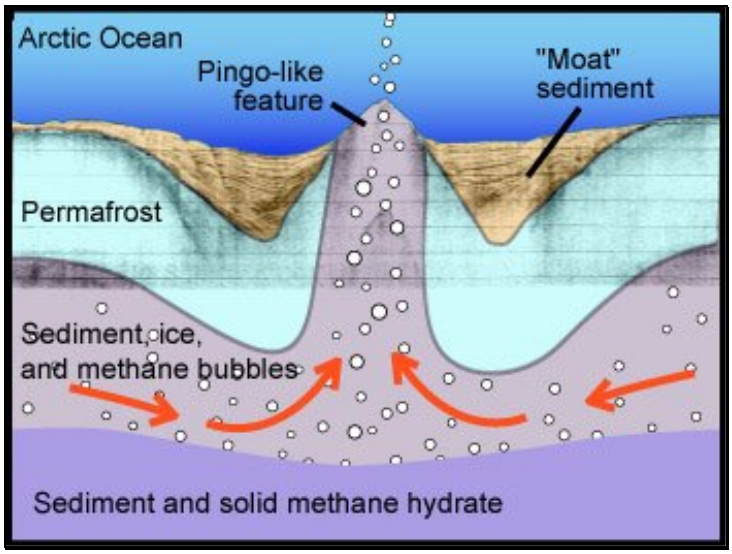

Figure 6 : *As the Arctic warms the permafrost melts letting methane gas escape into the atmosphere, which accelerates global warming still further; Source [28].*

3.3 Change in Arctic Ecosystems

Arctic ecosystems are simple in structure, but often have long food chains which link both terrestrial and marine ecosystems. Ecosystems in the Arctic region are characterized by low species diversity and a high relative number of endemic species, species found nowhere else on the planet [4]. The chemical properties of the Arctic environment and the multiple physical, biogeochemical and ecological processes act on and within the ecosystems. Any change in these attributes and processes ultimately contribute to the variable and dynamic responses within the Arctic ecosystems.

A number of species can be affected by the rise in temperature and its results. This ranges from fish stock in the Arctic Ocean which is sensitive to the ocean temperature, even small

changes can result in major shifts in the geographical locations and productivity in the stock with results that may be difficult to predict, to small creatures such as worms, crustaceans and molluscs that can be transported to different area by melted ice and snow [29]. For example, the aquaculture of the Salmon and Trout, which is a major industry in the Arctic [20].

Many Arctic animals such as polar bears, seals, walruses and seabirds rely on the sea's biological productivity and on the presence of the sea ice [30]. The unusual warm winters are dramatically effecting the population of the Peary caribou of the high Canadian Arctic [31]. Polar bears live on sea ice while hunting their prey and reductions in sea ice due to warming have resulted in shorter feeding periods and decreased accessibility to the seals that they hunt [27, 32]. This all eventually has impact on the local people who depend on them.

Table 4 : Potential Challenges – Change in Arctic Ecosystems.

Potential challenges – Change in Arctic ecosystems	
1	Extent and type of sea ice as well as the increasing fresh water effecting fish stock, hence seals, polar bears and so on.
2	Effects on ecosystems of exploration/explosions – knock-on effects from natural disasters?
3	Ecosystems – sustainable species management, e.g. fishing, etc.
4	Increasing marine temperature and fresh water effecting weather conditions, changes in fish stock.
5	Colder summer temperatures causing the size, abundance, productivity and variety of plants to decrease.

3.4 Arctic Vegetation Zones

The Arctic region has three main types of vegetation: Polar deserts in the north, boreal forests in the south and tundra in between. Rising temperatures are expected to favour a northward expansion of boreal forest into the tundra and of tundra into the polar desert. The expansion of forests is likely to amplify the global warming, because the newly forested areas are darker than the tundra, they replace and absorb more of the sun's energy. Climate change is expected to increase the range of crops that can be grown in the Arctic and to extend the growing season. But due to the warming, insect's outbreaks can increasingly disturb the large areas of the crops and forests [30].

Observation taking place covering the entire region of Arctic suggests that tree lines advanced upslope by up to 60 meters in altitude in northern Sweden during the 20th century. The rate of advance in recent decades has been half a meter per year and 40 meters per degree Celsius. A southward shift in tree line associated with pollution, deforestation, agriculture, and the growth of bogs that leads to the death of trees is also found in Russian. At the same time, rapid changing warm and cold episodes in winter found in some areas of Finland and northern Sweden has given rise to bud damage in birch trees. The most obvious impact of the increase in temperature is found to be taking place in northern Scandinavia where large shifts in vegetation occurred [33].

3.5 Infrastructures

Sea level rise is likely to cause flooding of marshes and coastal plains and accelerate beach erosion. Furthermore, because sea ice forms a natural breakwater against storm wave action, ice melting allows large storm surges to develop and causes erosion, sedimentation, and coastal inundation. Some towns and industrial facilities are already suffering severe damage as a result of erosion, and are now facing the prospect of relocation. The melting of the permafrost layer poses significant engineering challenges for and/or has damaged houses, airports, roads, buildings, pipelines, thicker insulation, and other preventive measures that will increase construction costs [12]. It also caused landscape erosion, slope instability, and landslides. Local coastal losses to erosion of up to 100 feet per year have been observed in some locations in the Siberian, Alaskan and Canadian Arctic [34].

An example of coastal erosion that took place in Alaska's Arctic coast is shown in Figure 7. For this type of case scenario, the town dump, which has seawater within 8 feet of it, could pollute the nearby marine environment for years if inundated. Advancing seawater has contaminated Shishmaref's drinking water supply [35].

Figure 7 : *Recent erosion along Alaska's Arctic coast; note the collapsed block of ice-rich permafrost. Courtesy of Benjamin Jones, USGS ; Source [36].*

Dispersed settlements and few roads in the Arctic region create a challenge from the preparedness perspective. Long distances, both over land and sea, and the number of bases housing necessary equipment present a challenge when incidents require total coverage of an area. In most incidents, time is critical. With difficulties related to availability, travel time, infrastructure, and manpower, increases in human activity in the Arctic will change the pre-conditions for preparedness.

Table 5 : Potential Challenge – Infrastructure.

Potential challenges – Infrastructures	
1	Icing of infrastructure (electricity, etc.). Loss of power and issues related to reconnection because of remoteness and cold climate.
2	Corrosion of pipelines
3	Coastal and landscape erosion, and collapse of permafrost potentially leading to pollution/contamination resulting from town and industrial facilities being flooded with sea water.
4	Remoteness: lack of road access; roads inaccessible because of cold climate and other infrastructure issues leading to access issues
5	Engineering challenges for damaged houses, airports, roads, buildings, pipelines, etc.

4. Ongoing concerns mainly due to human activities

4.1 Persistent Organic Pollutants (POPs)

POPs are carbon based chemical compounds and mixtures that include the industrial chemicals such as PCBs, pesticides like DDT and unwanted wastes such as dioxins [37]. These chemicals are highly toxic, persistent and mobile in the environment and can persist in the environment for decades. POPs can travel through air and water to regions distant from their original source through the process of evaporation and redeposition known as the 'grasshopper effect'. As the Arctic air is cold and evaporation is minimal, therefore these POPs are accumulating in the Arctic environment even though their sources are scattered elsewhere around the globe. Research has shown that levels of many POPs contaminants in the Arctic are likely to remain at, or close to, the existing levels for decades because of their resistance to degradation, the slow rate of derivative processes, and the recycling of existing accumulations [38]. United nations environment programme (UNEP) has identified 12 most common POPs named 'the dirty dozen' effecting the Arctic (DDT, heptachlor, texaphene, mirex, aldrin, endrin, dieldrin, chlordane, hexachlorobenzene, PCB, dioxins and furans) [38].

POPs can enter into ecosystems at any level of the food chain including right from the bottom when organisms absorb them from the air and water. This is then passed on to bigger and bigger predators until eventually human beings who are at the top of the food chain will have all the pollutants previously accumulated [39].

As a whole, efforts to quantify the amount of POPs transported to the Arctic and to determine the source regions are quite limited. Organic contaminant in the Arctic environment share many characteristics that make them especially insidious for people and wildlife in the Arctic region. Following are some biological effects of POPs on life in the Arctic region [40].

- Most of the POPs are fat soluble and accumulate in the fatty tissues of the animals.
- Some POPs interfere with the sex hormones of the Arctic animals that inhibit the growth of the reproductive tract and the mammary glands.
- POPs limit the cell medicated immunity, the branch of the immune system that fights cancer cell and parasites.
- Some POPs are suspected of being responsible for increased rate of tumours in wildlife of the Arctic region.

- Recent Northern Contaminants Programme (NCP) has reported that traditional food of Arctic region contains multiple contaminants. Of greatest concern are texaphene and chlordane, the mean intake of which are found to be four times greater than the tolerable daily intake values by health Canada [38].

Potential challenge

Addressing these issues at a local level, when surrounding conditions can vary dramatically between different regions is difficult. Several control programs exist, for example the United Nations Environment Programme (UNEP), Northern Contaminants Programme (NCP), Arctic Monitoring & Assessment Programme (AMAP), but their effect is limited because of the variability of the surroundings being addressed. This leads to a challenge in identification of specific regions, mapping their varying conditions and determining potential solutions on a local level.

4.2 Tourism Activities

Tourism is a fast growing commercial activity in the Arctic. Cruise holidays to the Arctic has been expanding by 50% in the past 15 years [2]. It is difficult to attach this increase in activity to one particular factor or even whether or not this purely results from easier access because of climate change. The future figure for tourism activity is therefore still difficult to predict as with climate change, its result can be seen in two different ways. With more routes created every minute, more landscape is being discovered. On the other hand, decrease in local habitats such as those for polar bears might detract from the tourist experience. Either way, nevertheless, has impacts on the region.

While a potential decrease in tourism activity might affect the local economy where the main driver mechanism is from the tourists and their activities, increasing tourism activities are disturbing the wilderness and wild life of the Arctic region, Figure 8. For example over-flights are disturbing the birds and mammals and kerosene released from the aircraft is residing on the ecosystems of the Arctic. Similarly, cruise tourism is disturbing the wildlife and polluting the Arctic water. Land based tourism has the potential for the greatest damage owing to the permanent facilities for transport and accommodation which it requires. As a whole increase tourism has potentially harmful results, though good planning can go a long way in mitigating these results and it is possible to over stress this potential challenge.

Regarding the connection between the tourism industry and global warming based on the growth of cruise tourism so far, several researchers and commentators suggest that, with the decrease in sea-ice extent every month, Arctic regions will continue being visited by more cruise activity [41-43]. This predicted figure hence leads to the generalization that cruise tourism might be one of the very few desirable consequences associated with climate change in the Arctic [44].

Table 6 : Potential Challenges – Tourism Activities.

Potential challenges – Tourism activities	
1	More people visiting creating more problems; • Disturbing wildlife. • Polluting the surroundings. • Necessitating permanent facilities for transport and accommodation on land.
2	Tourism emergency – what is in place to deal with potential issues.
3	Tourism issues – pollution and people management in the event of incidents.
4	Lack of access to regions with extreme weather conditions such as the sea between Iceland and Greenland.
5	Raised concerns of rescuing injured tourists if things go wrong.
6	The increasing presence of humans fragments vital habitats for wildlife and plants.

Figure 8 : *Increasing tourism activity can disturb local habitats ; Source [45]* .

4.3 Radioactive Waste

Radioactivity is one of the growing challenges for the Arctic environment. The largest indicators for region-wide radionuclide contamination in the Arctic marine environment appear to arise from [46] ;

1. Atmospheric testing of nuclear weapons, an on-going practice.
2. Nuclear fuel waste into Arctic reprocessing facilities.
3. Accidents such as Chernobyl.

The radioactive discharged from nuclear reprocessing facilities in Western Europe, such as from Sellafield (UK), Mayak (Russia) La Hague (France), have contributed to the sum of radionuclide in the Arctic sea. The waste material is swept away by ocean currents and can be observed both in sea-ice and sea-water in the Arctic Ocean and at the bottom of the Atlantic Ocean [47].

It is estimated that every year 10 million cubic metres of liquid radioactive waste are being dumped in the water reservoirs which leads to about 400 cubic metres of radioactive water which are being held back from the river system only by a simple rampart [48]. Another estimation of this figure is also that the total amount of radioactive waste dumped in Arctic Seas was estimated to be approximately 90 PBq (90 x 1015 Bq) [49]. The dumped items included six nuclear submarine reactors containing spent fuel; a shielding assembly from an

icebreaker reactor containing spent fuel; ten nuclear reactors without fuel; and solid and liquid low level waste. Of the total estimated inventory, 89 PBq was contained in high-level wastes comprising reactors with and without spent fuel. The solid wastes, including the reactors mentioned above, were dumped in the Kara Sea, mainly in the shallow fjords of Novaya Zemlya, where the depths of the dumping sites range from 12 to 135 meters and in the Novaya Zemlya Trough at depths of up to 380 meters. Liquid low-level wastes were released in the open Barents and Kara Seas [50].

Moreover there are numerous military sources of potential radioactive impact located in the Russian Arctic. Most of these are well known, such as the storage facilities for spent nuclear fuel in the Andreev Bay close to the Norwegian border and in Gremikha on the northeast shore of Kola Peninsula. Radioactive pollution by radionuclide is of particular concern following the Chernobyl accident of 1986 and the widespread use of nuclear reactors in marine vessels and power stations in the Arctic.

Table 7 : Potential Challenges – Radioactive Waste.

Potential challenges – Radioactive waste	
1	Nuclear fuel storage facilities, increasing use of nuclear reactors in marine vessels and power raising concerns of contamination and explosion.
2	Ships with hazardous and radioactive cargo are welcome in Iceland but not in Norway.
3	Radioactive waste, temperature changes can increase corrosion rates.
4	Effects of incidents on indigenous species – marine and land.

4.4 Dangerous Goods and Substances

In areas with a high industrial growth rate, an issue of goods and substances involved in production, transportation as well as consumption processes can be another source of threat to local civilians. For instance, the northern area of Sweden, especially the coastal region, has a lot of heavy industry. Many of these industrial plants are Seveso-facilities (i.e. facilities that need to follow the *Council Directive 96/82/EC of 9 December 1996 on the control of major-accident hazards involving dangerous substances*). In this area over 60 Seveso-facilities are located. When an industry is not as big as a Seveso facility it is classified as a “dangerous industry” according to the Swedish Civil Protection Act. In the northern area of Sweden more

than 120 organisations (including Seveso-facilities) are classified in this category. There are also large amounts of dangerous goods transported to and from these industrial sites. Figures 10a and 10b below show the amount of dangerous goods, in tonnes, transported on railway and road respectively during September 2006 in northern Sweden.

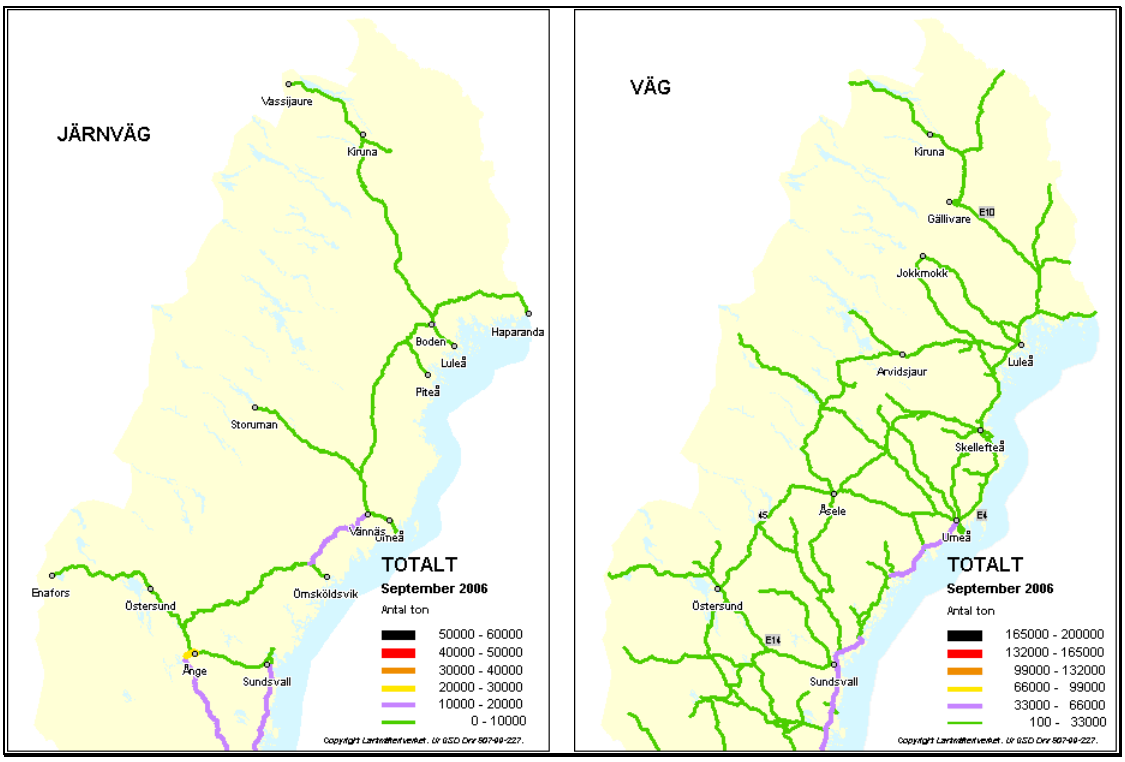

Figure 10a **Figure 10b**

Figures 10a and 10b *above depict* *the amount of dangerous goods in tonnes transported on railway (a) and roads (b), during September 2006 in northern Sweden. Source MSB.*

Table 8 Potential challenges – Dangerous Goods and Substances

Potential challenges – Dangerous goods and substances	
1	Direct leak of dangerous chemical from factories
2	Road/train accidents that result in releasing toxic substances
3	Invisible contaminant in water, air and soil
4	Explosion of explosive materials
5	Fire causing release of toxins
6	Acts of terrorism

5. International cooperation and politics

The Arctic region is a focus of international political interest. International Arctic cooperation got underway on a broad scale well over ten years ago. The International Arctic Science Committee (IASC), hundreds of scientists and specialists of the Arctic Council, the Barents Euro-Arctic Council and its regional cooperation have compiled high quality information on the Arctic.

No country owns the geographic North Pole or the region of the Arctic Ocean surrounding it. The surrounding Arctic states that border the Arctic Ocean — Russia, Norway, the United States, Canada and Denmark (via Greenland)—are limited to a 370 kilometre (200 nautical mile) economic zone around their coasts.

Upon ratification of the United Nations Convention on the Law of the Sea, a country has ten years to make claims to extend its 200 mile zone [14]. Due to this, Norway (which ratified the convention in 1996), [15] Russia (ratified in 1997), [15] Canada (ratified in 2003) [15] and Denmark (ratified in 2004) [15] launched projects to establish claims that certain Arctic sectors should belong to their territories.

On August 2, 2007, two Russian bathyscaphes, MIR-1 and MIR-2, for the first time in history descended to the Arctic seabed beneath the North Pole and placed there a Russian flag made of rust-proof titanium alloy. The mission was a scientific expedition, but the flag-placing raised concerns of a race for control of the Arctic's vast petroleum resources.[16] (See 2007 Russian North Pole expedition.)

Foreign ministers and other officials representing Canada, Denmark, Norway, Russia, and the United States met in Ilulissat, Greenland on May 28, 2008 at the Arctic Ocean Conference and announced the Ilulissat Declaration [17][18].

Table 9 : Potential Challenges – International Cooperation and Politics.

Potential challenges – International cooperation and politics	
1	Increased military activities and their effects.
2	Russian test sites for nuclear armaments in the area – what impacts will climate change have on these test sites?
3	Political and border issues.
4	Standards and regulations – cross border access and issues.
5	Access to people who make decisions – political issues.
6	Languages in a cross-border / mobility context.

6. Other challenges

Apart from issues that can be categorized as above, there are also other types of potential challenges gathered from the brainstorming activity amongst the project partners. These challenges are shown in Table 10.

Table 10 : Other Potential Challenges.

Other potential challenges	
1	Energy issues under a situation of increased demand – lack of, sources of, new developments.
2	Built environment issues / construction industry.
3	People migration issues.
4	Health and welfare issues with increased populations/migrating population.
5	Management of all of the above.
6	Psychological effects.
7	Common incidents/accidents, e.g. traffic accidents, can represent great problems when they happen in remote areas.

7. Recent events

Type of event : Volcanic eruption

Place / date of event : Eyjafjallajokull, Iceland. Started on March 20, 2010 and lasted for 3 weeks including the major one taken place on April, 14.

Information related and Impacts:

- The total length of the fissure is about two kilometers [51].
- Over six hundred people needed to be evacuated from their homes on the first night, mostly residents in urban areas in the South.
- No air traffic was allowed in a large area above and around the eruption site. The no flight zones did affect routes to and from Norway, Russia, northern Europe and the European mainland.
- Gases from past large volcanoes have actually lowered Earth's temperatures, triggered lung ailments, causing acid rain and thinning our protective ozone layer.
- Hot fumes melted up to a third of the glacial ice covering the crater, causing a nearby river to burst its banks.
- The area affected by the eruption is an important agricultural area, containing 15% of all cattle, 6% of all sheep and 17% of all horses in Iceland. The inhabitants of around 20 farms closest to the volcano itself had to be relocated.

What lies ahead?

It is hard to forecast the future development of the eruption. Eyjafjallajökull has erupted three times since the 9th century A.D., in all cases preceding or following an eruption of neighbouring volcano, Katla, which is under Mýrdalsjökull glacier. The danger involved in a Katla eruption is mostly due to glacial burst floods. To-date there has been no indication of an impending eruption in Katla.

At this point nothing can be said regarding further complications. If widespread ash fall persists over an extended period of time the toxic materials in the ash can have adverse effects on vegetation and the health of livestock. Such developments are not unknown in Iceland in certain areas and last occurred in 1980 following an eruption of another volcano [52].

Table 11 : Potential challenges – Volcanic Eruption

Potential challenges – Volcanic eruption	
1	Emergency evacuation in remote/cold climate areas
2	Sudden infrastructure failure, e.g. bridges collapse.
3	Landslide/floods
4	Loss of power
5	Air pollution due to the ash
6	Long term damage to local economic and ecosystems
7	Large scale displacement of people due to air transport disruption over varying lengths of time
8	Economic damage to other industrial sectors and world regions due to ash cloud dispersal around the globe.
9	Ecosystem damage in other world regions due to ash cloud dispersal around the globe

8. Questionnaire for Current and Past Operators

MSB are involved in the civil protection sector and have regular contact within the oil and gas industries and it was decided that this was the most appropriate way to approach the industry and also the most likely route to gather results. A draft questionnaire was prepared by the PRETEAR team and submitted to MSB for conversion to an online form, the existence of which would be notified to known contact by email. The draft questionnaire is shown in Appendix 1. The original draft document was modified slightly by MSB to make it more accessible as some of the language used was thought to be too complicated for non-native English speakers. The revised questionnaire document is attached in Appendix 2.

The results gathered from the questionnaire were extremely disappointing, with no responses at all from the sector. This lack of uptake was discussed in detail at the PRETEAR final project meeting in Stockholm on 4 March 2011. It was agreed by all partners that, although the results were disappointing, it was not really very surprising that no-one wished to commit reports to paper of any incidents. The questionnaire was addressed in a very personal manner which, given the litigious nature of the sector, could place individuals at risk of being seen as 'whistle blowers' within their organisations and could, in a court of law, amount to admissions of culpability.

Under the circumstances it was agreed that a template (used successfully within another project) for a revised version of the questionnaire should be recorded within the project paperwork, but, with the project closing, it was not feasible to create a new project-specific questionnaire template, approach industry again and gather meaningful data for incorporation into the project. Instead the suggested template for a questionnaire document should be stored for future possible application. This revised questionnaire template can be seen in Appendix 3.

9. Summary

As reported in the previous pages, the challenges facing the Arctic region are many and varied. The 'cause and effect' of many of the problems faced by the region is unclear, but preparation for readiness in the event of incidents is clearly a need. The more complete the list of challenges, the more likely it is that both regions and nations can work together to find possible solutions to threats or, at least, be prepared to take action to mitigate the impacts of incidents.

Only through approaching the tasks collaboratively will it be possible to find lasting solutions, so cross-border activity is essential. The challenges identified of this early stage of the PRETEAR project are summarized in the Table 12 below. From this list, the project partners aim is to select a number of challenges representing the largest in terms of volume, impact potential or frequency and develop these through risk assessment, scenario building and identification of training gaps to start the process of addressing the issues.

It is to be hoped that this essential work will continue beyond the end of project PRETEAR to fill more of the needs identified, with funding through various sources.

The project team would like to thank the EU Civil Protection Financial Instrument for co-funding this preliminary work.

Table 12 : Summary of Potential Challenges Concerning All Categories.

Potential challenges - Natural resources	
1	Availability, or lack of availability, of secure infrastructure: routes of access.
2	Possible speed of access to remote locations/installations
3	Underwater pumping (in sea ice conditions) - how is access possible?
4	Access to marine fires for salvage vessels because of remote locations.
5	Icing of equipment and structures on shipping creates stability issues, and containerships are particularly vulnerable.
6	Work conditions on installations/platforms because of temperature conditions.
7	Responses in the event of loss of power lines – cold climate effects on humans.
8	Offshore rescue best practice will have to change (sea ice, more snow, etc).
9	Lack of daylight for exploration, etc.
10	Lack of signal sent and received or small vessels in shadow areas increasing risk of narcotics, weapons, dangerous chemical and illegal goods transportations

	in/out. More radar detecting stations and cooperation from neighbor countries required.
Potential challenges – climate change	
1	Stock management in the event of climate warming / cooling – effects on nomadic lifestyles, social outcomes.
2	Economic, education, issues in cold climate conditions.
3	Sea warming – invasion of other species colonization, effects on indigenous species.
4	Ice melt from Greenland effects on gulf stream will change climate condition.
5	Floods can contaminate drinking water for variable periods of time.
6	More fresh water gradually added to dams can result in sudden dam failure. Dam failure is also a problem in the mining industry.
7	Higher amount of precipitation and warmer climate, forest fires can occur more easily.
Potential challenges – Oil / Gas Exploration and Associated Increased Shipping Activities	
1	Icing of structures on shipping (stability issues) – containerships are particularly vulnerable
2	Oil and gas explosions – deep sea issues – health and safety of all involved
3	Environmental protection with pipeline breakages or similar issues
4	Transportation from deep sea areas to mainland.
5	Corrosion/materials issues – what will be used to replace pipelines?
6	Import of structures for oil and gas industry – effects on infrastructures (road, ships, etc).
7	Terrorism – with increased resource exploitation.
8	Difficulties in managing the oil industry growth and environmental protection still remaining political issues.
9	More melting ice creating shorter routes leading to energy saving for trips and less emissions but drift ice, lack of infrastructure and environmental risks still present serious problems.
10	Effects of incidents on indigenous species – marine and land.
11	Container contents, transportation generally, ballast water issues.
12	More traffic, more pollution and threats, disturbing natural habitat - Laws and regulations amongst neighboring countries are desirable.
Potential challenges – Change in Arctic ecosystems	
1	Extent and type of sea ice as well as the increasing fresh water effecting fish stock, hence seals, polar bears and so on.

2	Effects on ecosystems of exploration/explosions – knock-on effect from natural disasters?
3	Ecosystems – sustainable species management, e.g. fishing …
4	Increasing marine temperature and fresh water effecting weather conditions, changes in fish stock.
5	Colder summer temperatures causing the size, abundance, productivity and variety of plants to decrease.
Potential challenges – Infrastructures	
1	Icing of infrastructure (electricity, etc.). Loss of power and issues related to reconnection because of remoteness and cold climate.
2	Corrosion of pipelines
3	Coastal and landscape erosion, and collapse of permafrost potentially leading to pollution/contamination resulting from town and industrial facilities being flooded with sea water.
4	Remoteness: lack of road access; roads inaccessible because of cold climate and other infrastructure issues leading to access issues
5	Engineering challenges for damaged houses, airports, roads, buildings, pipelines, etc.
Potential challenges – Tourism activities	
1	More people visiting creating more problems; Disturbing wildlife. Polluting the surroundings. Necessitating permanent facilities for transport and accommodation on land.
2	Tourism emergency – what is in place to deal with potential issues.
3	Tourism issues – pollution and people management in the event of incidents.
4	Lack of access to regions with extreme weather conditions such as the sea between Iceland and Greenland.
5	Raising concerns of rescuing injured tourists if things go wrong.
6	The increasing presence of humans fragments vital habitats for wildlife and plants.
Potential challenges – Radioactive waste	
1	Nuclear fuel storage facilities, increasing use of nuclear reactors in marine vessels and power raising concerns of contamination and explosion.
2	Ships with hazardous and radioactive cargo are welcome in Iceland but not in Norway.

3	Radioactive waste, temperature changes can increase corrosion rates.
4	Effects of incidents on indigenous species – marine and land.
Potential challenges – Dangerous goods and substances	
1	Direct leak of dangerous chemical from factories
2	Road/train accidents that result in releasing toxic substances
3	Invisible contaminant in water, air and soil
4	Explosion of explosive materials
5	Fire causing release of toxins
6	Acts of terrorism
Potential challenges – International cooperation and politics	
1	Increased military activities and their effects.
2	Russian test sites for nuclear armaments in the area – what impacts will climate change have on these test sites?
3	Political and border issues.
4	Standards and regulations – cross border access and issues.
5	Access to people who make decisions – political issues.
6	Languages in across-border / mobility context.
Other potential challenges	
1	Energy issues under a situation increased demand – lack of, sources of, new developments.
2	Built environment issues / construction industry.
3	People migration issues.
4	Health and welfare issues with increased populations/migrating population.
5	Management of all of the above.

6	Psychological effects.
7	Common incidents/accidents, e.g. traffic accidents, can represent great problems when they happen in remote areas.
Potential challenges – Volcanic eruption	
1	Emergency evacuation in remote areas
2	Sudden infrastructure failure, e.g. bridges collapse.
3	Landslide/foods
4	Loss of power
5	Air pollution due to the ash
6	Long term damage to local economic and ecosystems
7	Large scale displacement of people due to air transport disruption over varying lengths of time
8	Economic damage to other industrial sectors and world regions due to ash cloud dispersal around the globe.
9	Ecosystem damage in other world regions due to ash cloud dispersal around the globe

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Appendix 1 – Draft Questionnaire

DRAFT QUESTIONNAIRE FOR THE PRETEAR PROJECT

We, at the Norwegian Fire Protection Training Institute, are coordinating a Research Project involving partners from those European Nations having borders within the arctic region entitled "Preparation for threats to to environments in Arctic regions". To support our efforts with realistic assessments of existing conditions in the arctic regions we are seeking information related to the existence of such risks and their perception for the entire range of operations from technical personnel working in Norway.

This on-line survey has been designed to provide us with an initial response from as wide a range of practical experience as possible. The survey is intended as a first cut at establishing the level of understanding of the nature of such risks amongst the technical community and we hope that it will also assist us in the quantification of the problems so that the exercise of assessment of threats we intend to perform can be made in a rational manner.

Ten questions have been devised for personnel working for operating companies in arctic Norway. What are their personal opinions relating to possible effects on communities and individuals within the Norwegian arctic region from damage to environmental features from man made accidents.

There are nine questions in three groups of three questions each and a single final question.

GROUP 1: THREAT

Your company, like every other company which runs an operation, poses a potential threat to its neighbours however small it may be either directly or indirectly through risk of an accidental occurrence in the pursuance of the operation.

QUESTION 1. Would you identify that threat as one which:

a. Is related to a continuous aspect of the company's operation, in effect a chronic threat?

b. Is related to a one-off accidental incident, in effect an acute threat?

QUESTION 2, How would you consider this threat to relate to your company's operations:

a. Directly? For example, a release of toxic material would be directly related to the company's use of a toxic

substance in its operations with a potential for its leakage into the environment from that operation.

b. Indirectly but due to the company's operations? For instance, the company manufactures a dangerous chemical which then poses the threat due to misuse of that chemical by an operator to whom the material has been sold.

c. Incidentally as the result of alteration, by the company's operations, to local circumstances leading to the manifestation of a threat not present before? To take an extreme example to clarify this choice, the company is involved in an operation which attracts public hostility. with the potential for some form of terrorist activity.

QUESTION 3, Do you think that this potential threat from your company's operations is adequately prepared for at:

a. Your company level?

b. Your industry level?

c. Your district level?

d. The national level?

e. None.

GROUP 2 TARGET

The following list identifies 6 potential targets vulnerable to damage which would affect its population which we believe to be relevant to our study:

(a) company employees and neighbourhood communities,

(b) fragile and vulnerable terestial ecosystems,

(c) the natural waterways and marine environments,

(d) neighbouring designated areas of scientific importance,

(e) access infrastructure - roads, railways, waterways, ports and airports,

(f) buildings and structures critical to health, safety and security.

QUESTION 1, Which of these targets within the Norwegian arctic region do you think is the most vulnerable to the potential threat posed

by your company's operations - a to f?

QUESTION 2, Do you think that there are the same or similar targets within the neighbouring arctic areas which might be vulnerable to the potential threat posed by your company's operations - Sweden, Denmark, Finland or Russia?

QUESTION 3, Assuming the alternative perspective of a resident in arctic Norway which of these targets (a to f) do you believe to be the most vulnerable from man made threats emanating from outside Norway.

GROUP 3 RISK ASSESSMENT

Envisage the worst possible accidental incident occurring in your company's operations which would have a potential to cause damage to your neighbourhood in the arctic region of Norway.

QUESTION 1, How often would such an accident happen:

a. Never, that is to say less than once in 10,000 years?

b. Within a generation, that is to say once in 100 years?

c. Within the duration of your employment by the company, that is to say once in 10 years?

QUESTION 2, To what distance from the centre of this accident would damage to the community spread:

a. Reaching beyond the immediate community well into the surrounding areas, that is to say to beyond a distance of 10km?

b. Restricted to within the immediate community, that is to say not beyond a distance of 3km

c. Restricted to within the Company's premisses, that is to say within a distance of 300m?

QUESTION 3, On investigation of this accident, if it were to happen, would you expect to find, without laying the blame on any individual, that:

a. The accident was due to a failure in the equipment - for instance the rupture of a pipeline leading to a fire?

b. The accident was due to a failure in how the operation was performed - as exemplified by the deliberate choice on economic grounds of a high risk route for the product manufacture in preference to an alternative safer route?

c. The accident was due to a failure in how the operation was managed - a simple example being the absence of any Safe Work Permit system for an operation handling flammable fluids?

FINAL QUESTION

What would you, as a resident rather than an operator, like to see happen in this arctic region with respect to its preparation for circumstances involving the threat to the community from such an event?

a. Nothing, leaving the problem to your company, in the first instance, and other operators to solve?

b. A review of how existing circumstances affect the risk of such an event and how changes and trends in change may alter this risk in the future so that defences can be determined now and put in place in a timely manner?

c. Support for a study which not only performs the tasks set out in solution (b) above but also prescribes a long term approach to preparation for threats in arctic regions with cooperation from the neighbouring countries?

Appendix 2 – Final Questionnaire

Questionnaire for the PRETEAR project

We, at the Norwegian Fire Protection Training Institute, are coordinating a Research Project involving partners from those European Nations having borders within the arctic region entitled "Preparation for threats to environments in Arctic regions". To support our efforts with realistic assessments of existing conditions in the arctic regions we are seeking information related to the existence of such risks and their perception for the entire range of operations from technical personnel working in this area.

This on-line survey has been designed to provide us with an initial response from as wide a range of practical experience as possible. The survey is intended as a first cut at establishing the level of understanding of the nature of such risks amongst the technical community and we hope that it will also assist us in the quantification of the problems so that the exercise of assessment of threats we intend to perform can be made in a rational manner.

Ten questions have been devised for personnel working for operating companies in the Arctic region. What are their personal opinions relating to possible effects on communities and individuals within the Arctic region from damage to environmental features from man made accidents?

.

There are nine questions in three groups of three questions each and a single final question.

Your identity will be hidden

Read about hidden identity. (Opens in a new window)

GROUP 1: THREAT

Your company, like every other company which runs an operation, poses a potential threat to its neighbours however small it may be either directly or indirectly through risk of an accidental occurrence in the pursuance of the operation.

1) QUESTION 1. Would you identify that threat as one which:

- Is related to a continuous aspect of the company's operation, in effect a chronic threat?
- Is related to a one-off accidental incident, in effect an acute threat?

2) Comments

3) QUESTION 2. How would you consider this threat to relate to your company's operations:

- Directly? For example, a release of toxic material would be directly related to the company's use of a toxic substance in its operations with a potential for its leakage into the environment from that operation.
- Indirectly but due to the company's operations? For instance, the company manufactures a dangerous chemical which then poses the threat due to misuse of that chemical by an operator to whom the material hasbeen sold.
- Incidentally as the result of alteration, by the company's operations, to local circumstances leading to the manifestation of a threat not present before? To take an

extreme example to clarify this choice, the company is involved in an operation which attracts public hostility with the potential for some form of terrorist activity.

4) Comments

5) QUESTION 3, Do you think that this potential threat from your company's operations is adequately prepared for at:

- ☐ Your company level?
- ☐ Your industry level?
- ☐ Your district level?
- ☐ The national level?
- ☐ None.

6) Comments

GROUP 2 TARGET

The following list identifies 6 potential targets vulnerable to damage which would affect its population which we believe to be relevant to our study:

(a) company employees and neighbourhood communities,
(b) fragile and vulnerable terestial ecosystems,
(c) the natural waterways and marine environments,
(d) neighbouring designated areas of scientific importance,
e) access infrastructure - roads, railways, waterways, ports and airports,
(f) buildings and structures critical to health, safety and security.

7) QUESTION 1, Which of these targets within the arctic

region do you think is the most vulnerable to the potential threat posed by your company's operations?

- Company employees and neighbourhood communities,
- Fragile and vulnerable terestial ecosystems,
- The natural waterways and marine environments,
- Neighbouring designated areas of scientific importance,
- Access infrastructure - roads, railways, waterways, ports and airports,
- Buildings and structures critical to health, safety and security.

8) Comments

9) QUESTION 2, Do you think that there are the same or similar targets within the arctic areas which might be vulnerable to the potential threat posed by your company's operations - Sweden, Denmark, Norway, Iceland, Finland or Russia?

10) QUESTION 3, Assuming the alternative perspective of a resident in the Arctic area which of these targets (a to f) do you believe to be the most vulnerable from man made threats.

- Company employees and neighbourhood communities,
- Fragile and vulnerable terestial ecosystems,
- The natural waterways and marine environments,
- Neighbouring designated areas of scientific importance,

- Access infrastructure - roads, railways, waterways, ports and airports,

- Buildings and structures critical to health, safety and security.

11) Comments

GROUP 3 RISK ASSESSMENT

Envisage the worst possible accidental incident occurring in your company's operations which would have a potential to cause damage to your neighbourhood in the arctic region.

12) QUESTION 1, How often would such an accident happen:

- Never, that is to say less than once in 10,000 years?

- Within a generation, that is to say once in 100 years?

- Within the duration of your employment by the company, that is to say once in 10 years?

13) Comments

14) QUESTION 2, To what distance from the centre of this accident would damage to the community spread:

- Reaching beyond the immediate community well into the surrounding areas, that is to say to beyond a distance of 10km?

- Restricted to within the immediate community, that is to say not beyond a distance of 3km

- Restricted to within the Company's premisses, that is to

say within a distance of 300m?

15) Comments

16) QUESTION 3, On investigation of this accident, if it were to happen, would you expect to find, without laying the blame on any individual, that:

☐ The accident was due to a failure in the equipment - for instance the rupture of a pipeline leading to a fire?

☐ The accident was due to a failure in how the operation was performed - as exemplified by the deliberate choice on economic grounds of a high risk route for the product manufacture in preference to an alternative safer route?

☐ The accident was due to a failure in how the operation was managed - a simple example being the absence of any Safe Work Permit system for an operation handling flammable fluids?

17) Comments

FINAL QUESTION

18) What would you, as a resident rather than an operator, like to see happen in this arctic region with respect to its preparation for circumstances involving the threat to the community from such an event?

● Nothing, leaving the problem to your company, in the first instance, and other operators to solve?

● A review of how existing circumstances affect the risk of such an event and how changes and trends in change may alter this risk in the future so that defences can be

determined now and put in place in a timely manner?

- Support for a study which not only performs the tasks set out in solution (b) above but also prescribes a long term approach to preparation for threats in arctic regions with cooperation from the neighbouring countries?

19) Comments

Appendix 3 – Suggested Questionnaire Template

INTERVIEW TEMPLATE

Requirements

PATCH PROJECT

"Personal biological Aerosol Tester for exposure Control with High efficiency"

Attendee(s) name:

Function:

Company:

Interviewer:

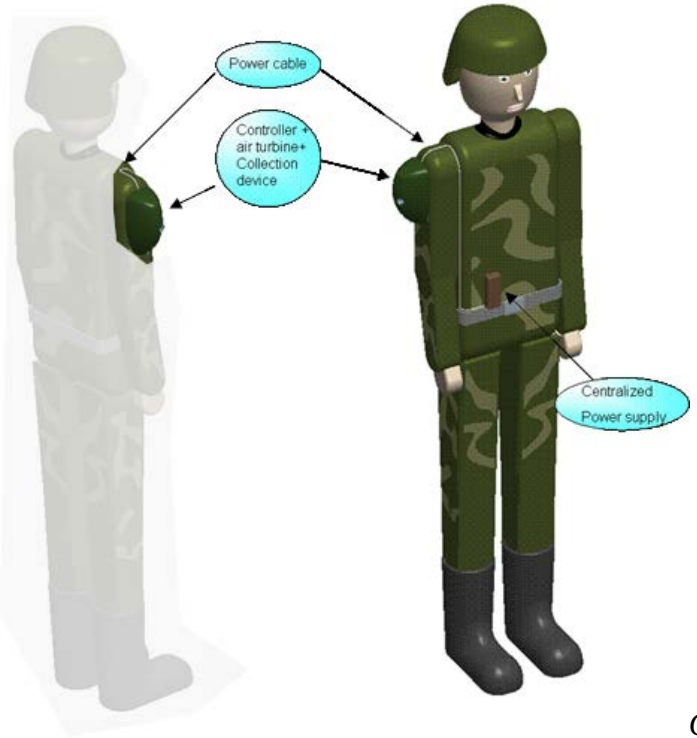
Date:

PATCH Project summary and objectives of the project

The PATCH project is aimed at using new developments in nanotechnology for the design and development of a novel **"Personal Biological Aerosol Collector for Exposure Control"**.

The objective is to provide a small, portable and robust device that can be integrated with the soldiers' combat suit, for collecting biological aerosols that he/she may be exposed to during a mission.

This device can help answer the question "Was the operator exposed during the mission?"



Concept example

This device will allow for the discovery of airborne biohazards and will provide direct individual exposure information so that appropriate medical treatment can be administered as soon as 24 hours after inhalation.

The consortium of this project is composed of six partners (TECNALIA, IFB, EADS-IW, ITM, CNRS/ENS, BERTIN TECHNOLOGIES), from four European countries (Spain, Slovenia, Germany, France), well-balanced in terms of companies, universities and research centers, many of which with decades of experience in the biological field.

1. Scenario

The interviewee has to describe a scenario type for which the use of a biodosimeter presents a strong interest. Our objective is to develop a device dedicated to military application; so try to focus the interviews on this scenario.

The second goal of these interviews can be to identity others needs but it's not the priority.

- Mission Duration (= sampling time):

……

- Where (= characterisation of the site):

- Industrialized site? Countryside? Forest? Mountains? Desert? Rivers? Sea?
  ……
- Opened or closed site? (building, outside, industrial site, subway, tunnel,…..)
  ……
- Dimensions in kms: ……
- Altitude: ……
- ……

❖ Environmental conditions:
- Temperature: ……
- Humidity: ……
- Dust environment? ……

❖ Constraints of the mission:

……

❖ End of the mission:
- Decontamination protocol on devices?

……

- Decontamination protocol on clothes?

……

- Decontamination protocol on operators?

……

- Where? Site well equipped for samples analysis (PCR, immunoassay, culture, GC/MS, flow cytometry and microscopy…..)? If no, is there a close laboratory?

……

2. Operators
   - Who?

❖ First responders
❖ Police
❖ Army
❖ Security members (RATP, SNCF,…)
❖ Others

……

- Suit / clothes description

❖ Free space for the integration of the device?: description,……
……
❖ Power supply
  - Centralized energy? Location? Available energy?
    ……

- Batteries type: ……..

❖ Picture available?

3. Description of the ideal device

❖ Autonomy: ……..
❖ Sampling time: ……
❖ Size (similar to a mobile phone?):
……..
❖ Weight: ……..
❖ Particles / micro-organisms of interest:
……
❖ Power consumption: ……..

4. Current solutions? Description
❖ Advantages:
……
❖ Drawbacks
……

❖ Collection of chemical (e.g. VOCs, formaldehyde, ethylene oxide, inorganic mercury, sulfur dioxide)? Capture of radioactive, explosive and toxic particulates? Which device?
……
5. Other person to be contact?
……

6. Suggestions of the interviewee / Discussion
……