ARCTIC SAFETY AND CHALLENGES

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Norway has a long tradition as a maritime nation. Fishery and shipping have been, and still are, important contributors to the Norwegian economy. Fishing and shipping are also associated with a degree of risk. According to the Joint Rescue Coordination Centre (JRCC), we have twice as many accidental cases on the sea now as compared to 15 years ago (Grønnestad et al.2018). We have the recent years also experienced an increasing human presence in the Arctic, through marine transport, oil and gas related activities, research and education projects, tourism, fishery and other maritime activities. Commercial- and tourist organizations are increasingly looking for business opportunities in the Arctic.

However, the Arctic waters, due to remoteness, limited infrastructure and harsh and dynamic climatic conditions are challenging for safe maritime activity, making preparedness a key factor for maritime operations under these conditions. Thus, there is a need to build special Arctic preparedness competence and capacities, including around Svalbard.

Empirical findings stem from data collected from several preparedness exercises in the maritime environment around Svalbard, the IMO Polar Code requirement regarding survival following a shipwreck in Arctic waters and reports following accidents in these waters.

The article starts with a presentation of challenges of operating in Arctic waters and then follows a presentation of the preparedness concept, with particular emphasis on the preparedness phases which will include training and exercises. The findings are then discussed in relation to the preparedness concept. We conclude with the need for preparedness structures that reflects the special conditions for operating in Arctic waters.

Preparedness and rescue capacities in Arctic waters: the case of the Northguider

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Keywords: Arctic waters, Shipwreck, Polar Code, Preparedness

28. December 2018 the trawler Northguider grounded in the Hinlopen strait, in Svalbard, while trawling for shrimps. All 14 crewmembers were rescued in a dramatic rescue operation. In light of this shipwreck, this paper examines the special challenges for operating in Arctic waters, and the special requirements for safety and preparedness to meet these challenges.

A foundation for the article is the preparedness requirements specified in the international code for ships operating in polar waters - the Polar Code (IMO, 2014) and the following demands for the ship owners' own preparedness when operating in Arctic waters. This discussion is based on a conceptual framework of preparedness.

This paper questions the level of preparedness resources in Arctic waters available for a prompt and efficient response following a shipwreck, both related to the ship owners own preparations, but also the availability of Norwegian government rescue capacities.

The empirical findings stem from experiences and observations from search and rescue operations and exercises, including exercises in Arctic waters (SARex2 and SARex3) and on literature reviews on the Northguider shipwreck, on the special challenges of operating in Arctic waters, on the Polar Code and on Norwegian reports (ref SARiNOR) on safety and preparedness measures in the Arctic.

The main findings point out that there seems to be a gap between the various maritime actors desire to operate in Arctic waters, and their preparedness structures, and the available public and private preparedness resources available should a shipwreck or other acute situations occur.

Survival through teambuilding following a shipwreck in Arctic waters

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***Keywords*:** *Polar code*, Arctic waters, Shipwreck, Survival, Team

19. June 1989, the Soviet cruise liner Maksim Gorkiy hit an ice floe in Arctic waters, Northwest of Spitsbergen, Svalbard. The passengers and parts of her crew abandoned the ship, in lifeboats. A massive rescue operation followed. Some 700 crew and passengers were rescued, in addition to the ship. This is only one of several examples of serious shipwrecks in Arctic waters.

This paper examines the special challenges following a shipwreck in Arctic waters, through the requirements spesified in the international code for ships operating in polar waters - the Polar Code (IMO, 2014) and the theoretical lenses of teamwork, sensemaking and resilience.

The paper aims to study how teamwork among a group of strangers may contribute to the groups sutvival following a shipwreck in Arctic waters.

The empirical findings stem from likterature surveys and experiences and particpant observations from a life raft exercise in Spitsbergen early May 2017, the SARex2-exercise (Solberg, Gudmestad, & Skjærseth, 2017), and literature review on special challenges of operating in Arctic waters.

The article starts with a presentation of challenges of operating in Artic waters, and some relevant parts of the Polar Code. Then the conceptual frameworks of the study is presented. Then follows a presentation of the SARex2 exercise and a discussion of “roads” to resilience following a shipwreck in Arctic waters. Finally, some concluding remarks are presented, on how to transfer a group of strangers into a team required for survival after a ship wreck in Arctic waters.

Vessel of Opportunity

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***Keywords*:** Arctic, expedition cruise traffic, maritime operations, accidents and incidents, search – and rescue, resources, cooperation.

Abstract

A vessel of opportunity is a vessel close enough to aid a vessel in distress. Under international law, every vessel at sea is required to assist in a distress situation. If the ship receiving the distress alert is unable to assist, for example because the ship does not have enough fuel to reach the vessel in distress, the ship must inform the appropriate search and rescue (SAR) service accordingly. The vessel of opportunity can be released from the obligation to assist if the vessel in distress or search and rescue responders informs them that their assistance is not needed.

The Arctic is characterized by long distances and limited search and rescue capabilities. Vessels of opportunity can be an invaluable asset in SAR operations in the Arctic. In many cases, a vessel of opportunity will be able to reach a vessel in distress long before search and rescue vessels or other assistance can arrive on site. In the summer months, expedition cruise ships sailing in Arctic waters represent a great resource for preparedness and response. Not only are these vessels present in remote locations far from other search and rescue assets, the ships also carry equipment, supplies and personnel that enable them to make a significant contribution to SAR operations. Cruise ships carry food, water, medical supplies, and may have doctors, numerous high-speed small vessels and other resources onboard that are useful in SAR operations.

Tabletop exercises organized by AECO and SAR entities have shown that there is a potential for making better use of the resource that cruise ships represent. Increased dialogue between SAR entities and operators and vessel owners will give a better understanding of available resources, needs and operational requirements. AECO is working with Arctic SAR entities to facilitate this dialogue. One important platform for collaboration is the Joint Arctic SAR Tabletop Exercise and Workshop, which AECO organizes annually in collaboration with the Icelandic Coast Guard and Joint Rescue Coordination Center Northern Norway. AECO is also one of 21 international partners in the international ARCSAR (Arctic Search and Rescue) project, which will include a live exercise on a cruise vessel.

AECO, the Association of Arctic Expedition Cruise Operators have 70 international members operating more than 50 expedition cruise vessels in the Arctic.

This presentation will present Arctic cruise tourism, measures to ensure safety and especially focus on the potential for making better use of the resource that cruise ships represent and their role as vessel of opportunity. The presentation will also shed light on how AECO is working to achieve this by facilitating dialogue and cooperation between the expedition cruise industry and search and rescue entities.

THE ROLE OF AGREEMENTS UNDER THE AUSPICES OF THE ARCTIC COUCIL IN BUILDING SAFETY IN THE REGION

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Keywords: *Arctic safety*, *Arctic Council*, *Arctic Agreements*, *Arctic Cooperation*

Preventing and fighting emergencies is one of the most protracted cooperation areas within the framework of the Arctic Council. It is no accident that all three legally-binding agreements, that were concluded by the eight Arctic States under the auspices of the Arctic Council, have direct implication to safety measures in the region. Those agreements are: Agreement on Cooperation on Aeronautical and Marine Search and Rescue in the Arctic (2011), Agreement on Arctic Marine Oil Pollution Preparedness and Response (2013), and Agreement on Enhancing International Arctic Scientific Cooperation (2017) respectively. By looking at these agreements, this paper first investigates how they have contributed to safety across the Circumpolar North. It argues that despite some challenges in place, the implementation of all three documents is essential in dealing with hazards associated with search and rescue, the issue of readiness – (technical capabilities, trained staff, contingency plans, etc.) to fight marine oil spills. It further shows how these documents serve as instrumental measures for cooperation in managing search and rescue operations, marine oil spills, sharing of best practices and scientific knowledge relevant to the issues of Arctic safety. My paper also analyses how practical implementation of these agreements, could be important for their further re-thinking and evolvement in dealing with safety in light of current changes taking place in the Arctic rim.

AVALANCHE WARNING IN SVALBARD

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Keywords: *Avalanche warning, avalanche forecasting, risk management, climate change, Varsom.*

Svalbard has an extensive avalanche problem. Avalanches pose a real threat to roads, ski lift, snowmobile tracks, airport, infrastructure and buildings, including houses, apartment buildings, schools, hotels and restaurants. Avalanche risk is inherent to field-based activities such as backcountry skiing, snowmobiling and dog sledging. Researchers, students and travel operators have to consider avalanche risk when planning and conducting field-based activities. Since 2000, seven people have died in five avalanches: Five on snowmobiles (4.2.2001, 22.3.2004, 15.3.2009, 24.1.2015) and two in buildings (19.12.2015). NVE and UNIS launched a public avalanche warning service for Svalbard on Varsom.no in February 2016, after a test period in April 2015: UNIS doing field observations and NVE forecasting. The 2015 accident also prompted a local warning in Longyearbyen, launched a few days after the accident.

Public warnings are published daily for the region Nordenskiöld Land on Varsom.no from December to May, based on 2-3 observations weekly. For the rest of Svalbard and the rest of the season, warnings are issued for danger level 4 or 5 and based on no or few observations. Methods and organisation used are the same as for the 21 regions on mainland Norway. However, when natural release of avalanches size 3 or larger is expect in Nordenskiöld Land, a forecaster is tasked to forecast for 23 avalanche paths threatening houses until the situation is normalised. Local warnings use observations in and around Longyearbyen (2-3 observations weekly at fixed locations, laser scanning and automatic stations), as well as regional observations. NGI and Skred AS assisted in running the local warnings. In 2019, Skred AS started doing the local warnings together with UNIS. From December 2016 to January 2019, 433 regional warnings were published for Nordenskiöld Land and 32 for other regions. The Governor received 39 written and 5 at-location local warnings during a total of 17 periods from the accident in December 2015 to the end of January 2019. 1558 manual field observations were submitted on Varsom Regobs (www.regobs.no).

Public and local warnings were established quickly. Recruitment and training of observers were crucial, as was collaboration with UNIS and end users. Site-specific challenges included the polar night that places special demands on equipment (night vision) and measures to safeguard the observer's work (pre-planned observation routes). An evaluation of the local warning concluded that a short/clear message with detailed documentation of the assessment ensures effective communication during a situation and allows for an analysis afterwards. It was recommended to pay more attention to uncertainty (due to climate change and limited observational history) and quality assurance (due to reliance on few experts) in the warning process, and be aware that severe wind in combination with loose snow may cause a very rapid increase in avalanche danger. An evaluation of the regional warning concluded that it had improved civil preparedness and avalanche competence/awareness in Norway, and probably prevented loss of lives.

Norway-Russia disaster diplomacy:

A case study of Svalbard

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***Keywords*:** disaster diplomacy, diplomacy, disaster risk reduction, Svalbard, Russia

Disaster diplomacy is a field of research examining how addressing disasters before, during, and after does and does not impact diplomatic collaboration, peace, and conflict. So far, investigations of case studies across hazards, vulnerabilities, risks, and disasters have not found instances where new, lasting diplomacy was created over the long-term. Short-term catalysis of some ongoing diplomatic processes are evidenced. The work here uses a case study of Norway-Russia relations on, for, and around Svalbard to examine how disaster-related activities might be used, or should not be used, more to foster peaceful links between Norway and Russia.

Three disaster scenarios are considered to see how Norway-Russia relations might be helped, be hindered, or be unaffected. One scenario is oil spill emergency management, building on the extensive work, training, and experience already available. The two others have had little work so far. First, radiation release from a ship, which might be a nuclear-powered vessel or might be transporting nuclear waste. Second, a disease outbreak in Barentsburg.

No evidence is found of new Norway-Russia diplomacy being generated as a result of disaster-related activities for these three scenarios. Nor do prospects appear for how this might happen, at least in the immediate future. Longer-term influences and influencers are harder to determine. Consequently, this case study so far confirms the disaster diplomacy conclusions that disaster-related activities sometimes catalyse diplomacy in the short-term while, over the long-term, other factors supersede risk and disaster imperatives.

One possible pathway forward is to consider science diplomacy more. Currently, environmental monitoring, observation, risk analysis, and safety science represent key scientific collaborations around Svalbard. Other research on the archipelago relevant to disasters includes political science, heritage, tourism, social impacts of climate change, and higher education. Even though strong scientific collaboration continues between Norway and Russia, it seems unlikely to spillover into other realms, with science diplomacy thus also supporting the main disaster diplomacy conclusions.

SAFETY IN SIOS

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Keywords: *International collaboration, field safety, Svalbard*

SIOS is an international consortium of research institutions that conduct Earth System Science (ESS) research and own research infrastructure in Svalbard and surrounding waters. Currently 26 research institutions from 11 countries are members or observers of SIOS. These institutions cooperate to create an integrated observing system for ESS, in which core variables are measured over time and made available to all members of the consortium. By sharing data, infrastructure and knowledge, SIOS members seek to optimise the existing research infrastructure and make joint decisions on priorities.

Access to the research infrastructure owned by SIOS members is organised through the SIOS access programme (https://sios-svalbard.org/RIAccess). The annual calls for access allow researchers from within SIOS, as well as external users, to apply for funded access to the facilities and services offered by SIOS members. All of the facilities offered in the SIOS call for access are located in the Svalbard archipelago in the High Arctic. Some are located in towns or research settlements while others are remote field stations. Due to the many safety considerations when conducting field research in the Arctic, the participants in the SIOS access programme are required to submit a basic risk assessment along with their application. This allows the evaluation panel and facility owner to make a judgement on what experience and skills are necessary to carry out the project, and – based on that – what safety training the project participants require. SIOS always offers funding for safety training as part of the allocation for accepted projects.

Presently, there is no standard way that field safety is handled within SIOS. It is challenging to reach consensus on safety procedures in such a large and international consortium. Each institution that is responsible for infrastructure has its own safety rules and procedures in place. Some SIOS members take on full responsibility for the safety of researchers using their facilities, but in most cases the person in charge of the project is responsible for the safety of all participants. Due to such differences it is difficult for SIOS to establish and operate a standard set of procedures that apply to all SIOS facilities. As such, it can be difficult for users of the access programme to understand what is expected of them and what they can expect from SIOS. On the other hand, SIOS members collectively have a large amount of knowledge and experience of safe working in Svalbard which could be a resource for the community.

A workshop on safety in SIOS was held in January 2019. The aim was to establish some common ground among SIOS members on how SIOS can and should support members on the safety aspects of Arctic research. This presentation will examine in further detail the challenges faced, and the discussions and the eventual outcomes of the workshop.

On the Concept of Risk and Its Application in the Complex Operational Conditions

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***Keywords*:** Risk index, Arctic, Consequnce, Hazard identification, Survivability

Risk is perceived differently in different countries, different cultures, and different organizations. The complexity can be seen more when it comes to quantify the risk and specially with the models that define the risk. The main difference in these models are parameters that has been chosen to define the risk index. The most dominant model that is used to quantify the risk is the probability of failure multiplied by the consequence of the failure. Theses consequences can be short or long-term effects of failures. Although, with this many different risk indexes, there is a need for a more comprehensive risk index that can be used by different stakeholders dealing with different type of hazards. On the other hand, developed risk index should be enough flexible to be able to be understood and adapted in different sectors that use risk as a basis of working. To do so at first there is a need for a complete understanding of the current state of the risk model and how the risk is perceived around the world. This is possible by conducting a literature review in the concept of risk and risk models; this paper has done a systematic literature review on the risk concept and models. After conducting the literature review and the understanding over the concept of risk and risk models, a new risk index will be developed. This new risk index consists of Consequence of failure, probability of hazard occurrence and, survivability is used as the main term of developed risk index. Survivability consists of three new parameters, technology readiness level (TRL), integration readiness level (IRL) and crew readiness level (CRL).

Business continuity management in Greenland

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***Keywords*:** Business continuity; risk management; Emergency response; mining (10 font size)

The literature on business continuity is sparse when it comes to the Arctic. With the growing interest in developing mining projects in Greenland, the need for knowledge about how to handle critical incidents is increasing. The Greenlandic context provides an excellent setting for studying the clash between business interests in small resource-rich nations—an environment which differs significantly from any other place on earth—and the civil society groups concerned about the presence of an extractive industry (Hansen, Vanclay, Croal & Skjervedal, 2016; Horowitz, 2010; Perner et al., 2010; Rosing et al., 2014). The capacity of national emergency preparedness in Greenland is designed to meet the needs that exist today but will need to be strengthened if it is to be able to handle incidents involving several hundred people, hundreds of kilometres away at one of these mining sites. There is, therefore, a need for companies operating on the fringes of Greenlandic society to develop systems and procedures that can not only protect themselves and their stakeholders but also form part of a resource that authorities, communities, and other companies can draw on. The study investigates four mining operations in Greenland that are either in production, under construction, or in the planning phases to determine their level of preparedness and organisational resilience to events that can affect business continuity. Three types of uncertainties are salient in connection with the companies' business continuity capacity. First are value chain risks that can affect the company's ability to carry out its processes (Dobretsov & Pokhilenko, 2010; Kuokkanen, 2018; Rendu, 2017). Second are risks arising from the companies' relationship with the local community directly affected by company activities (Calvano, 2008; Taarup-Esbensen & Movsisyan, 2018). The third are risks that relate to society in general, where groups either support or oppose these types of activities because of their environmental, social, or cultural effects (Hansen et al., 2016; Smits, van Leeuwen & van Tatenhove, 2017). The study finds that mining companies in Greenland are exposed to all three types of business continuity risks.

Creating value and becoming efficient is difficult under Arctic conditions as conditions can change in a short period. This means that companies, with experience in mining but who know less about working in the Arctic tend to overestimate their capabilities. For example, a gold mine in Nalunag opened, closed, and reopened several times owing variously to company mismanagement or bankruptcy as a consequence of the high cost of doing business even in some of the milder regions of the country. In 2018, Ironbark tried to convince investors that their zinc project was feasible by sailing an ore ship into Citron Fjord in the northern part of the island. However, the ship made it only to the entrance of the fjord before it had to turn back due to icy conditions. There have also been risks associated with gaining legitimacy with local communities. While the idea of gaining access to employment is appealing to most Greenlanders, there are concerns about the arrival of migrant workers to often very small villages and towns, the environmental impact, and whether the companies are sufficiently prepared for the conditions in which they are going to conduct their operations. Finally, there have been concerns on a political level regarding whether the companies have done sufficient due diligence and have the experience needed to ensure their project is economically viable. Having had more than 70 mining companies engaging in activities in Greenland but only one functioning mine has made politicians and government administrators question mining companies' capabilities and competencies. At this time, there have been no major incidents involving mining companies, but there is a growing concern that when projects mature so will the scale and scope of business continuity challenges

that they will need to address. Based on the findings, it is recommended that more research investigate business continuity under Arctic conditions, the role of private-public partnerships in emergency response, and how mining communities can strengthen their resilience.

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Performance measurement and management in the dynamic Arctic region

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Keywords: Performance measurement, Arctic operational conditions, Reliability, Maintainability, throughput capacity

The Arctic has unique and challenging operational conditions with strict regulations and requirement for safety and environment. Design for the Arctic is challenging where lack of data, experience and clear understanding regarding the operational conditions may increase the uncertainty significantly. The concept of performance measurement is used frequently by stakeholders to control their objectives and goals. Performance measurement is an essential tool provides information to evaluate and compare design criteria with the past results or other companies. However, a review of available studies about performance measurement shows that different stakeholders and operators use different measures to quantify and describe the performance measurement of their production facilities and there is no common understanding regarding the performance measurement. The most dominated concept for describing the performance of a system is throughput capacity and the main terms of performance are reliability, maintainability and maintenance support. However, throughput capacity is though important, but it is not enough to reflect the performance of system working in the complex and dynamic operational condition like the Arctic area. Moreover, some important elements like those that financial performance and sustainability are absent.

This paper attempt to identify the shortcomings in the integrated performance frameworks for the Arctic and discuses effect of the Artic operational condition on different element of performance measurement. Moreover, we are introducing a modified performance measurement as a term that can deal with the dynamic operational condition of the Arctic.

THE ROLE AND DEVELOPMENT OF TRUST IN EMERGENCY PHASES

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***Keywords*:** emergency management phases, inter-organizational trust, swift trust, trust development, Arctic sea region

This study aims to explore the roles of inter-organizational trust and process of trust development across phases of emergency management, and to develop a framework of trust in emergency management. To achieve this, a critical case study of the cross-national Arctic sea region, with mainly qualitative data from civil and military organizations, is conducted. Regarding the role of trust, the study identifies that inter-organizational trust influences the outcome of emergency operations because it helps the involved organizations to work more safely together under command and control in responses, to develop competence regarding each other, to learn from experiences and to overcome vulnerability. Consequently, inter-organizational trust may positively impact the collaborative response and the quality of emergency management. The role of trust in the different phases is summarized in table 1.

Table 1. The role of inter-organizational trust in Emergency Management (EM)

Phases of EM	**Preparation**	**Response**	**Evaluation**
The role of inter-organizat-ional trust	Improves coordination, collaboration, communication, information sharing and preparedness. Reduces conflicts.	'Lets the I become we' Enable different organizations to act cooperatively. Improves reliability and openness and the overall response quality.	Improves learning from response experiences in general and from mistakes in particular.

Regarding the process of trust development, the study identifies that the preparation phase contributes in developing inter-organizational trust, in particular by joint table-top exercises and joint training programs. Moreover, the response phase contributes highly in developing swift inter-organizational trust. Finally, the evaluation phase has huge potential to use this swift and fragile trust to develop more resilient inter-organizational trust, but due to the low priority of this phase in our case, this potential is hardly utilized.
To develop a framework of trust in emergency management, a process model is developed. This model is combining the model from Schilke and Cook (2013), for the cross-level development of trust and relationships in Emergency Management and Gausdal's (2013) five trust building processes. The model includes the phases, relationship stages, trust building processes and levels of trust.

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The Lion and the Bear: Norway and Russia's Unique Arctic Cooperation is a Model of Risk Reduction

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Keywords: Safety at Sea, Risk Reduction, Arctic Cooperation, International Agreements, International Cooperation

The Arctic is a region that is experiencing extraordinary environmental changes as a result of climate change. As the ice melts, the previously inaccessible is accessible. These changes, coupled with the Arctic's extraordinary potential as both a transport corridor and natural resource base, are driving an increase in both activity and risk. Norway and Russia's relationship in the Barents region is a replicable model of Arctic cooperation that reduces the risk of a maritime disaster and increases sustainability.

The project started with the following three questions: 1) How are agreements in the Barents Sea implemented at the "street level" by cross-border agencies?; 2) How is the Russian and Norwegian relationship in the Barents Sea insulated from disputes outside the region?; and 3) How effective is the Barents Vessel Traffic Management and Information System (VTMIS) and could a similar service be implemented in the Bering Strait Region? Forty-one expert interviews conducted over a four-month period in 2018 serve as the foundation of this report. Interviewees were promised confidentiality. The interview data are supported by a broad literature review that includes popular media, books, peer-reviewed journal articles, government reports, and international agreements. Additionally, the research is supported by extensive travel in the Barents region. This broad qualitative study provides a multi-faceted approach to answer the research questions. All interviewees have been afforded the opportunity to comment on the report and their feedback has been incorporated into the final product.

The research demonstrates that the Barents cooperation at sea and in adjacent land areas is both broad and successful. Cooperation between the two partners in the broader Barents region includes health, economics, the environment, fisheries, nuclear waste cleanup, oil spill prevention and response, search and rescue, and a visa-free area. This cooperation continues despite increased tensions between Norway and Russia after Russia's illegal annexation of Crimea. A majority of the interviewees supported the idea that at least part of the relationship between Norway and Russia could be viewed as a model. Interviewees stressed both the importance of the apolitical nature of the cooperation and the fact that the cooperation is multilayered with street-level bureaucrats who are empowered to act within their respective area of expertise. Interviewees noted that that the most successful cooperation is occurring in safety at sea which includes joint exercises, Coast Guard cooperation, and the Barents VTMIS. When asked if the relationship was replicable the interviewees noted that the agreements, joint management of fisheries, safety at sea, and multi-level and decentralized cooperation at the street/expert level could be replicated elsewhere.

The Norwegian and Russian model of decentralized cooperation by "street level" experts, that is wrapped by both bilateral and multilateral cooperative structures, reduces the risk of a maritime disaster in the Barents Sea. Of particular interest is Norway and Russia's cooperation in activities related to safety at sea: to include multiple annual joint exercises, search and rescue, and the Barents VTMIS. The data demonstrate that Norway and Russia's relationship is durable, extensive, multilayered, and replicable. This model of

[1] The views and opinions expressed here are those of the author and do not necessarily reflect the official policy or position of the U.S. Coast Guard, the Department of Homeland Security, or the United States government.

cooperation could be used to reduce the risk of a maritime disaster in other shared marine areas in the Arctic that are working to mitigate the increased risk associated with increased activity.

DEVELOPING DECISION MAKING CAPABILITY FOR CRISIS MANAGEMENT UNDER CONTEXT COMPLEXITY

- # A CASE STUDY FROM AN OIL- AND GAS LICENSE HOLDER ON THE NORWEGIAN CONTINENTAL SHELF

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***Keywords*:** Capabilities in crisis management, decision making, standard operating procedures, improvisation, Arctic oil- and gas production,

Abstract: This paper examines a development strategy of decision making capabilities in crisis management under context complexity.

In recent years, several oil- and gas organizations have experienced crisis-like scenarios (e.g. Macondo, In Amenas hostage crisis), which have led to increased awareness within the industry. The study focuses on the Norwegian subsidiary as well as the International headquarters of a multinational oil- and gas company. The article analyses the efforts and structures with regards to their development of crisis management (subsidiary strategic level and Headquarters level). An empirical qualitative single case study approach is chosen. Data is stemming from multiple data sources and includes among others 19 semi-structured interviews.

The development of capabilities on crisis management level underlays constraints due to the day-to-day management tasks of the managers who will only act on their crisis-specific decision making roles during crisis. This stands in contrast to tactical and operational levels (emergency management and incident management) who are exposed to obligatory education and extensive relevant training schemes to perform their roles during an emergency.

The studied organization has dedicated professionals who have put procedures for their crisis management system in place, in case there is an emergency with potential to lead to a crisis. The study assesses how these professionals and managers evaluate the potential of established standard operating procedures (SOP), possible limitations and the potential necessity for improvisation in selected areas. Analysis suggests, that improvisation is regarded as an important decision making capability on crisis management level under context complexity, however way less than it is often described for incident- and emergency management level.

With limited resources to prepare for crisis management, the organization actually focuses on training and developing the SOP as a base. This can be seen in contrast to recent studies in the area of crisis management which have recommended more training in improvisation and somewhat disregarded the

existing improvisation literature (general management, jazz,...) which demands extensive knowledge of a course of defined actions to be able to improvise. Hence, the contribution of this study is, that with limited resources available, putting SOP in place as well as understanding the boundaries of tacit knowledge on procedures and processes, needs to be regarded even more as a pre-requisite for developing flexibility for decision making in crisis management and for improvisation.

Analysis of Arctic Safety Incidents

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***Keywords*:** Arctic; Safety Management; Incidents; Incident Analysis

The Arctic is increasingly becoming an important area in Industry, Science, Tourism, and Education. With the increased activity, the number of accidents is increasing and causing a demand for better safety management. It is found that little research into the topic is previously conducted. Three datasets with incidents in the Svalbard region have been investigated, using a combination of accident concentration analysis, cause analysis and preventive strategies analysis. It is found that most accidents either occur during the spring or late summer period at Svalbard due to the scooter and maritime season respectively. Five incident types that are characteristic for the Arctic region has been identified; Assistance person, fall due to ice or snow, scooter incidents, unintentional discharge of weapons, and events that can not be foreseen. It is found that industrial activities do not show any significant differences caused by being in the Arctic. Research and education field operations have multiple challenges in both safety management systems and incident concentrations.

Snow cornice hazard forecasting possibilities

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***Keywords*:** Snow, cornice, avalanche, forecasting, Longyearbyen.

Snow cornice accretion occurs seasonally on the edges of the plateau mountains above Longyearbyen in central Svalbard. Cornice failures and the resulting cornice fall avalanches comprise nearly 50% of observed snow avalanche activity near Longyearbyen and endanger human life and infrastructure annually. Although the hazards posed by cornice failure here and in other locations throughout the world are well recognized, accurately forecasting the timing of cornice failure and managing the associated avalanche hazards continues to be problematic for avalanche forecasters. To gain a better process understanding of cornice dynamics, we monitored cornice accretion, deformation, failure, and associated avalanche activity on the slopes surrounding Longyearbyen with a terrestrial laser scanner (TLS) over the 2016/2017 and 2017/2018 winter seasons. The spatio-temporal resolution at which we acquired cornice snow surface data via TLS allowed us to observe and quantify changes to the cornice systems in detail not previously achieved. Analyzing these cornice data in combination with local meteorological variables allowed us to more specifically investigate the meteorological controls on cornice accretion and failure. The largest cornice failures we observed were associated with winter storms due to rapid loading of the cornices' leading edges, but previous research has also linked cornice failure to increased air temperatures near the end of the winter season weakening the cornice structure. Cornice fall avalanche size depended both on the size of the detached cornice block and on the snow conditions in the release area impacted by the cornice.

This improved understanding of cornice dynamics allows us to propose potential routines to improve avalanche forecasts and hazard management strategies in areas where cornices pose a snow avalanche hazard. As cornice failure is currently not an official avalanche problem recognized by the European Avalanche Warning Services (EAWS), we first link observed cornice falls to the avalanche problems listed in the avalanche forecast during the day of cornice failure. We also detail the importance of the snow conditions in the avalanche release area impacted by the cornice failure in determining resulting avalanche size and destructive potential. A comprehensive cornice fall hazard forecast will thus include both assessments of the potential for cornice failure and the likelihood for the cornice fall to trigger a larger avalanche on the slopes below. As both components of a proposed cornice fall avalanche forecast can be related to existing avalanche problems in the EAWS, we provide a method for avalanche forecasters to consider cornice fall avalanches within the existing forecasting framework.

DRIVA – Snow depth data to assist hazard assessment in Longyearbyen, Svalbard

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***Keywords*:** Snow, avalanche, forecasting, Longyearbyen.

Reliable avalanche forecasts depend to a large extent on accurate snow depth measurements in mountainous areas. Although avalanches regularly endanger recreational activity and infrastructure near Longyearbyen, Svalbard, Norway, the region has previously lacked automated snow depth measurements in locations relevant for avalanche hazard assessment. Avalanche forecasting efforts near Longyearbyen have increased in response to 6 snowmobiler avalanche fatalities since 2000 and avalanches in consecutive winter seasons (2015/2016 and 2016/2017) that resulted in the deaths of two residents in their homes, numerous injuries, and rendered fourteen residential building uninhabitable. To support avalanche forecasts issued by The Norwegian Water Resources and Energy Directorate (NVE) and hazard assessments by institutions (e.g. The University Centre in Svalbard) and private recreationalists, we installed a network of snow depth sensors in locations where avalanches threaten infrastructure and/or heavily trafficked snowmobile routes. These relatively low-cost sensors transmit data using a Low Power Wide Area Network (LPWAN) technology called Narrow band IoT (NB-IoT) made publically available by Telenor via the LTE (4G) network. This allows for near real-time data access with minimal power requirements. Sensor design and data transmission routines have sought to address problems encountered with previous attempts at snow depth monitoring in Svalbard, including cost, ease of installation, power supply, and communication protocols. With the DRIVA snow sensors, near real-time access to snow depth data allows users to monitor snow depth changes in avalanche release areas during storm events and provides an additional resource for hazard management decisions during times of increased avalanche hazard. Here, we detail the challenges and successes associated with the DRIVA's inaugural season and provide a framework for how these data can improve hazard assessment and decision making with future project development

How will different risk perspectives within naval organizations operating in the High North affect Societal Resilience?

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Keywords: *Risk perspectives*, *Societal safety*, *Resilience*, *Risk management*, *Civil preparedness*

ABSTRACT

In this study, we investigated how different risk perspectives within naval organizations operating in the High North might affect Societal Resilience. Societal resilience is understood as the reactions and strategies at the level of individuals, organizations and society, which are effective and can contribute to solutions that empower a society to be more resilient to current and future challenges, as tension,crisis or conflict.

The discussion lean on data collected among sixteen Norwegian naval organizations and units holding vital roles and tasks in a necessary cooperation during a crisis. Empirical data indicates that studied organizations have splayed risk perspectives. Splayed risk perspectives also apply to strategic and operative levels within the studied organizations as well as the numerous documents and directives regulating their task. Important elements of crisis management presupposes a common understanding of the ruling concepts to ensure smooth coordination, effective and transparent information and communication processes. We expect that splayed risk perspectives will influence risk communication, how ruling concepts are understood and how coordination and information processes are conducted. Consequently, the overall security picture and societal resilience will be affected.

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Support for scientists to better prepare and conduct fieldwork in the Arctic: The INTERACT *Fieldwork Planning Handbook* and *Practical Field Guide*

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Keywords: Fieldwork, Arctic, Scientists, Preparation

For many scientists, fieldwork is an important part of the research process. In the Arctic, being well prepared is essential for successful fieldwork and to ensure a high level of safety for all participants. The caveat is that many Early Career Researchers (ECR) may never have organised fieldwork nor been to the Arctic before.

To help ECR, and scientists more generally, to be better prepared for fieldwork in the Arctic and high Alpine regions, the *INTERACT Fieldwork Planning Handbook* and *Practical Field Guide* were jointly developed within the framework of the EU Horizon 2020 project INTERACT in close cooperation with the Association of Polar Early Career Scientists (APECS) and research station managers.
The *Fieldwork Planning Handbook* provides an overview of all important aspects related to planning and performing cold regions fieldwork. Its six chapters outline how to plan and prepare for fieldwork, what researchers need to think about when they are in the field, and what they need to consider when they return home. A particular focus is put on safety aspects during transport to and from the field, at INTERACT stations or field camps, the most common natural hazards in the field, as well as environmental considerations. The Handbook emphasizes the best measures to prevent incidents; preparedness through risk assessments and contingency plans, education and training, safety equipment, and commonly used communication and navigation tools. In addition, the handbook provides comprehensive checklists, contacts, and online resources for jurisdictional information about fieldwork in the Arctic.

Concurrent with the handbook, we also publish the *INTERACT Practical Field Guide,* a handy guidebook that is based on the *Fieldwork Planning Handbook* and that is designed to be taken into the field as a reminder of the main safety aspects and best practices. It provides checklists, specific safety tips, first aid basics, information on emergency preparedness, and space for adding emergency contact details. Both publications provide an excellent resource for planning and preparing fieldwork in the Arctic and high alpine regions.

CLIMATE CHANGE, ENERGY, AND MARITIME SAFETY

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***Keywords*:** Climate change, energy, security, maritime safety, Arctic, critical infrastructure

Climate change manifested in rising global mean temperatures, more variable and extreme weather is threatening the resilience of current national and international energy systems. Stronger storms, such as an increased cyclone intensity in the Pacific, all impact the way we produce and consume energy. Yet, climate change will also open new opportunities, for instance for resource extraction and new shipping routes in the Arctic, all bearing environmental, political and social implications. Moreover, there are evident links between climate change mitigation and energy security: while countries need to reduce carbon dioxide emissions to mitigate global warming, they also need to reduce oil import dependency to achieve energy security. Both can be addressed by increasing the share of carbon-neutral energy sources. This, however, confronts us with difficult choices. The production of renewables or nuclear energy can compromise human security through environmental pollution, loss of biodiversity, and nuclear accidents.

LOGISTIC AND MEDICAL ASPECTS IN ARCTIC ACCIDENTS

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***Keywords**: accidents, arctic, emergency, rescue, telemedicine*

Exploitation of natural resources, geo-political aims, transportation and leisure activities result in a significant increase in permanent, seasonal and temporal Arctic populations of different ethnic origins. Their knowledge of the high-latitude environments, their training and equipment, their adaptability, health conditions and physiological responses to environmental exposures are extremely variable. The hype of "sustainable arctic tourism" and the lure of cruising industry in particular, brings every year large numbers of individuals into an environment, where they completely depend on technology to live and on external assistance in an emergency.

The presentation firstly outlines the main factors of accidental exposure to polar environments, like the physiological characteristics of groups at risks and the analysis of realistic chances of survival in different scenarios of Arctic accidents, considering the medical and search and rescue perspectives. Further, the critical issues in the survival equipment, in the current procedures,in the training of the tourist industry service personnel and the importance of a behaviour and situation management in the post-accident phases are highlighted.

Secondly, the current methods in search, location and identification of survivors during ship-, air- and land-borne S&R operations are mentioned. These include the "passive devices", e.g. radar reflectors or thermal infrared cameras, and active transmitters like SENDS (Satellite Emergency Notification Devices) or PLB (Personal Locator Beacons.) Critical issues in a retrieval and evacuation of survivors, the organisation and means of their transport to the appropriate treatment facilities of and the possibilities and limits of external assistance through remote surveillance and telemedicine are discussed.

The conclusion provides some recommendation for improvement or modification of the equipment, procedures, survival technologies and in the training. It emphasizes the urgent need for more responsible approach by the tourism industry in polar regions. Many of the results presented here were obtained during the SAREX 1-3 trials in 2016 – 2018. The interested reader may wish to consult the full reports from these exercises.

RISK MANAGEMENT OF WIND ENERGY TRANSITION IN THE ARCTIC REGION

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***Keywords*:** Arctic, Risk analysis, Risk-based methods, Renewable energy, Wind farm

Investment in renewable energy technology has increased in recent years to reduce carbon dioxide emissions and increased the percentage of renewable energy in the energy mix. There are various risks involved in different stages of any renewable energy production technology. Therefore, it is important to measure the associated risk during planning, construction and operation of these technologies. The operating environment parameters for these technologies influence the dependability (reliability, maintainability, supportability) characteristics of the renewable energy technology. Consequently, these factors influence the dimensioning of product support and its evaluation and forecasting to achieve efficiency and cost effectiveness. The most important category of associated risk for application of renewal energy includes: political, economic, social and legal, technological and environmental. The most efficient forms are renewable energies are: geothermal energy, biomass, solar energy, hydropower and wind power. Wind energy production is growing every day due to its high efficiency in electricity production and cost effectiveness. The arctic is considered as a region with great potential for wind energy since, the wind speed is higher in this area due to less temperature. The aim of this paper is to identify and assess associated risk and discussing quantitative and semi-quantitative risk-based methods such as: mean-variance portfolio analysis, real option analysis, stochastic optimization techniques, Monte-Carlo simulation, scenario analysis and multi-criteria decision analysis for the application of wind farm in the Arctic and provide an extensive and systematic literature review of how risk and uncertainty should be considered and modelled with respect to this area. Thereafter, a methodology will be developed to quantify such risks. The methodology provides an appropriate risk index that will act as essential input for designers and managers.

GIS TECHNOLOGY TO SHOW MARITIME ACCIDENTS IN THE ARCTIC AND LEARN FROM "CASE STUDY"

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***Keywords*:** ArcGIS online, Story map, Arctic, case study, accidents

The growth of maritime activities in the Arctic (tourism, fishing, transport, exploration) increases the risk of unwanted events and accidents in the remote sea areas, where search and rescue resources are very limited. The International group of researchers in the frame of MARPART (Maritime preparedness and partnership on High North) projects makes an assessment of the activity and risk level, safety issues for different regions of Atlantic Arctic (Marchenko, 2015-2017) and collect data of previous accidents, national and international exercises. The data is presented in online Geographical Information System (GIS), showing the events on the map, explaining how situation developed and what conclusions were drawn. Learning from others mistakes to enhance personal and ship safety is essential, that's why it is important to make these data available and prepared for the best perception to ensure the proper response to the emergency situation and social awareness about possible outcome of dangerous situation.

As a web-resource where it is possible to find and visualize information about previous accidents and natural conditions, our GIS is a database of cases, a teaching tools and a networking platform at the same time. There are several online layers, devoted to the particular regions and accident types (See Fig.1 as example) and "Case study story maps" for the most famous and instructive events combining maps with narrative text, images, and multimedia content (Fig.2). Hyperlinks give opportunity to dive into the details of presented cases. Possible inclusion of the GIS into the existing web-map services, like BarentsWatch or Norwegian Coastal Administration "KystInfo" will make data available and requested.

Using ESRI software and Story Map concept allows contribute to emergency management competence and increase response capacities, via innovative training and knowledge dissemination.

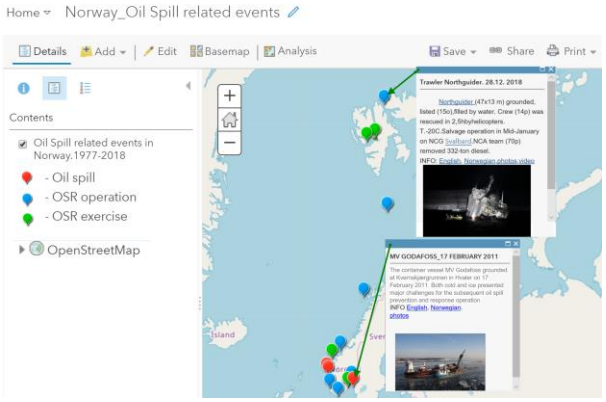

Fig.1. ArcGIS online view with "Oil spill-related events" layer and ESRI basemap opened. Two events are "clicked" to show the description. Blue words mean links to the web-pages with

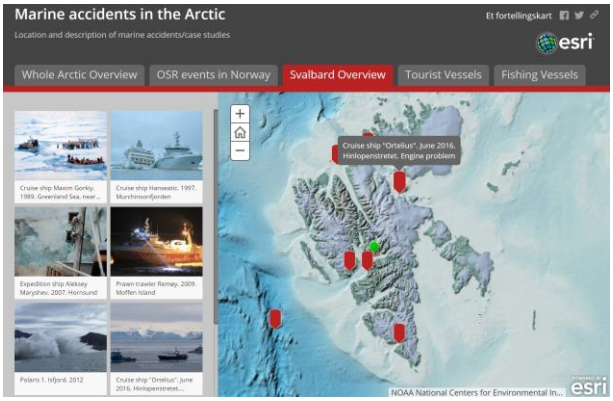

Fig. 2. Story Map with "Svalbard overview" tab opened. Photos with short info (type, ship name, year, place) on the left side are correspond to the points/symbol on the zoomable map.

additional info (reports, articles, photo, video)

Click on the photo or symbol will open description.

SAFETY MANAGEMENT RELATED TO OIL AND GAS PRODUCTION İN COLD CLIMATE REGIONS

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Safety Management is the cornerstone to ensure safe operations of all industrial activities that have a major accident potential. Equinor will present its framework for safety management related to oil and gas operations in cold climate regions. The presentation will describe how Equinor works to identify and control risks from concept development through project execution to actual operations. It will also give insight into the many factors that are in place to manage both generic risks associated with production of oil and gas, as well as pointing to methods used to identify and resolve specific challenges related to cold climate operations. Future development needs of knowledge, tools, and methods will also be highlighted.

The aim of the presentation is to give insight into 'State of the Art' Process Safety Management of an energy company. It should also give the audience background to reflect on areas where they perceive there is opportunity for further improvements in safety work related to oil and gas production. The approach to Process Safety Management should also be relevant for other activities exposed to industrial or environmental risks.

TECHNOLOGICAL SOLUTIONS TO ENSURE SAFE OIL AND GAS OPERATIONS İN COLD CLIMATE REGIONS

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Keywords: *Technology*, *Safe operations*, *Arctic*

Oil and gas production in cold climate regions might require specific technological solutions, mainly due to harsh environments and remote locations. The solutions needed to protect people, environment and equipment may have an impact on the major accident potential. This presentation will primarily focus on the different characteristics on explosion and fire risk in cold climate conditions. To achieve tolerable risk levels, different risk reducing measures are evaluated.

The presentation will highlight the effect cold climate conditions may have on explosion and fire risk, the challenges related to safe operations, and show how these risks are being addressed through technology development initiatives and increase knowledge.

The main topics to be addressed are:

- The balance between inherently safe explosion and fire design principles and the protection of people, environment and assets. Traditionally natural ventilated (open) assets are the preferred solutions to control explosion and fire risk. Operating in harsh environment will require more enclosures for personnel protection and higher degrees of confinement. A new concept of active wind panels will be presented and show how risk can be managed.

- Firefighting systems in cold climate conditions may be challenging due to low temperatures and the subsequent ice formation. The results from experimental testing to manage this challenge and increase knowledge will be presentenced.

- Functionality of lifeboats in cold climate conditions, especially related to surface ice accretion has been studied. The results of the studies and a solution developed to mitigate the effect of icing will be presented.

HUMAN ADAPTIVE CAPABILITIES IN HARSH ENVIRONMENTS

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Keywords: *Human performance*, *psychology*, *safety*, *arctic*

Harsh environments, such as the Arctic, stretches the adaptive capability of humans to the limit due to extremes of cold and rapidly changing weather, lack of natural sunlight in winter and continuous daylight in summer, hazardous wildlife, challenging terrain and remoteness. This paper reports findings from a literature overview focusing on human psychology and physiology with the aim to better explain human capabilities and limitations, and how this can affect human performance in harsh environments. In environments where humans are not naturally suited, we need to have knowledge, understanding and awareness of the psychological and physiological capabilities and limitations of humans to grasp the risks that pose a threat to both health and safety. Awareness and understanding is also a necessity to be able to adapt to the constraints of cold, dark/light, challenging and remote locations and find the necessary coping strategies for successful human performance.

Adaptation to cold environments has been of interest in many studies (Launay and Savourey, 2009; Mäkinen, 2007). Cold affects both the physical and cognitive performance of the human by reducing manual skills and alertness, discomfort and reduced decision-making ability (Balindres et al. 2016; Mäkinen, 2007). Sleep problems and fatigue are the two most common health issues reported among those who have stayed for longer periods in Arctic environments. Even moderate levels of sleep distortion and fatigue can impair performance and increase the risk of erroneous actions for routine tasks, repetitive tasks or tasks that require prolonged alertness (Parkes, 2007; Belenky et al. 2014). Studies have also shown individual differences in the symptom's individuals experience and report (Palinkas and Suedfeld, 2008). A "one size fits all" approach will thereby not cover the complexities of human adaptation to harsh environments, but there are some general human, group and environmental characteristics that can be explained to develop strategies and understand more about what influences human performance.

The paper describes a traditional view of human performance as seen from a human factors perspective, as well as a human resilience perspective where the positive aspects and consequences of coping with stress is highlighted. The human resilience capabilities needed to endure and thrive on psychological and physiological strain in harsh environments, both individually and in groups, is of interest for further studies. It seems that it can be the key to explaining resistance to certain types of risks across the lifespan, how challenges are dealt with and that resilience as such is an important factor for health, safety and well-being.

Collaboration and Continuous Improvement in the Petroleum Industry

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Keywords: *Petroleum, authorities, collaboration, safety, emergency preparedness*

The purpose of this paper is to examine collaboration in the Norwegian petroleum industry, national and international organisations and the effect it has on continuous improvement in safety of operations in the Barents Sea and the broader Arctic region.

The paper considers initiatives, including ones "hidden" in acronyms like AORF, BaSEC, EPPR, SARINOR and SAREX, which are vital to the development of operational safety and emergency preparedness for activities in the Arctic.

There has been petroleum activity in the Barents Sea since 1980. The area has experienced renewed interest since 2005 and the opening of the Barents Sea South East for petroleum activity in 2013. Areas further from the coast have been explored introducing new risks and challenges that require careful consideration.

The Petroleum Safety Authority (PSA) regulates safety in the petroleum industry promoting collaboration and maturing awareness regarding risk and uncertainty. Industry stakeholders, workforce representatives and PSA work continually with topics regarding safety of operations and maturing common approaches to shared challenges.

In addition to work performed by companies directly involved in the petroleum industry, there are numerous other initiatives where both PSA and the petroleum industry participate. These initiatives provide an arena to discuss and share knowledge amongst the Arctic nations.

The paper considers initiatives which are vital to reduce uncertainty and understand risk to ensure prudent and safe operations. Results of the efforts are exemplified by achievements within emergency preparedness. These are mainly additional resources in the Barents Sea such as SAR helicopters, facilities to land on and refuel helicopters and vessels supporting operations. In addition, there is an improved awareness of the challenges, access to competent personnel and willingness to collaborate and share knowledge.

We endeavour to demonstrate that, with broad involvement of industry stakeholders and PSA participation continually challenging industry, there is an exchange of ideas and expectations resulting in continuous improvement in safety within the petroleum industry in the Barents Sea and the Arctic.

Monitoring environmental hazards in the Svalbard region

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***Keywords**: rockbursts, icequakes, calving, earthquakes, radionuclides*

For more than 25 years the Kola branch of the Geophysical service RAS in Russia has been cooperating with the NORSAR institute in Norway in carrying out joint geophysical research in the Svalbard region. Supported by the Research Council of Norway, digital seismic and acoustic stations have been installed in Barentsburg and Pyramiden. Additionally, two stations in the International Monitoring System were installed near Longyearbyen: a seismic array AS72 in 1992 and a radionuclide station RN49 in 2003. These developments contributed to improve the monitoring capability for local seismic events (mining activities, quarry blasts, rockbursts), in addition to seismic disturbances related to the movement of glaciers (icequakes, calving), regional earthquakes as well as some unfortunate accidents.

Infrasonic and seismic data are in addition important to monitor the effects of global warming through the systematic observation of movements of glaciers and calving of icebergs. The ongoing reduction in the weight of the polar ice sheet on the Earth's crust is a cause of an increasing number of earthquakes. Global warming increases the seismic activity in Arctic (Greenland, Svalbard) and now we have a new class of seismic events: *glacial earthquakes.* Scientists have noted a triggering effect of Svalbard earthquakes in connection with glacial movements (Kremenetskaya E. et al. 2001; Asming V.E. et al. 2003; Baranov S. et al., 2011, Asming V.E. et al. 2012).

Analysis of data from the radionuclide station RN49 periodically shows an increased concentration of such isotopes as Xe133, Xe135, Tc99M, Ba140 and some others, which are usually associated with emissions from nuclear power plants, nuclear explosions or nuclear pharmacology facilities (M. Elbahrawy et al., 2010). There are no sources of radioactive isotopes in Svalbard; therefore, attempts were made to search for appropriate external sources. For each registered case of elevated levels of radionuclides, we applied the developed methodology using calculations of direct and inverse atmospheric transport to determine the likely source areas in which radiation could be released into the atmosphere (Ringbom et al., 2014).

The highest level of radioactive contamination was observed in 2011, due to the accident at the Japanese nuclear power plant Fukushima. The level of registered isotopes and noble gases by the station RN49 was comparable to the level registered by Japanese stations. And in 2012-2016, a seasonal increase in isotopes was recorded in late summer and early autumn. The potential sources of radionuclides were found to be located in North-West Greenland, Chukotka and Eastern Canada. A similar conclusion was made on the basis of data recorded by the radionuclide station RN34 in Iceland.

The analysis showed that, given the location of Svalbard and the specific distribution of atmospheric flows in the Arctic, even such an ecologically clean region is subject to serious pollution.

COLLECTIVE IMPROVISATION IN EMERGENCY MANAGEMENT UNDER EXTREME COMPLEXITY

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***Keywords*:** Collective improvisation, obsticle to improvisation, emergency managment, complexity, collaboration

Emergency situations are characterized by ambiguity and confusion, the emergency period typically involved a blend of public, private and volunteer organizations. Responding to emergencies requires the capability to meet the unforeseen and adapt to new condition. The need for improvisation can therefore be an imperative factor for the success of an operation. Moreover, the interconnectedness nature of emergencies calls for collaboration. Thus, collective improvisation can be a tool for handling challenges under extreme complexity of emergency situation. The Arctic sea region was selected for the context of this study. The potential types of emergencies here are search and rescue (SAR), oil spills, terror attacks, fires on board and mass evacuations. Even if the probability of such emergencies are low, if they occur, they could have complex and catastrophic consequences. The Arctic sea region is multinational and emergency management at sea involves both civil and military or naval organizations which makes the improvisation even more complex. This study will emphasis both negative and positive outcomes of improvisation. It uses different improvisational metaphors such as theatre, jazz and football to examine the implications of collective improvisational process in emergency situations. The aim of this conceptual paper is to explore how the emergency response is influenced by collective improvisation and what are the obstacle to improvise under extreme complexity. To achieve this, a combination of a literature review and an empirical pilot study is conducted. The literature review contributes to demonstrate the current state of knowledge within the research area, and to connect the study to the wider theoretical picture. Since it is deemed an appropriate design to answer "how" and "what" questions, and also because the phenomenon of collective improvisation and emergency response needs to be understood within the complex context, an in-depth single case study with qualitative data is chosen for the empirical pilot study. The purpose with the pilot study is to check if the propositions are supported, to look for practical examples, to look inductively for aspects of the research question outside the literature review and to prepare for further studies to test the propositions quantitatively.

A REVIEW OF VIBRATION CONDITION MONITORING AND RISK ASSESSMENT OF WIND TURBINES UNDER ICING

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Keywords: wind turbines, icing, vibration, risk index, condition monitoring

Abstract:
The global average capacity of installed wind power throughout the past couple of years exceeded 50 GW per year, where 2015 marked a record-breaking year in which the global installed wind power capacity exceeded 60 GW. Norway has a total installed wind power capacity of 1,162 MW, of which 324 MW was installed during 2017 alone. The total number of installed wind turbines is 466. Norway is generally known as a cold climate region with several wind farms installed in what is known as the Arctic region, such as Nygårdsfjellet Wind Farm, located in Narvik and Fakken Wind Park, which is located north of the Polar circle.

Wind turbines are favorably installed in high mountainous cold regions due to higher air density in these regions (air is almost 27% denser than at -30^{o}C than +35^{o}C), but also on offshore locations (on seabed if not deep water, or floating if in deep water). However, operation of wind turbines in such regions imposes increased operational risks, and it is estimated that 20-50% of the annual power produced by wind turbines installed in cold regions can be lost due to icing (Tammelin et al, 2000). In addition, there are increased risks with respect to failures of components, as well as to maintenance crews and operators. Harsh weather can increase failure rate of components as well as the system as a whole.

In this paper we illustrate the components that comprise the wind mill's structure, and thereafter analyze how the effects of cold climate and remote locations may influence operation and maintenance of the installation. Furthermore, we discuss the use of modern condition monitoring techniques and risk based approaches can be used to predict failures and to carry out proper maintenance measures before failures take place. In addition, a risk assessment methodology is followed considering the probability of failure (PoF) and consequence of failure (CoF) in order to calculate the risk index of vibration-type failure, prioritize the risk and compare it against a risk acceptance criterion, and to eventually take the proper risk mitigation measures. At last, the benefits of integrating the condition monitoring system with the control system of the wind turbine are discussed in terms of cost, technical development and quality assurance.

Tammelin, B., Böhringer, A., Cavaliere, M., Holttinen, H., Morgan, C., Seifert, H., ... Vølund, P. (2000). Wind energy production in cold climate (WECO), Helsinki: Finnish Meteorological Institute, http://orbit.dtu.dk/files/167477321/26134.pdf, accessed February 26, 2019

SPRAY ICING OVER THE NORWEGIAN ARCTIC WATERS – STATISTICAL OVERVIEW AND LONG-TERM SAFETY CONCERNS

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Keywords: Sea-spray icing, icing rate and frequency, MINCOG mode, Barents Sea, Climatological information

Sea-spray icing is a one of major safey concerns for vessels operating in Arctic waters. There have been numerous reports of vessel cpasizing resulting in loss of lives and vessel damage over the past decades in the Arctic offshore including the north of Iceland, northern seas of Japan, and off the coast of Alaska. Heavy spray icing threatens the safety of offshore Oil and Gas (O&G) installations as well. Severe accretion of ice on Ocean Beauty drilling platfrom during a heavy icing storm in the winter of 1979-1980 in Cook Inlet, Alaska, is a case in point where spray icing might affect the stability of offshore oil and gas (O&G) platfroms. The crew had to discharge the drilling mud from the platfrom in order to maintain its stability. Although the present-day technology and relative height of platforms reduces the risk of platfrom's loss of stability, spray icing does affect the safety of crew on-board and contributes to loss of functionality of exposed equipment, escape ways, figherfighting systems, evacuation means, etc.

Most of available spray icing prediction models are revolved around modelling the interaction between vessels/platforms and waves as this is the major source of spray icing leading to ice accretion under certain conditions. Although limited, various data sets containing observations of spray icing events in different Arctic waters that may be used for verification of spray icing models. However, as O&G industry is expanding its activities further in the Arctic offshore, the need for having a thorough information regarding spray icing over vast regions of Arctic waters has been highlighted. Climatological information on spray icing that can be used to provide decision-makers with necessary information on optimal options and solutions in advance for assessing, managing, and mitigating the risks imposed by spray icing.

In this study, due to the importance of spray icing on vessels, a Marine-Icing model for the Norwegian COast Guard (MINCOG) is adapted to study and analyse the ice accretion on the vessels operating in sea areas between Northern Norway and Spitsbergen. This study uses NOrwegian ReAnalysis 10km data (NORA10) of atmosphere and ocean parameters as input to the icing model from 1980 to 2012. As information on icing rates and the probability of the occurrence of icing events are key inputs to risk-informed decisions in Arctic waters operations, this study presents the statistics of icing rate and frequencies, as well as long-term spatial and temporal variations of icing frequency over the sea areas between Northern Norway and Spitsbergen. Long-term changes some meteorological and atmospheric parameters are studied statistically and their impact of icing rates and frequencies are analysed and discussed as well.

The developed spray icing maps representing spatial and temporal variation of icing severity, rate and frequency at different junctures can be used in making risk-based decisions in various Arctic offshore operations including logistics, oil spill combat operations, rescue operations, etc. In addition, the results of this study confirm the long-term changes in the Arctic offshore environment, which in turn necessitate a dynamic and time-dependent spray icing risk analysis, especially for the long-term industrial applications. A particular case in point is the region near the sea-ice edge in the Barents Sea, where sea-ice retreats. This

indicates a change in the associated hazards and their risks as well as the need for modification of risk mitigation measures in the long term.

RISKS AND UNCERTAINTIES ASSOCIATED WITH PROJECT MANAGEMENTS IN ARCTIC OFFSHORE OIL AND GAS INDUSTRY

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Keywords: Risk and uncertainty, project management, Arctic offshore, oil and gas, feild development

Project management is generally defined as the application of knowledge, skills, tools, and techniques in order to carry out some activities to meet the requirements of projects while being limited by time and resources. It is widely used for planning and monitoring the execution of plans and thus enabling the companies achieve project objectives. Projects are accomplished in steps, which are often reformulated in terms of planning, executing, controlling, and closing.

Exploration and production (E&P) of oil and gas (O&G) fields often involve complex and high-risk projects with a multidisciplinary nature that often absorb the largest portion of invested capital in oil and gas industry. Such characteristics, as well as high risks and uncertainties associated with E&P projects, make E&P decision processes highly complex. In this regard, an effective and successful project management is strongly recommended and and thus required.

There are various principles for E&P project management, such as stage-gate project management process, where a project is broken into consecutive stages to facilitate the general project management process. However, the success of each stage depends on how well they are planned, monitored and executed. In regions where the industry has adequate level of experience, various sorts of associated uncertainties (with different types and sources) can be characterized and accounted for in each step. However, the O&G industry somewhat lacks extensive experience on running E&P projects in the Arctic offshore due to a relatively small number of fields developed to date. In addition, the Arctic offshore environment increase the uncertainties associated with the different project management steps through its harsh climatic conditions, remote distance to the market, reduced visibility due to long polar nights and summer fog, and less-developed infrastructure – in effect, the execution of different project stages are complicated.

An additional factor, related to the nature of Arctic offshore, which adds to the complexity of E&P project managements, their planning, and their execution, is unforeseen risks and operational safety issues, which not only contribute to an increased project costs through implementation of further design- and operation-related modifications, or through imposing operational delays. Such a potential loss may negatively influence the organisation's safety culture and put managers and decision makers under pressure that could lead to taking unnecessary risks and undermining safety of crew, facility, and operations. A case in point is the blowout of Macondo wellbore and explosion of Deepwater Horizon in Gulf of Mexico in 2010.

In this study, characteristics of Arctic conditions and their impact on different project management phases are discussed from the perspective or their risks and uncertainties. The crucial role that they play in having successful E&P projects are reviewed and discussed as well. In addition, this study highlights the importance of understanding and modelling how the uncertainties related to the Arctic offshore conditions can affect the execution of projects in order to take them into account during the planning phases. This finally contributes to reducing the gap in knowledge caused by uncertainty that decision-makers are troubled by,

and by reducing this gap, the implementation of project management for E&P of oil and gas resources in the Arctic offshore can become more successful.

Polar bear – human interactions in Svalbard: Using demographic and interaction data to minimize conflict

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***Keywords*:** *Polar bears, Bear-human conflicts, Safety, Svalbard*

Changes in movement behaviour due to sea ice loss and reestablishment of local polar bears close to settlements in Svalbard may increase conflicts between polar bears and humans. In addition to the biological changes, human field activities have increased. Currently more people use field locations in larger parts in Svalbard during a longer field season than earlier. Conflicts between bears and humans may cause fear, harm and may be lethal for bears and people involved. Due to strict environmental regulations, there are relatively few lethal human incidences, while polar bears are shot in self-defence annually. In order to support sustainable research, tourism and recreation, the ongoing project CONBEAR aims to reduce the frequency and effects of conflicts. In the project, data on interactions during field trips are collected to document, describe and analyse situations where polar bears and people interact. Tracking data from demographic studies of polar bears, on-site observations and subsequent in-depth interviews will be used. The information will feed into a database for future analysis, with the aim to be compatible with the existing circumpolar database for polar bear-human interactions, PBHIMS (Polar Bear Human Information Management System). The results from the project will provide a better understanding of polar bear behaviour, and reveal what situations are most dangerous, and where and when conflicts occur. The project finally aims to develop improved safety protocols for polar bear encounters. The environmental benefits of the project include a potential reduction in the number of killed or relocated bears. The societal benefits include a decline of the risk of weapon use, the costs of SAR operations, and the societal costs of human injuries and possible death.

LEARNİNG FROM CRİSİS: THE 2015 AND 2017 AVALANCHES İN LONGYEARBYEN.

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Keywords: *organisational learning, crisis, avalanches, climate change*

Longyearbyen has been hit by two avalanches in recent years causing severe damages. 19.12.2015 an avalanche lead to two fatalities and the destruction of 11 houses in Longyearbyen, while in 21.02.2017 another destroyed two apartment houses. In addition, parts of Longyearbyen have been temporally evacuated in numerous instances due to the danger of avalanches. In this study we investigate organised learning processes regarding emergency preparedness and response following the avalanches.

Longyearbyen provides a case of particular interest. First, climatic change is rapidly altering the environmental conditions in Longyearbyen, including the risk of avalanches. As such, Longyearbyen is an early warning on the consequences of climate change. Second, there is a high turnover of the local population in Longyearbyen (average 3-4 years), making both intra-and inter-organisational learning particularly challenging and important.

The study is based documentat analysis of formal learning processes - such as, evaluation reports, policies and planning documents - in addition to a series of interviews with key actors in avalanche preparedness in Longyearbyen. Focus is on the time-period from the first avalanche in December 2015, until the present. The study will have a particular focus on the role of formal authorities; Longyearbyen local government (local authority), Governor of Svalbard (State authority), The Norwegian Water Resources and Energy Directorate (NVE) (sector agency).

First, the study provides a timeline and overview of the organisation, scope and participation of learning processes. This provides a basis for adressing who learns, when and what is the scope. Second we investigate whether the lessons learnt are single-loop or double-loop. That is, if they focus on corrective actions and measures to improve the performance of existing systems and policies, or if they address the more fundamental aspects, such as norms, strategies and policies. Third, we distinguish learning focused on the prevention of or preparedness to future incidents, and whether it is directed at hard (physical) or soft (processes) barriers. Finally, we investigate how learning has been followed up by implementation.

The study concludes that the first avalanche of 2015 led to an inclusive evaluation and learning process and a series of recommended measures, including the establishment of an avalanche warning system. It also initiated a broader double-loop process of reassessing risks, redrawing the plans and maps of Longyearbyen, raising physical preventive barriers. However, the second avalanche demonstrated the limitations of the

established system. This spurred on efforts to further implement measures already agreed upon, including physical barriers and relocation of parts of the community.

RESILIENCE ASSESSMENT AND MANAGEMENT: TOWARDS A RESILIENCE TOURISM INFRASTRUCTURE IN THE ARCTIC

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***Keywords*:** Resilience, Infrastructure, Arctic, Tourism, Management

Over the last few years, almost every coastal community located in the North Atlantic region has witnessed a substantial increase in the number of visiting cruise ships. While direct benefits on local community remains yet unclear – concerns have aroused on the capabilities of the tourism critical infrastructure. Shipping is rapidly increasing in the North Atlantic region, bringing in new challenges for both local communities and the overall area. Increased safe and resilient infrastructure is one of the most important aspects when developing a sustainable maritime tourism framework. Focus is on the infrastructures that are related to and/or in use in maritime and tourism activities in the Arctic. These infrastructures should be designed (or redesigned) in a way that are able to withstand different types of Arctic hazards, and in case of hazards acting on the system in an adverse way, be able to bounce back to operating conditions quick. Considering this fact that Arctic infrastructures are becoming more interconnected, so they are increasingly reliant upon their neighbors, both under normal operating conditions and in the event of an incident, hence a common understating of resilience and resilience measurement is of utmost importance. However, there is no common methodology for measuring resilience, and different countries and operators using their own techniques for implementing resilience concepts in managing tourism infrastructures.

Six partners located in Iceland, Greenland, Norway and Svalbard – UiT - University of Tromsø, the Icelandic Arctic Cooperation Network (IACN), Center for Arktisk Teknologi (ARTEK), the Arctic Safety Centre, University of Iceland, Centre for Arctic Policy Studies (CAPS), and the Icelandic Coast Guard established a permanent partnership to develop a project called “Resilience Assessment and Management: Toward a Resilient Tourism Infrastructure in the Arctic (RAMTIA)”, in order to tackle and reduce risks related with Arctic shipping by increasing preparedness and safety of tourism critical infrastructures using the concept of resilience.

RAMTIA will simplify the measuring and evaluation of resilience in tourism infrastructure, supporting in this way all stakeholders engaged with maritime tourism industry in the Arctic region industry in better understand the relevance of resilience in tourism critical infrastructure.

EDUCATIONAL GAPS WITHIN EMERGENCY MANAGEMENT IN RUSSIA

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***Keywords*:** emergency management, Arctic, preparedness.

Incidents usually happen with little or no advance warning, and require an immediate response taking into account the Arctic context. Low temperature and harsh weather, lack of infrastructure and emergency resources can hamper the emergency response and demand higher level of cooperation between emergency preparedness organizations. Major incidents may require a response involving large number of participants from many companies, organizations and institutions, including governmental entities. Such incidents may also involve numerous parallel activities such as ensuring the safety of the public and responders, source control, protecting the environment, securing property and infrastructure from damage, and providing timely communications. It may also be regarded as an extremely complex and dynamic operation where actions, problems, resources and solutions are mixed in a flux that is difficult to overview and even more difficult to decide upon. As emergency services grow in complexity, the need for greater coordination and better education also grows.

This paper focuses on competences within emergency management provided by professional training institutions and associated organizations in the Russia. We build upon the study cases emphasizing the context of the cold climate conditions and the management challenges of emergency response which could be caused by educational gaps. Our research is oriented towards revealing possible gaps in emergency management education and training preparing the operating units and professional emergency agencies for operation in an Arctic environment. The short overview of Russian trainings and academic educational programs is provided. Based on the analysis of educational gaps regarding the emergency response, we reflect on the demand-side of emergency management competence needed in large-scale incidents, with focus on the response organizations in Russia.

Although improvements have been made regarding emergency response in the Arctic, our research indicates that there are areas where development of management competence is difficult, and specific areas in need of better knowledge.

INFORMATION SHARING AND EMERGENCY RESPONSE COORDINATION.
THE CASE OF RESCUE OPERATIONS IN THE SVALBARD SEA AREAS

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Keywords: *information sharing*, *emergency management*, *emergency response coordination*, *SAR*, *complex environment*

Joint response operations in the Arctic oceans is a challenging task due to limited resources, vast distances, harsh weather conditions and technical limitations on equipment functionality. Coordination is facilitated by established incident command systems that define managerial roles and information flows between individuals and organizations participating in rescue work in large-scale crises. The tactical and operational management-levels may have to adapt and improvise both their organization and task-work to function efficiently under these conditions.

Information sharing between emergency agencies may be complicated by diverging information flows, that communication channels are not interoperable or there is a lack of sufficient information. Previous studies assert that there is a need for adapted managerial role models and inter-organizational coordination tools to face challenges in high complexity environments, such as the high Arctic. An adequate informational infrastructure contributes to joint situational awareness and effective decision-making. In mass rescue operations information about scale and complexity of the event is crucial for the functioning of joint emergency operations.

This paper has a focus on how the managerial roles patterns may influence information sharing between the participants in a complex rescue operation. We will explore what information is critically needed and how such information is distributed.

In our study will build upon cases of rescue operations in the waters around Svalbard in the Arctic. In this region there has been a substantial growth in maritime traffic, including cruise liners with 2-4 thousand pax, calling into question the capacity and effectiveness of established emergency preparedness. Cruise adventure tourism boosts extremely the last years reaching 2-4 thousand tourists on board the cruise liners which run up to 80N. We demonstrate how information sharing and coordination mechanisms may be adapted to complex rescue operations and discuss the implications for the planning of mass rescue operations.

IN GUIDE WE TRUST – REALLY?

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***Keywords*:** Expeditions, safety, polar guides, training, wildlife

Negative impacts of rapidly growing polar cruise ship-based tourism on the circumpolar physical environment, on the wildlife and on the indigenous communities are widely known. Some mitigation measures are being implemented by international cruise industry associations in the Arctic and the Antarctic; however, these are not legally binding

While the IMO Polar Code provides operational guidelines for the vessels and for the safety equipment, the activities of the participants during the land or ice excursions are much less regulated and depend significantly on the qualification of the trip guides. The rapid growth of a commercially driven "extreme polar tourism" during the last decades created a similar situation in trips overland and on the polar ice. The tour operators are under pressure to offer more action; the financial background of the customer is often the most important criterion in participation in such commercial expeditions. Certain physical fitness is required, but a knowledge about the polar environment is not and this trend is increasing.

The focus of the presentation is on the spectrum and selection of expedition participants, on the qualification and certification of the Arctic guides and on the current practices during commercial polar expeditions in comparison with the international mountaineering standards. Critical issues in preparation, equipment, leadership and behavior profiles of the guides, in proper management of emergencies and in approach to wildlife are highlighted. Examples of wrong situation management due to improper guiding practices are analyzed.

Further, the international training standards, the periodical proof of competency in Arctic guiding, the improvement in wildlife protection practices, the possibilities of restricted corridors for travel in the Arctic, the responsibilities of tour operators for reporting of accidents and near-misses in the Arctic are recommended.

Finally, the potential problems associated with of legal status the Arctic ocean versus the land and adjacent territorial waters and the need for an objective information to the general public about the impact of Arctic tourism are discussed.

MANAGING POLAR BEAR-HUMAN INTERACTIONS IN UNEXPECTED LOCATIONS

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Keywords: *Polar Bear, Greenland, Summit Station, Firearms, Bear Detection*

Polar bears are a natural hazard in the Arctic and interactions with them are a known risk in many Arctic coastal communities. However, bear activity and ranges are changing in ways that are beginning to impact human activities and operations far inland. Here, we summarize a recent polar bear event at Summit Station, Greenland, the lessons learned, and subsequent planning to mitigate future bear-human interactions.

On 13 June 2018 at ~ 0530 local time, a polar bear was observed at the north end of Summit Station, Greenland. Summit Station began operating in 1989 and sits near the center of the Greenland Ice Sheet at ~3200 masl and ~300 kilometers inland from the ice edge and nearest fjord to the east. This was the first bear encounter at Summit Station. It followed two other bear occurrences, one in 2016 and the other just two weeks prior to the bear arriving at Summit Station, at the EastGRIP (East Greenland Ice Core Project) camp which is located 350 km north of Summit Station at a similar distance from the eastern ice edge and coastal fjords.

Station personnel normally sleep in a mixture of hard-sided buildings and tents. Daily operations typically begin in the morning and cease in the evening. Though no bear response plan was in effect for the station, 30 of 31 personnel were alerted and safely evacuated to hard-sided buildings within a few minutes. One person had to remain in his tent as the bear approached more closely, but a heavy equipment operator was able to deter the bear long enough with a tractor so the person could make it to a safe shelter. With no firearms on station, all 31 personnel remained sequestered for the next 36 hours while station management coordinated with NSF and the Greenland authorities to respond to the situation. Through close coordination with the authorities, a Twin Otter carrying 2 hunters arrived in the afternoon of the second day. Warning shots failed to push the bear away from the station and it was subsequently dispatched.

This incident raises new concerns about how a changing Arctic can trigger hazards in locations previously considered safe. The frequency at which these hazards will occur in unexpected places is unknown. Safety measures that were immediately enacted included hiring a night watch person, implementing polar bear awareness and safety training, providing bear deterrents (bear spray, air horns, flares, bangers), and bear defense (rifles and training). Long-term safety measures include plans for installation of a bear detection system (such as radar, lidar, IR, fiber-optic perimeter detection, or remote sensing), and providing hard-sided berthing for all summer occupants.
Addressing human safety concerns requires a balance between reasonable precautions and preparedness, and the complacency that may arise if significant time passes between events. This balance can likely be achieved through the application of new technology, infrastructure designed to minimize surprise encounters, and training specific to these new and rare events in unusual locations. The pros and cons, and cost-benefit, of each of these approaches are discussed.

Past, present and future of sailings in the Arctic.

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Keywords: Arctic, martimte activty, Safety, Search and rescue

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From the days of the explorers via the seal and whale hunters to present maritime traffic in the Arctic Seas, sailings in the Arctic have always represented a challenge.

Starting from a review of past learnings, today's knowledge and regulations are discussed with emphasis on the IMO Polar Code that came into enforcement on 1st January 2017. Search and rescue exercises which were held in 2016, 2017 and 2018 revealed gaps in knowledge and equipment to protect personnel who has to evacuate a vessel in distress. The long distances from rescue centres and the scarcity of emergency response equipment available call for self-sufficiency for a period of at least five days in case evacuation from a vessel is needed. The paper will discuss the identified gaps and will also discuss additional gaps where the knowledge is insufficient.

Furthermore, some thoughts regarding scenarios for the future of sailings in the Arctic will be discussed.

Knowledge based planning, development and monitoring in the Arctic. Linking top-down with buttom-up approaches.

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***Keywords*:** Community-based monitoring, co-management, Asset Based Community Development (ABCD), Linking top down and buttom up approaches / knowledge, Arctic

Safety and risks involves people and local communities, especially in areas that are inhabited. This is also true for the Arctic region, where both indigenous people, and other settlements and communities are challenged by climate change and increased risks due to more frequent extreme weather conditions and natural disasters .Effective responses to rapid environmental change rely on observing systems to inform planning and decision-making. Building on experience from Arctic community-based monitoring programs, comparing top-down, (non-) governmental program driven approaches with bottom-up approaches initiated and steered at the community level, connecting these two approaches, and linking to Indigenous and local knowledge can yield substantial benefits from local- to global scale observing programs. This presentation is sharing some of the experience and approaches from the INTAROS project (Integrated Arctic Observing Systems-Horizon 2020)- where we are stating as one of the main objectives that knowledge-based planning of the future is required. This is crucial in order to strengthen the societal and economic role of the Arctic region, and to support the EU strategy for the Arctic and related maritime and environmental policies. Safety and risks are part of this picture. In the INTAROS project, Workpackage 4, one of the overall goals is to enhance community-based observing programs by further developing the capacity of scientists and community members, addressing participatory research and capacity-building, improve the cost-effectiveness of data collection in support of economic and societal activities, and contribute to enhance the livelihoods of the indigenous and local communities. In Svalbard, almost 25% of the areas are protected as national parks, where the precautionary principle is the main monitoring approach.

The INTAROS WP 4 partners have been approaching safety, monitoring and development issuses by combining community based monitoring, scientific and local knowledge, through a survey and analysis of existing community-based observing programs, working to advance tools for cross-fertilizing indigenous and local knowledge with scientific knowledge, pilot community-based observing to support decision-making processes, and to develop a model of how community-based observing can cross-fertilize w/ scientist-executed observing and demonstrate use of the model.

In addition to my research in INTAROS, through my work as a public sector PhD candidate, I look at how local communities can contribute to a mobilization of people and resources to achieve a sustainable development, combined with the monitoring perspectives. Through the analytical perspectives of linking and bridging social capital, placemaking, participation and democracy in planning and development, and through an Asset Based Community Development(ABCD) approach, I argue there is a need for co-creation, broad knowledge, and a facilitation of these processes in order to reach the UN sustainability goals, and to secure a safe and holistic management and development.