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NERSC Special Report no. 105

UAK 2018: Research School in Svalbard

Photo: E. Storheim, NERSC

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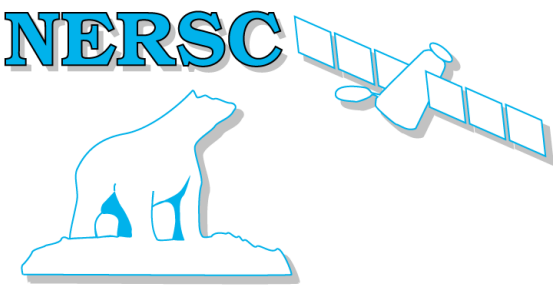

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https://uak.ucalgary.ca

Report from the Research School on cross-disciplinary science and collaboration with local communities

02 – 07 December 2018
UNIS, Longyearbyen, Svalbard

http://intaros.eu

Longyearbyen in winter night www.photosight.org

The research school was organised by the Nansen Environmental and Remote Sensing Center under the project **Useful Arctic Knowledge: partnership for research and education (UAK)** funded by the INTPART programme 2018-2020 under contract no 274891. INTPART (International partnerships for excellent education, research and innovation) is funded by the Research Council of Norway and the Norwegian Centre for International Cooperation in Education. The project, which includes partners from Norway, USA and Canada, brings together leading researchers, educators and young scientists working on selected Arctic science topics. The research school was also part of the H2020 project INTAROS – Integrated Arctic Observation System, contract no 727890 (http://intaros.eu, http://intaros.nersc.no).

The lecture presentations and other material form the research school are available at the project website: https://uak.ucalgary.ca/svalbard-research-school/

The UAK research school is supported the INTPART programme under the Research Council of Norway contract no. 274891 and the European Union's Horizon 2020 research and innovation programme under grant agreement no. 727890 (INTAROS).

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1. Project partners and contact persons

Nansen Environmental and Remote Sensing Center (NERSC): project coordinator	Stein Sandven, Hanne Sagen, Torill Hamre, Lisbeth Iversen
University of Bergen, Department of Earth Science (UIB-GEO)	Mathilde Sørensen
Norwegian Meteorological Institute (MET Norway)	Øystein Godøy
Western Norway University of Applied Sciences (HVL)	Kjell Eivind Frøysa
The University of Manitoba (UM)	Søren Rysgaard
University of Calgary, Arctic Institute of North America (UC-AINA)	Maribeth Murray
University of Colorado, Boulder, National Snow and Ice Data Center (UCB-NSIDC)	Peter Pulsifer

2. Project summary

The overarching goal of UAK is to build and maintain strong partnerships between educational and research institutions in Norway, USA and Canada on selected Arctic topics. These topics are: (1) studies of natural and human-made hazards with focus on earthquakes, slope failures and fuel-spills. The studies include physical processes and causes behind the hazards, how they may be influenced by climatic changes, how they can be monitored and how risks can be minimized and impact mitigated. (2) Status and change of the ocean acoustic environment, which is affected by increased shipping, tourism and exploitation of resources in the Arctic regions, will be investigated. UAK will provide workshops and training courses in on the impacts of acoustic pollution of the environment in the different regions, which is important for developing mitigation plans for protection of marine life. (3) Cross-disciplinary data management and building knowledge from the increasing amount of data in the Arctic, especially from satellites, is important. UAK will provide training of scientists and data managers in development and use of integrated observing systems. (4) Community based monitoring evolves as an important contribution to an integrated Arctic Observing System, but this approach is not much used in Norwegian research. UAK will capitalize from the experience in USA and Canada on Community based monitoring and refine it for use in Norwegian research programs and education. UAK brings together leading researchers and educators in natural science topics, community-based monitoring and data management. The training and education activities will contribute to build cross-disciplinary competence and use of modern data collection and dissemination methods. It is also expected that the educational programs developed in UAK will have positive impact on cooperation among the science, business and public sectors through our collaboration with local communities and stakeholders in the study areas.

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3. Topics, lecturers and participants

Topics for the research school

(1) Studies of natural and human-made hazards in the Arctic addressing problems such as earthquakes, oil spills, slope failures and ice-related hazards. The studies include physical processes and causes behind the hazards, how they can be detected and monitored, and how risks can be minimized and impact mitigated.

(2) Status and change of the ocean acoustic environment is affected by increased shipping, tourism and exploitation of resources in the Arctic regions. The research school will demonstrate how acoustic data is collected, processed and used to study natural processes and human-induced noise.

(3) Cross-disciplinary data analysis and data management is important in order to and build knowledge from the increasing amount of data in the Arctic. The research school will have lectures and practical exercises based on data from topic (1) and (2), satellite data and other data proposed by the students.

(4) Community-based monitoring evolves as an important contribution to an integrated Arctic Observing System, with focus on collaboration and communication between academic research and local communities. The research school will have lectures on such activities in Canada, Alaska and Svalbard.

Lecturers from the project partners

Stein Sandven Nansen Environmental and Remote Sensing Center (NERSC): Stein is the leader of the UAK proposal and the coordinator of the INTAROS project.

Hanne Sagen (NERSC): Hanne has expertise in ocean acoustics and has been leader of several projects on ocean acoustics in the Arctic.

Torill Hamre (NERSC): Torill has expertise in computer science and has been working with data processing and data management in many projects related to Arctic and marine research

Lisbeth Iversen (NERSC): Lisbeth is a social scientist working with Community based monitoring – projects/political and socio-economic approach.

Mathilde Sørensen, University of Bergen. Department of Earth Science (UIB-GEO). Mathilde has a leading role and provides education in earthquake seismology, seismic hazard, tsunami hazard and seismo-tectonics.

Øystein Godøy, Norwegian Meteorological Institute (MET Norway). Øystein will contribute with expertise in Arctic data management.

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Kjell Eivind Frøysa, Western Norway University of Applied Sciences (HVL). Kjell Eivind has expertise and provides education in underwater and subsea instrumentation as well as ocean acoustics at HVL.

Søren Rysgaard, University of Manitoba and Aarhus University. Søren has wide expertise in cross-disciplinary Arctic research and will contribute to education in community-based observing, human and natural hazards, and data integration.

Leendert Vergeynst, Aarhus University, postdoc, expertise in Ice hazards and oil spills

Maribeth Murray, Arctic Institute of North America, University of Calgary (AINA/UC). She will contribute to education in natural and human hazards, ocean acoustics and community-based observing.

Peter Pulsifer, National Snow and Ice Center, University of Colorado, Boulder (UCB). Peter will contribute with expertise and education in data management and integration as well as in community-based observing.

Pedro Gonçalves, Terradue, expertise in EO data processing, management, interoperability

Marthe T. Fjellestad, academic director at the University of Bergen Library Picture Collection.

Invited lecturers from UNIS and Longyearbyen community

Ann Christin Auestad, UNIS. Ann Christin will give a presentation of the newly established Arctic Safety Centre at UNIS.

Børge Damsgård, UNIS. Børge is professor in marine biology, Vice Dean of Research and the departmental leader of the UNIS Arctic Biology department.

Hanne Christiansen UNIS. Hanne is professor in physical geography, Vice Dean of Education and department leader of UNIS Arctic Geology department.

Frigg Jørgensen, Executive Director of AECO - Association of Arctic Expedition Cruise Operators

Hilde Fålund Strøm, Product manager, Hurtigruten Svalbard. Local inhabitant of Svalbard working with tourism and role as "citizen scientist"

List of participants

Name	Inst. Country	Background - competence
Trygve Halsne (MSc, res. scientist)	Meteorological Inst. Norway	Remote sensing, data management, Sea ice algorithms

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Joshua Jones (MSc, researcher III)	Univ. Alaska, Fairbanks, USA	Sea ice and hazards, CBM, AAOKH (linked to INTAROS)
Takuya Nakanowatari (researcher)	NIPR, Japan	Sea ice modelling and forecasting, Arctic navigation
Zeinab Jeddi (postdoc)	Univ. of Bergen, Norway	Seismology, earth quakes, data processing, works on INTAROS
Henrik Hellem (MSc student)	Univ. of Bergen, Norway	Processing and analysis of acoustic data
Bjørnar H. Røsvik (MSc student)	Univ. of Bergen, Norway	Processing and analysis of acoustic data
Jan Michalek (senior engineer)	Univ. of Bergen, Norway	Seismic data processing, visualization and management
Sascha Schjøtt (PhD student)	Aarhus Univ., Denmark	Marine ecosystems. Also at Greenland Inst. of Nat. Resources
Samantha Jones (PhD student)	Univ. Calgary, Canada	Lakes, rivers, ecosystems, hazards, CBM work
Oliver Bartlett (PhD student)	Univ. of Exeter, UK	Hazardous glaciers, remote sensing, GIS
Delphine Collin (MSc student)	Sorbonne Univ., France	Cross-disciplinary environmental studies, hazards, GIS,
Agata Grynczel (PhD student)	IOPAN, Poland	Oceanography, sea ice
Morgan Ip (PhD student)	Oslo School Arch. and Design, Norway	Ethnographic data, cultural landscape, data management tools
Thomas Tuesen (PhD student)	Univ. of Bergen, Norway	Natural hazards: flooding and slope failure, cross-disciplinary
Alexandra Meyer (PhD student)	Univ. of Vienna, Austria	Social scientist, working on the H2020 NUNATARYUK project

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Figure 1. Photo of participants and lecturers inside UNIS where the research school was held

Figure 2. Arrival to Longyearbyen airport and transport by bus to UNIS in the early afternoon on 02 December. There is 24 hour darkness in Svalbard at this time of year.

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4. The daily programme

Sunday 02 December. Welcome and introduction

A brief introduction session was given in Lassegrotta auditorium at the University Centre in Svalbard (UNIS) from 1700 to 1830 after the participants had arrived and checked in at the UNIS Guest House. Director Harald Ellingsen gave a short presentation of Svalbard and an overview of the UNIS, which is the world's northernmost higher education institution, located in Longyearbyen, at the High Arctic archipelago of Svalbard (78º N). UNIS offers high quality courses at the undergraduate, graduate and postgraduate level in Arctic Biology, Arctic Geology, Arctic Geophysics and Arctic Technology. In 2018, more than 800 students attended longer and shorter courses at UNIS. After the introduction, Stein Sandven gave an overview of the plan for the research school, with practical information.

Monday 03 December. Topic: Natural hazards in the Arctic

Peter Pulsifer, National Snow and Ice Data Center, University of Colorado, gave an introduction lecture with title "From Data Collection to Long-Term Preservation and Use: Arctic data as part of a global system". The lecture included the following topics:

- The word of data, Polar data in the Global System
- Domains of Data: physical sciences, life sciences, social sciences, Indigenous Knowledge, CBMs
- The Data Lifecycle
- Data Collection
- Data Sharing
- Data Discovery
- Data Reuse
- Arctic Data Community

Maribeth Murray, Arctic Institute of North America, University of Calgary, gave a lecture with title "Arctic Research Infrastructure and Interdisciplinary Research in Canada". The lectures presented examples of existing infrastructures (stations, vessels), gaps in infrastructures, barriers to research and expectations to research and connected activities in the Arctic as well as the need for Arctic Observing System. The Canadian Consortium for Arctic Data Interoperability and some major research questions were also mentioned.

Hanne Christiansen, professor in physical geography and department leader of UNIS, gave a lecture on permafrost and its effects on landscape processes in the Arctic. The permafrost in Svalbard is the warmest so far north in the Arctic, causing increased occurrence of landslides. In Longyearbyen the warming of the permafrost has started to have severe effect on building which are founded on pillars resting in the permafrost.

Mathilde Sørensen, Department of Earth Science, University of Bergen, gave a lecture on natural hazards in the Arctic in a wider context. Natural hazards in the Arctic include earthquakes, landslides,

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snow avalanches, extreme meteorological events, flooding and volcanic eruption and tsunamis. In Svalbard there is significant seismic activities, and the largest earthquake of magnitude 6 was observed in Storfjorden. In the Karrat Fjord Greenland an earthquake event in 2017 cause a landslide and subsequent tsunami that caused severe damage and killed people in the Nuugaatsiaq village. In 2015 a snow avalanche in Longyearbyen damaged several building and killed three people. Observing systems in the Arctic should be implemented to 1) observe events when they occur, 2) monitor temporal changes, 3) map previous events, and 4) forecast and/or detect precursors to events. Long-term observation of sea level rise is also part of natural hazard monitoring.

Peter Pulsifer, National Snow and Ice Data Center, University of Colorado presented the elements of a Data Management Plan, which is a requirement in most research contracts. A Data Management Plan should address what types of data are produced in t a project, what standards are used for data and metadata, what policies apply, how can data be re-used and preserved.

Jan Michalek (senior engineer), Department of Earth Science, University of Bergen, presented Enlighten-Web, a data visualization tool and a virtual research environment. The tool is used in the European Plate Observation System (EPOS), but the tool is more general and can be used in many applications. It is based on Jupyter notebook, a web application to create and share documents that contain live code, equations, visualizations and explanatory text or presentations. The tool allows features such as

- Interactive real-time visualization linked to a dynamic programming interface
- Effective visualization of large multidimensional data sets
- Interactive mapping of millions of points
- Explorative visualization, e.g. for extracting trends and outliers in the data
- Confirmative visualization for analysis of hypotheses
- Brushing and linking

After the presentation, the students had a session on training in use of the tool.

Short presentations by the participants

The participants gave a short 5 min presentation of their ongoing work. A summary of their work is presented in this section.

Trygve Halsne, Norwegian Meteorological Institute, Norway

He is employed as research scientist in the department of remote sensing and data management. He works on distribution of Sentinel data through the Norwegian National Ground Segment, funded by The Norwegian Space Agency. In addition, he is involved in automatic sea ice segmentation from SAR and passive microwave products.

Joshua Jones, The Geophysical Institute & International Arctic Research Center, University of Alaska Fairbanks, United States

He is a researcher in the Sea Ice Group at UAF, working with sea ice dynamics, land fast sea ice processes, Arctic oceanography, and the use/interactions of various stake holders (native Arctic peoples, industry, mariners, etc.). The work includes assessing the impact of sea ice associated hazards,

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like land fast ice breakouts, swift convergence of ice towards shore, and ice in marine traffic, on stake holders. He is also the Research Coordinator for a community-based observing program in Northern Alaska, the Alaska Arctic Observatory & Knowledge Hub (AAOKH). AAOKH is intended to provide Arctic Alaskan communities with the tools and support to make science and community relevant observations regarding the seasonal environmental cycle and changes to it, sea ice and oceanic conditions, and wildlife. AAOKH also networks with international community-based observing programs, such as through the INTAROS project.

Takuya Nakanowatari, National Institute of Polar Research, Japan

He is a researcher working at the national Arctic Research project in Japan (ArCS project), where he mainly studies the medium-range predictability of sea ice thickness distribution in the Arctic Ocean for the development of ship navigation system in Northern Sea Route. During autumn 2018 he was visiting scientist at NERSC, working with the TOPAZ ice-ocean modelling and data assimilation system.

Zeinab Jeddi, Department of Earth Sciences, University of Bergen, Norway

She has been employed as postdoc at the institute since mid-May 2018 under the INTAROS (Integrated Arctic Observing System) project. In her group work is focused on creating a unified earthquake catalogue for the Arctic which will serve as a baseline earthquake database. Such a catalogue is required to study the temporal variations of the Arctic seismicity and assess the seismic hazard in the area. In addition to fill part of the large observational gap in the offshore regions of the Arctic, three Ocean Bottom Seismometers (OBS) were deployed in the Fram Strait near the Northern Mid-Atlantic Ridge during summer 2018 and will sit on the sea floor for one year.

Henrik Hellem and Bjørnar Hallaråker Røsvik, University of Bergen, Norway

Both students are pursuing an integrated master's degree in marine technology at the University of Bergen. They are in the second year out of five in total. As part of the coursework this semester they have spent two days a week at working as trainees at the Nansen Centre, working with acoustic data and tools.

Jan Michalek, Department of Earth Science, University of Bergen, Norway

He received his PhD in 2014 and is employed at the department as senior engineer on the EPOS-N project since 2016. He works with data management and interoperability, integration of tools for data and metadata management. He has been working with earthquakes since 2006 and especially micro-earthquakes were of interest for me as those are much more frequent and finding patterns and relations between them could lead to understanding of processes at larger scale - evolution processes of larger earthquakes.

Sascha Schiøtt, Aarhus University, Denmark, and Greenland Institute of Natural Resources

She is presently Ph.d fellow at the Greenland Institute of Natural Resources, in collaboration with Arctic Research Centre at Aarhus University. The topic of her Ph.D is "Analysis of the ecosystem in Ilulissat Icefjord" where she works closely with local fishermen and hunters, and use methods as eDNA analysis, Fatty acid analysis, stabile isotopes, stomach content analysis, and interview survey with local people, to get an overview of the ecosystem in the Icefjord.

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Samantha Jones, Department of Geography, University of Calgary, Canada

She is a second year PhD student working with dissolved inorganic carbon (DIC) and carbon dioxide cycling in a lake – river – estuary continuum on Victoria Island, Nunavut. The research aims to quantify inorganic carbon fluxes and characterize seasonal variations in both inland waters and marine environments to establish baseline conditions and identify potential vulnerabilities to future change. The investigation of linkages between the different environments crosses boundaries, as inland waters and marine settings have been traditionally studied by separate research communities.

Oliver Bartlett, University of Exeter, United Kingdom

He is PhD researcher in Physical Geography, specializing in remote sensing of the cryosphere. The aim of his research is to use the latest available data and technology in remote sensing, i.e. the ArcticDEM and UAV photogrammetry, to develop methods for investigating ice masses in various geographical situations. Additionally, by implementing these methods the aim is to contribute new insights into the changing nature of ice dynamics and ice volume in a changing climate. My scientific background also includes an MSc in Polar and Alpine change where I studied current issues which may affect the Arctic including human and natural hazards.

Delphine Collin, Paris 1 Panthéon Sorbonne, France

She has a bachelor in Geography and Environement, Sorbonne Université in Paris, now in first year of Master in Sorbonne Université, Geography, Dynamics of Environment and risks (Dynarisk) During her studies she has obtained a cross-disciplinary view on environmental issues. The studies include biophysical dynamics of biodiversity as well as the human influence. In particular she has studied earthquakes, tsunamis or landslide hazards in a physical and a economical way (within Utrecht University, Erasmus Programme 2018). The methods and tools she used include surveys, interview, records, coring, creating maps using Arcmap or QGis.

Agata Grynczel, Institute of Oceanology, Polish Academy of Sciences, POLAND

She is PhD student at the Physical Oceanography Department, Institute of Oceanology Polish Academy of Sciences. Her studies are focused on the northward transport of warm and salty Atlantic water, carried by the West Spitsbergen Current, which has a significant impact on conversion and circulation of water masses, and heat content of the Arctic Ocean. Observational data collected by the Institute of Oceanology in the European Arctic cover almost two decades. The oceanographic data include temperature, salinity and ocean currents measured at fixed stations during the annual AREX surveys of RV Oceania and provide an excellent basis for analysing the impact of oceanic variability on the Arctic sea ice cover. The PhD work will contribute to expanding knowledge about how the changes in the temperature and strength of the Atlantic water inflow impact the extent and variability of sea ice concentration in the research area.

Morgan Ip, Oslo School of Architecture and Design, Norway

The topic of his PhD work is - Design Anthropology within Arctic Urban Landscapes. The work is focused on experimental ethnographic material (data) collected through interviews and an online co-mapping tool called MyBarents. Here the qualities of abstraction and spatial recollection of maps were combined with local impressions and visions of place. Citizens plotted a few hundred community ideas

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on digital and physical maps of Kirkenes and Vardø, Norway, and Nikel, Russia. This proved invaluable in capturing elements of the cultural landscape, namely as they pertain to local attachments to nature, and challenges and opportunities associated with globalism, migration, resource extraction, education and culture. However, designers at the scale of architecture and beyond are increasingly aware of the interdisciplinary value of combining several scientific and community-based evaluations of landscapes/cityscapes/seascapes to produce more contextually relevant design solutions. Architects, landscape architects and urban designers need better access to the vast wealth of data and ethnographic material, and I believe this workshop may assist with this task.

Thomas Thuesen, Department of Earth Sciences, University of Bergen, Norway

His PhD project is looking at the evidence for previous and present sedimentary processes for better understanding of how sediments are transported and deposited within different depositional environments. Specifically, natural geohazards related to slope failures from snow and rock avalanches and flooding events related to glaciers and precipitation are highly relevant for local communities in the Arctic, such as Longyearbyen. His research interests lie in quantifying sediment volumes and understanding the frequency of flooding events, and avalanches by looking at the evidence (the sediments) dating back to the last glacial maximum. Figuring out the volumes and frequency of geohazards such as avalanches and floods several hundreds and thousands of years back in time, trends and changes can be observed. These changes can be related to climate change, human impact etc. If we can understand how something works, we can better understand how to monitor it, minimize the risk of it towards humans, and how to mitigate its impact.

Tuesday 04 December. Topic: Ice and oil spill related hazards in the Arctic

*Søren Rysgaard**,** affiliated with University of Manitoba, Greenland Institute of Natural Resources and Aarhus University*, gave a lecture entitled "Decreasing ice – increasing ice hazards". The combination of less sea ice, more extreme weather events, better access to new areas of oil and gas exploration, and increased demand for energy will lead to high risks for accidents in the Arctic. Especially the risk for oil and gas pollution in a very vulnerable environment. Oil embedded in sea ice is very difficult to recover and can be transported over large distances by the drifting ice. The presence and drift of icebergs and ice islands add to the risk because collision with ice can cause severe damage to vessels and platforms.

Leendert Vergeynst, postdoc at Aarhus University, gave a lecture on the fate of oil spills in Arctic marine environments. The risk for oil spills is not only caused by production and transport of oil, but also from the growing ship traffic in the Arctic, especially the tourist traffic. Ship accidents like collision with ice or grounding can easily cause oil spills. The risk is higher in the Arctic compared to other areas because of the weather and ice conditions, darkness in winter, poor sea charts and remoteness to search and recue facilities. The lecture addressed the processes acting on oil when released on sea ice and cold water such as biodegradation which can contribute to breaking down oil spills. In the afternoon session, Leendert demonstrated an online system for oil spill simulation scenarios, where possible impacts of various types of oils spills could be studied. The participants could run exercises with this system, which had been developed by World Wildlife Foundation (https://arcticspills.wwf.ca/#home/).

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Øystein Godøy, Norwegian Meteorological Institute (MET Norway) gave a lecture on Arctic data management with focus on the operational aspects. There are quite different requirements and systems for operational data and scientific data. Operational data are provided in near-realtime and also for long term monitoring. The data shall support operational services, especially weather forecasting. The data collection and distribution follow standardized procedures including which variables are part of the operational data, how they are encoded and quality controlled. Scientific data don't follow the same strict standardized procedures as the operational data. The scientific data are much more diversified, although some of the data follows standards and are collected over long time for monitoring and are managed by data centers with responsibility for archiving. But a large part of the scientific data are collected over short time as part of process studies or for development of new sensors and platforms. These data are not managed in systematic and consistent way, and the FAIR principles are therefore difficult to follow. The lecture emphasized the importance of establishing good data management practices which start with planning of the data collection. Use of standards is important for both data and metadata. The WMO Information System (WIS) provides standards and guidelines for data management and sharing of meteorological and related data. The concept of WIS is to provide a single coordinated global infrastructure for the collection and sharing of information in support of all WMO and related programmes (http://www.wmo.int/pages/prog/www/WIS/).

Frigg Jørgensen, Executive Director of AECO - Association of Arctic Expedition Cruise Operators, gave a an overview presentation of what AECO is doing. AECO was founded in 2003 and has since become an important organization representing the concerns and views of Arctic expedition cruise operators. AECO is dedicated to managing responsible, environmentally friendly and safe tourism in the Arctic and strive to set the highest possible operating standards. More information about AECO is found at https://www.aeco.no/.

Pedro Gonçalves, director of Terradue, gave an introduction lecture to satellite data applications for arctic research. The lecture focused on use Synthetic Aperture Radar (SAR) data, which are provided from Sentinel-1 and other satellites. SAR and among the most important data for observation of sea ice and landice. Also other satellite data are important for sea ice/landice observations, such as passive microwave, radar altimeter, and optical/infrared data. For oil spill detection, SAR data is particularly useful, and these data are used operationally by national and European agencies with responsibility for pollution monitoring. Terradue provides tools for processing and analysis of satellite, which several of the participants were interested to use. Pedro Gonçalves offered support to use satellite data in some studies conducted by the participants.

Wednesday 05 December. Topic: The Ocean Acoustic environment

Hanne Sagen (NERSC) gave an introductory lecture on ocean acoustics with title "Sound for survival, pleasure and exploitation". Natural processes (e.g. sea ice, ocean waves, grounded icebergs), marine mammals, and human activities (e.g. ships, seismic surveys, offshore installations) generate acoustic energy that impacts the acoustic environment on local scale to basin-wide scale. Acoustic noise is one of the 11 indicators of good environmental status in the Marine Directive Strategy Framework (MDSF). MDSF is to be implemented and aims to achieve Good Environmental Status of the EU's marine waters by 2020. Increased shipping and exploitation of resources in the Arctic regions will change the ocean soundscape. Marine mammals spend most of their time underwater, with sound as their main tool to gather environmental information, and find food, either through active echolocation or passive

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listening. Understanding the impacts of acoustic pollution of the environment in the different regions is important for developing mitigation plans to respond and to reduce negative consequences for marine life. Regulation of noise exposure from human activities will need international collaboration and intergovernmental agreements based on state-of-the-art knowledge. Given the competing and perhaps conflicting interests of nations, industry, and local communities around Arctic development such an agreement will require substantive baseline data to inform policy development. Acoustic influences from shipping and seismic surveys are often sensitive topics in local communities, and knowledge-based information is often lacking or misinterpreted.

Maribeth Murray, Arctic Institute of North America, University of Calgary, gave a lecture on the need for ocean acoustics data in Arctic Canada. The impact of ocean acoustics is expected to increase as a result of growing shop traffic, mining, offshore development and other human activities generating acoustic stress in the ocean. Marine mammals are exposed to noise from seismic surveys in the northeastern Canadian Arctic, which is one of the environmental issues causing conflict between the Inuit and industry. Environmental legislation and Canada's international commitments requires that the movement and survival of marine mammals and other species is documented. Agencies need data for day-to-day decision support and long-term strategic planning. On this background acoustic monitoring observatories are being developed in Arctic Canada.

Ann Christin Auestad, UNIS, gave a presentation of the newly established Arctic Safety Centre at UNIS. The mission of the Centre is to build up knowledge and expertise on safe and sustainable human activities in the High Arctic. The Centre shall share this knowledge through education, tailor made courses, guidance of students, industry and residents of Longyearbyen. There is increasing demand for Arctic safety knowledge among all the people who are present, or plan to be present in the Arctic. The first Arctic Safety Conference will be organized at UNIS 13-15 May 2019. The aim of the conference is to bring multidisciplinary experts together for sharing experience, new findings and best practices for safety in the Arctic. The ambition for the conference is to advance in the understanding and management of risk, safety and reliability in an Arctic context. The conference address technological, human and societal aspects of arctic safety.

Kjell Eivind Frøysa, Western Norway University of Applied Sciences (HVL) gave a lecture on instrumentation and measurement methods in ocean acoustics. Examples of acoustic data from different sources were demonstrated, showing the wide range of frequencies that characterize acoustic data. The difference between active and passive acoustics was explained, and practice applications of ocean acoustic were explained, such as echo-sounders on ships for measuring the sea depth and detection of fish stocks. Finally, instruments used for collecting acoustic data were demonstrated. In the afternoon, a lab experiment was set up to measure sound speed in water. The participants were conducting own measurements and got hands-on experience with acoustic instruments.

Torill Hamre (NERSC) gave a lecture on acoustic data management. The lecture described how to prepare a data management plan, how data management starts with data collection, what types of data products can be derived from raw data, how data products can be stored in data portals and be integrated with other data. The concept of data lifecycle was explained in order to facilitate re-use of data. Also various tools and software for acoustic data management as well as guidelines for publishing data were described.

Espen Storheim (NERSC) had prepared practical exercises on acoustic data processing, which were presented in the afternoon. One exercise was to listen and look at passive acoustic data recorded from

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previous field experiments using a software package designed for processing acoustic data. Spectrogrammes were computes and displayed, and various filters were applied. Another exercise had focus on setting up relevant metadata for a given acoustic data set. The purpose of this exercise was to give the participants hands-on training in preparing metadata, which is an important part of data management.

Thursday 06 December: Topic – Community-based observing and communication

The programme for the day was organized by Lisbeth Iversen (NERSC) and Alexandra Meyer (University of Vienna) who is postdoc on the H2020 project NUNATARYK dealing with permafrost in the Arctic (https://nunataryuk.org/). The morning session had presentations in the morning and a dialogue workshop in the afternoon with invited representatives from Longyearbyen.

Lisbeth Iversen, NERSC, gave an introduction lecture on present work in the INTAROS project, where topic is development of community-based observing systems and communication between scientists and local communities. A central theme for the inhabitants in Longyearbyen is adaptation to climate change and the transition from a coal-mining town to a more diversified community which is not dependent on coal production. The adaptation involves many issues, in particular:

- Adaptation to climate change embraces both individuals and groups, nations and the international society.
- This means that research in this field includes both studies of politics, instruments and actions, their effect on the climate system, nature and society, and analyses of societies ability and willingness to explore and execute changes.
- Society needs through research, to find new solutions to how we can use nature and local conditions as tools for change and adaptation to climate change, and bring forward research that can stop, or even reverse or slow down climate change.
- «Research on adaptation to climate change also includes decisions, processes, actors and institutions. It is about variations in time and space, and includes research on principles and facts that can be the foundation for decisions, like cost efficiency, legitimacy, principles for allocation of resources, welfare consideration and power- and dependence relations»

Marthe T. Fjellestad, academic director at the University of Bergen Library Picture Collection, gave an invited lecture "Library, Archival, Information and Data Sciences in the Arctic". A key question was how library through information and data sciences can contribute to Arctic research in humanities and social sciences. Libraries can provide:

- Special collections, archives, and artefacts: Researching the Arctic in physical and digital formats
- Articulating the Arctic: Information representation, retrieval, and behavior in indigenous, local, and regional languages
- Statistics, facts, and figures: Arctic social sciences data curation and management
- Libraries and museums as spaces for society and culture: Communication, display, and critique of Arctic people and place

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Børge Damsgaard, professor in marine biology and the departmental leader of the UNIS, gave a lecture on a citizen science project in Svalbard. The term "citizen science " is often confusing and can mean different things. The following criteria must be fulfilled in order to be a citizen science project. It must:

1. Be coordinated by a research institution
2. Use citizens with the appropriate background
3. Address topics where citizens can give valuable contribution
4. Use methods that are safe and scientifical & ethical sound
5. Link the project with a learning or dissemination aspect

Citizen science projects can play an important role to involve non-scientists in scientific work and thereby raise peoples' trust and confidence in science. Community-based observing systems, which can include more or less scientific work, are usually defined by local communities and are designed to serve the interests of these communities. In the Arctic, community-based observations have potential to make significant contributions to science, but this requires that the observations satisfy points 1 -5 listed above.

Hilde Fålund Strøm, Product manager, Hurtigruten Svalbard. She gave a lecture on how it is to be a local inhabitant of Svalbard, experiencing the dramatic climate change, and the disastrous snow avalanche which took peoples' lives in December 2015. She also has the role as "citizen scientist" to collect scientific data during her overwintering in a trapper's cabin from 2019 – 2020.

In the afternoon a dialogue workshop was organized in a collaboration between UAK, INTAROS, NUNATARYUK and UNIS with invited persons from the Longyearbyen community. The workshop was facilitated by Lisbeth Iversen, NERSC, and Alexandra Meyer, NUNATARYUK. The aim of this workshop was to initiate a dialogue on knowledge, challenges and possibilities related to climate, nature, and the environment on Svalbard. A central question was how research on climate and the environment can be of use for the local community in Longyearbyen. Representatives from local actors gave short statements about what they see as the most important challenges and possibilities related to climate, nature, and the environment within their sector, as well as what knowledge is needed. A report from the dialogue workshop is attached in Appendix.

Friday 07 December: 0900-1200: Wrap-up of the research school

In the wrap-up session, the experience from the four days of the research school were presented by

- M. Sørensen on natural hazards with focus on seismic hazards,
- S. Rysgaard on ice and oil spill related hazards,
- K. E. Frøysa on ocean acoustics,
- L. Iversen/M. Murray on community-based observing and communication, and
- P. Pulsifer/Ø. Godøy on cross-disciplinary data collection, management and usage

Comments and questions from the participants showed that this type of cross-disciplinary research school can be difficult for some and interesting for others, depending on their background and interest in topics which are wider and extend beyond their daily work. Especially, organising student exercises involving data and software can easily become irrelevant or too technical for some of the participants. On the other hand, the mix of young scientist with very different background was very stimulating for the participants.

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The opinion from the participants were reported in two questionnaires, one was about communication and knowledge transfer and the other was direct feedback on the research school. These reports are presented in the following sections.

5. Questions and answers on communication and Knowledge Transfer

Questionnaire

The participants were given these questions to respond by the end of the research school:

1. Do you work in a community ? With a community ? In a remote location ? In a lab ? With end users of your data ? Please explain.

2. Who are the end users of your data ? What do they use it for ?

3. How much translation of your data/findings do you need to do in order to make accessible to your end users ? To a broader audience ? What does this involve ?

4. How do you engage with end users ? Stakeholders ? Rights holders ?

5. Dissemination of research ? Where, in what format(s), for which audience(s) ?

6. Do you think your research is societally relevant ? Why ? How do you convey this relevance to a non-scientific audience ?

7. Have you had experience talking about your research with different media ? (newspaper, radio, film, television, podcast, etc.). How did this work out with respect to the way in which your work was covered ? Was the outcome positive or negative ? What would you do differently ?

8. Have you ever taken a course in communication or been provided with any training on how to communicate scientific information to the public? Please explain.

9. Have your ever worked with a communications professional (for example University Relations or others) ?

10. Any other comments ?

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Replies to the Questionnaire by nine of the participants

1. Do you work in a community? With a community? In a remote location? In a lab? With end users of your data? Please explain.

"I work in a science community with both scientific topics and data management. I have some communications with the end user of our system".

"In one project, AAOKH, I work in many remote Arctic Alaska villages, with specific people who make various environmental and other observations. I also work on other projects in which I collect data for people who will ultimately use the data for their research, while I will not use it for my research".

"Our work in the earthquake monitoring network, provide information for the community e.g. earthqauke hazard maps. This is done in several separate sectors, gathering data about natural activity (remote locations), human made activity (in connections with mines,...),
how are the buildings are made in different parts (in connection with municipality and sometimes measurements in buildings) and how people are educated to react in case of catastrophic event (in schools or public venues,...)".

"I work with the communities of Kirkens and Vardø, Norway, and Nikel Russia, as well as previous work with Cape Dorset and Sanikiluaq, Nunavut. These are all remote locations, although the Canadian communities are only accessibly by plane or ship. Nikel and Kirkenes are all connected with the European highway system. End users are everyday citizens, as my work is on place perception and rights to the city/landscape as set out within the European Landscape Convention".

"Seismological observations are usually done at remote places where "mechanical" noise level is low. We do interact with people while installation is being made. We expose our results to end users via web page (map with locations of recent earthquakes, yearly catalogues of observed seismicity, yearly reports on seismicity)".

"I am working in laboratory to develop the Arctic shipping route search system in the present climate status based on the dynamical forecast model in a laboratory. This study is moulded by several researchers, but the outcome can be practically used for the determination of shipping route by the end users who are operating commercial vessels as well as research vessels".

"I work with local hunters in Ilulissat, Greenland in which the locals are collecting samples for us. I will also be collecting local and traditional ecological knowledge about Ilulissat Icefjord and will in that context, have public meetings where I will present my research".

"Yes. I work in the community of Cambridge Bay (approx. 1800 people). My field area includes locations that are important to the locals for subsistence, recreation, and cultural activities. I work with a government lab as well; the CHARS research station".

"I work in a community in a fjord called Fjærland with 300 inhabitants".

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2. Who are the end users of your data? What do they use it for?

"End users of the DM system span from scientific, SME's and private persons. They use the system for discovery and retrieval of Sentinel satellite data".

"For the AAOKH project, the community whaling crews use our ice thickness data to determine areas where ice is thinner and might be more likely to melt through quicker or break under a heavy load. My group at UAF also uses the local observer data to compare environmental conditions, and various community activities, to observe changes in behavior and/or the environment".

"The data is gathered normally somewhere far from city noise and transferred to office and it is available online which can be used by anyone. But in addition to random curious people, main end users of our data are either scientists want to understand more about earth, engineers who want to build infrastructures/ produce hazard maps, or most importantly decision makers (disaster management sectors) in case of big natural seismic activity".

"Ethnographic materials are intended to map out the cultural landscape in terms of local knowledge and perceptions of place, and speculations and desires for the future. This contextually rich material is intended to be used as a living repository that can inform decisions of spatial development and design".

"Oil companies: Monitoring is co-funded by Norwegian Research Council to which oil companies are contributing substantially. Reports to representatives of oil companies is done annually. Scientists: Data are shared via web services immediately and therefore available for scientists globally. Public: Information about felt earthquakes is collected online, results shared publicly on web page".

"The end user may be ship operator in the field and/or also the planner of it. The optimum route based on the dynamical forecast model data can be used to make a decision of shipping route in the field and its planning (timing, etc)".

"Other scientist that wants to do research in Ilulissat Icefjord, but also for all interested Greenlandic citizens with interests about the ecosystem in Ilulissat Icefjord".

"Potential end users of my data are:

- Other researchers who may use my data for context, constraints, and analogues for incorporation into bigger picture modelling or prediction initiatives
- Fisheries who may be interested in how global change affects habitat suitability in the coastal waters near the community.
- The municipality who may be able to use research outcomes to make decisions about wastewater release. Part of my work will focus on the way that late summer wastewater discharge into the coastal waters impacts carbon cycling (and acidification in the bay). The municipality may choose to consider the results of my study in making future decisions about wastewater treatment".

"All the data I am collecting will be used towards my PhD project that runs over 4 years. We have a cooperation with the glacier museum in this area. However, the project is small (only myself and my supervisors are involved). There is a future plan of making a fjord centre in Fjærland, and the visions

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of the people in this planning process is that a lot of the information and data I gather will be presented here. I hope that a lot of the data that I collect, will help in better understanding flood and avalanche hazards within the fjord. The end users that will be able to benefit from this is therefore the local community, and hopefully companies that deal in avalanche and flood risk prevention".

3. How much translation of your data/findings do you need to do in order to make accessible to your end users? To a broader audience? What does this involve?

"We make all our data available through our system"

"In some cases, the end users just need the processed data, i.e. ice thickness along a trail. In other cases, the end users need the data to be interpreted in the context in which they want to consider the outcomes. At the community level in the villages we work in, the data must be presented in such a way that non-scientist people can understand how the data that was collected is relevant to them".

"This really depends on end user, scientist end users can use raw data, but if want to provide decision makers data required to be analyzed quite in detail to be able to provide trustable knowledge. To broad audience, general information can be transferred after some processing and it is normally available online and also in the several mobile applications, however in case of catastrophic event, normally knowledge transferred through municipality to public not the scientists".

"The audience is multilingual, with Norwegian, Russian, Finnish, Swedish, and Saami being spoken and English often used as a lingua franca. Design resolutions are visual / image based and therefor transcend language, however all associated texts are in English. During outreach, translation in Norwegian, Russian and Finnish was undertaken, and the online map was also done in the four languages. This could be improved with better, holistic translation".

"Location of earthquakes is verified manually an published immediately on local web page (nnsn.geo.uib.no)".

"The search system of Arctic shipping route should be easily used for each user through the web-based application".

"I am myself born and raised in Greenland, and therefore speak Greenlandic, and have already had a couple of interviews in the Greenlandic radio where I presented my work, and plan on doing more, as I think it will benefit the locals to get more knowledge about the ecosystem".

"I will need to identify immediate benefits/considerations for the community since many of my results and implications are long term".

"So I work with understanding sediment transport. Major contributors to sediment transport is avalanches and floods, because the energy involved in these processes is large, and a lot of sediment is deposited. Why sediments? Because sediments can be mapped back-in-time (archive of events that has occurred), you can observe previous events, and therefore understand frequency and volumes. In order to translate that data into information that can be used by the community and hopefully companies that work in avalanche/flood prevention, it has to be applied to frequencies and sizes of events".

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4. How do you engage with end users? Stakeholders? Rights holders?

"Workshops and interactive through the contact form of the portal etc".

"With the villages, I try to present the science as just a way of looking at something they may already know, not in the sense that we know more about something that they have been living with and observing for probably much of their lives. Or maybe just as putting numbers on something they have observed. For instance, the villagers/end users know that the reduced presence of landfast ice is allowing storms to erode their shores more than it used to. I would show them that, on average, the landfast ice is forming two weeks earlier and breaking up two weeks later. I think the village members are all three end users, stakeholders, and rights holders."

"I engaged end users via social media pushes and posts, interviews with local newspapers that are published in paper and online, local tv interviews, and workshops organised with important local actors, as well as open house mapping events during popular local festivals. Interviews were also done with local miners and other actors, and participation in everyday activities also informed my ethnographic research. I also spoke with the local highschool in Kirkenes, and participated in local rejuvenation groups in Vardø. A design studio was also conducted, with international students based in Oslo learning ethnographic methods, and deploying a number of different strategies to engage with people in Kirkenes, or otherwise observe people via participant observation, to inform their designs, as well as taking previously collected material from my PhD research."

"Stakeholders and annual meetings"

"We held some workshops with stakeholders to discuss our study and whether our outcomes are really needed or not."

"Public meetings, radio, and press release."

"I have not completed any independent engagement activities. My supervisor completed some engagement activities before I joined the lab. I would like to come up with some ideas to continue this relationship building myself."

"Seeing as I have only been working for a year with the project, the only interaction has been with cooperation with the glacier museum in Fjærland."

5. Dissemination of research? Where, in what format(s), for which audience(s)?

"Conferences and workshops both national and international. Audiences span from scientists, governmental agencies, start-ups etc."

"We submit papers to be peer reviewed for publication for the scientific audience. For the villagers, they like to have something in their hands that they can take home and look at or they attend community presentations/forums in which the research must be presented at really a non-technical

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level. For the oil companies that we work with, we provide the research in way that would allow them to assess the research and make their decisions based on that."

"Most of permanent recording data are available for public through some international webservices,. In earthquake data, normally general information (time-location, how big) gathered in each station reported as text files and can be downloaded together with section of data which is relevant to earthquake. Continuous data usually are not available online, and will be provide up on request. However, temporary projects usually don't share data to public."

"The design studio research was disseminated via a month-long exhibition at the central public library, with student posters up alongside models and maps, and a published book of all their works as well as the teachers text-based articles on the course. Students also volunteered their time to a local festival to engage with local and visiting artists, and engage in conversation. Two peer-reviewed texts have so far been published (or are in print) that is directly resultant of the PhD research. Participation in local forums on the arctic, borders, migration, arts, occurred in Murmansk, Nikel, Vardø and Kirkenes. These include the Transborder café series organised by local arts group Pikene på broen, and Murmansk cultural producers Friday Milk, and were well attended. Also, I participated in the Kirkenes conference for two consecutive years that I lived in Kirkenes, which was mainly to an academic and political audience. "

"Research done on seismic observations is published in scientific journals mostly. Not much outreach for public audience is being made (except for the online maps)."

"At first, we wrote the scientific paper and after give the outcome in the form of press release. Finally, I will provide the application of shipping navigation system via web page. In this case, anyone can access this service."

"Public meetings, PhD thesis, publishing scientific articles, and communication through social media."

"I will also need to create products that are in a form that is accessible to the community. For example, development of short podcasts that can be shared online to explain key results or introduce myself and the project. I would like to create some visual products as well to communicate key messages and findings to a broad audience. Visual and audio products will also serve to communicate with an audience in my absence, making the knowledge mobilization an ongoing process rather than a one-time event."

"Dissemination will occur at international conferences, but with peers, and not local community or non-researchers. Why? Because a PhD demands that you represent your work in that way. My wish is also to present my findings in Fjærland, and make an exhibition of it at the Glacier museum."

6. Do you think your research is societally relevant? Why? How do you convey this relevance to a non-scientific audience?

"Yes, it is relevant. Our scientific output is operational sea ice charts in the area around Svalbard. Hence, fishermen, private persons, various companies use our products for e.g. ship navigation and route planning."

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"Yes, especially in the villages. We are researching the environment in which they live, and more often than not they are very interested to begin with. We try to engage and include them in the discussion and research itself as often as possible."

"Yes. The research is in direct relevance to the safety of people leaving in the earthquake-tsunami, landslide, etc. posed areas. The research is also important in discovering activities like nuclear explosion which is quite important for keeping our society safe. In addition, in building the infrastructures could be very useful."

"I believe my research is mainly about social relevance, and including local voices in the participation and co-creation of the communities in which they live. This is conveyed in the many non-academic settings I found myself in to describe and engage in the research work."

"Yes, people need to know what happened and whether other people (relatives) were injured/in danger. International agencies are disseminating such information."

"Our outcome may contribute to the reduction of shipping accident due to the crash with sea ice or ice berg. In this meaning, our research is societally relevant. However, on the other hand, I am concerned about that the promotion of the usage for the Arctic shipping route leads to the pollution of Arctic Ocean."

"Ilulissat Icefjord is on the UNESCO world heritage list, and knowledge about the ecosystem is therefore very relevant in that context, but also because the fjord system might have an important impact on the fishing industry in the area."

"Yes. My work contributes to understanding both baseline conditions in the Arctic and the vulnerabilities to global change. This is important globally because of the influence that the Arctic system has on the climate system of the entire planet. I use the links between changes in the carbon cycle, the hydrologic cycle, and the increased frequency and intensity of extreme events as an entry point to talk about my research. I have also talked about the carbon cycle, acidification, and food security as a starting point. Both the impact of extreme events and the need for food security are issues that most people can relate to from their own personal experiences."

"I think it is very socially relevant. It relates to avalanche and flood hazards, which is a frequent occurrence in Norway. The main way that hazard risk mapping is done, in relation to floods and avalanches, is by looking at history (what has previously occurred in that area). Therefore, by understanding avalanche and flood events far back in time (perhaps back to the last glacial maximum 10 000 years ago), we can better understand how the processes within this fjord has happened. People usually think of natural hazards as unusual events, but it is us that is the unusual factor, not the natural hazards. Example: A flooding event only becomes a hazard towards people, when we decided to build our houses on the flood plain."

7. Have you had experience talking about your research with different media? (newspaper, radio, film, television, podcast, etc.). How did this work out with respect to the way in which your work was covered? Was the outcome positive or negative? What would you do differently?

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"My only experience is using twitter - but there was a lack of comments ;) The tweet itself was about detecting oil spill outside Oslo from satellite imagery. However, it was more a proof of concept in terms of advertising all free satellite data available than quantifying the outcome of the oil spill itself."

"We are about to send out a newsletter to the villages, so we have yet to see that will be received. I think it will go over well, and folks will like to have more in the future. I have been interviewed on the radio alongside one of our local observers. I think it the outcome was pretty positive, it helped having a local community member who is a part of the research participate in the interview."

"No"

"Yes, as noted above, I presented my research intentions and opened it up for feedback and adaptation to local concerns via newspaper articles, online social media, and local television stations, in addition to participation in locally held conferences and popular festive events. All discussions tended to positively view the direction of the research, with critical feedback on concerns about outreach, motivation to participate, resistance or acquiescence to authority, etc… I would, in the future, work even more closely in determining research questions and organisation or documentation. I would also work better with translators, both in clearly outlining my research goals and intentions prior to recorded questioning and publication, as well as in establishing a two-way dialogue with communities via the various media being utilised."

"Yes, television (documentary). Positive, informing public about scientific monitoring, natural phenomena. In that region the seismic hazard is low."

"I have talked about my research with newspaper and television."

"I have been both in Greenlandic newspapers and radio and for now this has been a good experience as I have gained local contacts and I have been told that it is good that I share my research with the Greenlanders, in Greenlandic and in a language that wasn't too scientific."

"No"

"I have not had the experience of talking about my research with different media. However, by arranging "Geology day" and attending "Forskningsdagene" I have had some experience in how to convey what I am looking at, to people that have never heard of these things before. Also through writing grant applications I have had experience with explaining what I want to do, in simpler terms."

8. Have you ever taken a course in communication or been provided with any training on how to communicate scientific information to the public? Please explain.

"No, but they plan to offer locally at my working place."

"No, not really. But I have worked a lot with community members where we do research and have learned productive ways to communicate with other community members who may not be as personally involved."

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"Yes. one-week workshop in natural disaster management. The workshop was done in a very interactive way in two groups of people including scientist from different disciples and management sectors. We have given a data from past real situation on volcanic acticity in Etna and we required to analyze data and provide information to managers to decide about evacuation. It was very interesting because in addition to lectures we really required to interact with other scientists in different disciples than us and confirm our understanding of data with them and give a consistent report which should have been sending information to people how to react in case of eruption. "

"I have taken one seminar on how to communicate scientific information at an APECS conference in Whitehorse, where I won one of the poster awards. This was about how to organise posters to bring people through the research process and findings, however this was still far away from communications skills learned in design schools. There could be better bridges to connect the graphic design schools and natural and social sciences."

"Not directly. Learning by doing."

"I have not taken some courses related to the communication with public. I think we has the responsibility to tell the meaning of our research for public people through the social media. Therefore, we make an effort to show our research in a plain text as press release. To make a plain text for our research, we are often supported by the group of public relation in our institute."

"I attended a course called "communicating scientific research" – how to communicate to a broader audience and not just scientists, which helped a lot as I realised that you should leave out scientific terminologies and phrases when communication to people outside of the research environment, and how you can communicate so that the interviewer can understand your research."

"I have completed formal science communications training. I attended an intensive, multi-day science communications workshop (Beakerhead SciComm School at the Banff Centre) and have attended science communications training through on of my project funders. These sessions have provided tools and inspiration for me to start framing ideas for disseminating results."

9. Have you ever worked with a communications professional (for example University Relations or others).

"Yes. Part time job under my studies for sci-com for elementary schools up to high-school for encouraging them to study science."

"Yes, a communication professional produced the newsletter with the help of the science researchers."

"Only in workshops and short courses as mentioned in point 8."

"I have not."

"Not directly."

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"Yes, I have worked with the group of public relation in our institute to make the press release document of our research in plain text."

"No"

"No, I have not had communication training."

10. Any other comments?

"Communicating science to in cross-disciplinary and non-scientific environments are kind of seldom events. Hence, I think prioritizing these types of events are very important for getting even more people aware of the research and topics that we work on - and for them to see the relevance."

"I might misunderstand some of questions but I tried to contribute according to my experience. I may add that I know scientists (not few) that are believe in climate change, but also believe that considering interdisciplinary research should not limit the pure science. Therefore there is believe in that there should be specifically educated people dedicated to interdisciplinary science."

"Thank you for this questionnaire. It allows me to quickly distill and analyse me methods, look for areas of improvement, and also understand the multiple modes of engagement and data/material sharing."

"As the ability of researcher, I think that the communication ability with public people as well as the research ability is important. I suppose that this kind of discussion has been continued since about 10 years ago. On the other hand, the translation into plain text sometimes makes some errors on the interpretation of the research content. Therefore, we have to make an effort to tell the research content in a plain way without the precision, although this process seems to be difficult for most of researchers."

"Good questions!"

6. Participant feedback reports

Trygve Halsne, Norwegian Meteorological Institute

- *What do you think about the program and the inter-disciplinary approach in this research school?*

The interdisciplinary approach was interesting and useful - to some extent. It is interesting, and important, to see how other disciplines approaches topics in the cryosphere. And I guess the future needs inter-disciplinary work to close some of the gaps concerning unanswered questions in the arctic. However, there is a limit on how far one should go into other branches in order to follow up on the development in your own branch.

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- *Was the level of the presentations too low, too high or about right?*

In general, too low and about right. As far as I'm concerned, I think no presentations had too high level.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

In my opinion, it would be more fun to do some work on the data. E.g. a lecture describing the data and the topic, and then a Jupyter Notebook (or similar) where you could run the code directly on your PC to get familiar with the data and the ways of analyzing. I guess in the latter part (i.e. data analysis) there are overlaps across disciplines.

- *What has been the most interesting part of the research school for you?*

To me, the most interesting parts was to 1) get to know scientific groups within my field of expertise from other countries, 2) get more familiar with biological processes related to oil spills in the arctic.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

Hands-on work and cross-disciplinary work with follow-up lectures (30% lectures and 70% work). Not necessarily to do carry out measurements, but maybe work together on existing data from the field.

- *Did you get some new inter-disciplinary perspectives on your work?*

Yes. The strong coupling between the physical and biological processing taking place in the arctic sea ice.

- *General thoughts?*

As mentioned in the feedback session, reorganize the workshop to cover the various topics in single sessions/days. E.g. Data Management was smeared out throughout the week. One could instead have DM as topic on the last day with examples from each of the disciplines already presented.

Joshua Jones, University of Alaska, Fairbanks, USA

1. I thought the interdisciplinary approach of the research school was really good. There were topics that I have not really ever had any training in or discussion of (seismology in the Arctic, tomography, some cultural aspects), and some that went farther in depth than I have been involved in (data management plans, satellite data processing). It was also very interesting to

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learn how community-based observations take place and is supported in other places than Alaska.

2. The science-oriented presentations were spot on. I think they were the right level for those of us with a scientific background, though not necessarily in the field being covered. The presentations from outside the scientific area seemed a little out of place, but did provide a good perspective on how non-scientists interact with the Arctic science community on many different levels and how there is much enthusiasm for scientific and other operations in the region. Overall, all of the presentations were really good.

3. I think there could have been a little more work for the student participants to do relative to each topic that was presented. It just wasn't quite clear what was expected for some of the topics/modules. Maybe it was just the nature of the topic being presented that day that did not lend itself to having exercises or practical demonstrations, it just would have been helpful to know clearly what outcomes or products were required, or not required if that was the case.

4. There were many very interesting parts of the research school. The interdisciplinary focus was great. I really got a lot from learning about science that I'm not focused on, and from conversations with instructors and students whose work is in the Atlantic side of the Arctic while my research and work has been focused on the Pacific side.

5. If the school had lasted another week, I think spending more time on the topics presented in conjunction with some practical demonstrations and exercises would have been great. Additional topics that could have included more discussion could have been sea ice, other aspects of Arctic oceanography, weather and climate, and marine mammals and fisheries.

6. I did gain some more interdisciplinary perspectives. Specifically, how tomography is mapping physical characteristics of the Arctic Ocean and how our work might not necessarily be taken in the context we are expecting but provide some cultural aspect to a wider audience than just the scientific community.

7. In general, I thought the research course was great and I very much appreciate the opportunity to participate. I look forward to working more with UAK/INTAROS, and participating in or working on future research schools with these projects.

Takuya Nakanowatari, NIPR, Japan

Through the comprehensive lectures provided by many lectures who have different backgrounds in the Arctic Science, I was able to obtain new knowledges on the Arctic science. The topics are natural hazard in Savard Island such as earthquake, risk management of ice and oil spill, the application of acoustic technology on the measurement of ocean temperature, citizen science and its activity in Longyearbyen during quite short period. Although the duration of science school is very limited, I feel that more exercises about data management and utilization of SAR data are helpful for us.

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My research topic is to develop the Arctic navigation system based on operational sea ice forecast data, which highly depends on an ice-ocean model output for the detection of the sea ice thickness distribution and its predicted ice field. However, the model has about 10 km grid size and generally assumes viscos-plastic rheology as dynamical process. Therefore, we need to use additional information for the safe navigation of vessels even if the vessel has an ability of ice-breaking. As additional information of small-scale ice, high-resolution satellite data such as SAR image have a great potential to detect such small-scale ice. In this school, I was able to discuss with Pedro and his colleague on the possibility to use the SAR image data on Arctic Shipping route. In July 2014, an ice-blocked accident was occurred in the East Siberian Sea. Since the SAR image data are available in this period, we will diagnostically investigate the sea ice distribution derived from the SAR data and the relation to vessel speed.

According to the lecture, sea ice accident would not be necessarily decreased even if the sea ice cover has decreased, because the mobility of sea ice motion increases due to the decrease in sea ice thickness. This comment is very impressive for me and motivate me to investigate the influence of great Arctic cyclone on the medium-range predictability of sea ice distribution and its speed. Recent study pointed out that the number of Arctic cyclones has not changed during several decades (e.g., Koyama et al. 2017), but great size Arctic cyclones were found in 2012 and 2016 in summer. Such large-scale cyclone may lead to the serious accidents of commercial vessels and oil tankers as well as oil mines. Thus, we need to investigate the future projection of great Arctic cyclone as well as the sea ice thickness and distribution for the safe usage of Arctic Ocean as commercial purpose.

As for the improvement of atmospheric forecast skill, it was reported that the impact of additional radiosonde observation is effective on the extension of skillful forecast lead time through the improvement of initial condition of atmospheric forecast model (e.g., Inoue et al. 2015). Since, it is very difficult to access to the Arctic Ocean, it may be important for the additional radiosonde data to collaborate with commercial vessel in the Arctic Sea Route. The meteorological data even in one point would lead to the improvement of weather forecast in the same area, because the scale of atmospheric fluctuation is relatively small in high latitude. Thus, the voluntary meteorological observation by commercial vessel has a benefit on the improvement of atmospheric forecast skill not only in the downstream area, but also in own region. Since great Arctic cyclones were recently occurred in summer, there is possibility that severe accidents of commercial vessels occur in the Arctic Ocean. To avoid such severe accidents, the development of voluntary meteorological observing network is desirable in the future.

***Zeinab Jeddi, Department** of Earth Sciences, University of Bergen, Norway*

- *What do you think about the program and the inter-disciplinary approach in this research school?*

Being the first UAK research school, it covered a vast majority of different disciplines and it was very interesting to see some common issues in data managements and community base information in different disciplines addressed quiet broadly. Though I think it was a bit compact.

- *Was the level of the presentations too low, too high or about right?*

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It was really different. Student presentations were abstract and simple enough to get the main point. But lectures were quite different, some were really basic and some a bit high level information and many new terminology that could confuse if one is not in the that specific field. Also some of presenters had very short time to present themselves like EO data application. The tool seemed very useful but not that much time really to try it with guides.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

Some subjects got less time than others (mentioned before). And I think exercises could be a bit more practical. Acoustic exercise was planned in a better stage to go through some information with guides, which I think should have been done for all other exercises. Although, for example in acoustics I wanted to learn a bit more how to take out data and try together with some of my own data (according to my proposal) during student work time. But due to change of plans there was not much time to focus on that.

- *What has been the most interesting part of the research school for you?*

Getting information about all disciplines and data managing was very interesting. But overall, I like the Thursday afternoon where we had a local community talks and workshop afterwards. I missed such discussion in small groups during other days.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

I would suggest after getting information on different disciplines in first week, continue second week in getting some real case scenario/real database to work on.

This also could be done by having a field trip. Or use some available data from previous field to go a bit in detail of what we learned in detail.

The other approach will be that we work on our own project using the ideas we got in the workshop, this might not work for all proposals since some are long term planning. But for some other will be very useful.

I would also like to visit a local community by just walking around the town, and visit some local people and management sectors.

- *Did you get some new inter-disciplinary perspectives on your work?*

I was thinking to look at acoustic data in the region I work, I got an idea where I should look for data, so I think this is the first thing I will do.

EO data application was interesting, but since it was compact, I need to back to presentations and contact with presenters to see if I can use it for my work somehow.

It was interesting to see how acoustic use speed for measuring temperature and similar with what with do with seismic velocity. A good idea was suggested to see if we can use earthquake as

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acoustic source to measure temperature in ocean and do some tomography. It is not clear how complicated is that, but definitely I will look at it in more details.

- *General thoughts?*

Very nice course though a bit compact and diverse. I would prefer to have a bit more focused, but still interdisciplinary workshop. Many thanks for the organisers and of course looking forward to next one.

Henrik Hellem, University of Bergen, Norway

- *What do you think about the program and the inter-disciplinary approach in this research school?*

I found the program quite rewarding, and the inter-disciplinary approach intriguing. I have not spent much time in such settings earlier. So, the whole thing was an experience by itself.

- *Was the level of the presentations too low, too high or about right?*

The level of the presentations varied to some extent. Some presentations were a bit more technical in depth than needed be in my opinion. But despite this I did not feel that the level of the presentations was too high. Over all I felt that the level of the presentations was good.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

I felt like there could have been more practical work or group discussions/activities. The presentations were interesting. However, it is limited how much knowledge one can bring away from a long day of presentations. I am left with the impression that the inter-disciplinary goal of the Research School would have benefited from more interaction between the attendants.

Although the afternoon sessions were intended for this it seemed that to some degree that either the presentation would drag on, or the practical exercises left everyone focusing on their own computer. This was not the case for all the sessions, but it was present throughout the week. Other than that, I felt that the program was good, and well structured.

- *What has been the most interesting part of the research school for you?*

In my opinion the most interesting part was the variety of educational background the attendants and lecturers had. In other words, the inter-disciplinary focus. In addition to this I felt that including both lectures from UNIS and interacting with the Longyearbyen Lokalstyre was captivating.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

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As I still have some years before I will finish my master's degree it is a bit difficult for me to say. However, I was left with the impression that perhaps it would be meaningful to work together in groups, approaching some of the problems regarding Longyearbyen that emerged from the discussion during the session Thursday.

- *Did you get some new inter-disciplinary perspectives on your work?*

I got a broader perspective regarding the field of work I am currently pursuing in my on-going education. Some of the topics I felt could have applications for my future work would be the natural hazard part, and the remote sensing element of the research school.

- *General thoughts?*

The research school was a valuable experience and highly recommendable.

Bjørnar Hallaråker Røsvik, University of Bergen

- *What do you think about the program and the inter-disciplinary approach in this research school?*

I think the inter-disciplinary approach was interesting. It gave a better understanding of all the different challenges that are present in the Arctic. If people only work with their own research field it can be difficult to see the whole picture. The fact that researchers attending were discussing and exchanging data was cool to see.

- *Was the level of the presentations too low, too high or about right?*

Most of the presentations was just about right I would say, even though some of them was a bit more technical. It was great to get some of the lighter presentations in between, like Sascha's from Greenland and Takuya's about the northern lights.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

Personally, I feel like some of the lecture-sessions was a bit too long. Some of the presentations dragged out, and we had like two hours straight with new information. Her it could maybe been beneficial to have five minutes brakes every 45 minutes just to stretch our legs and get some air. These long sessions limited the group activity to some degree. People were working with the exercises and the group work that was intended from the first day, kind of disappeared.

- *What has been the most interesting part of the research school for you?*

I think learning about the new challenges the Arctic region is facing because of climate change was the most interesting. To look at the increasing hazard risks, both natural and human made. Also, the fact that it was so many bright minds from all over he world. To have discussions about problems and solutions with other students and researches from different backgrounds.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

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If it was one more week, I would suggest some more field work, even though I understand it is difficult with the logistics. Could maybe have been collecting acoustic data in Isfjorden, going all the steps with data collection, management and usage. We could also maybe go and watch the snow avalanche places or collect samples of sea ice.

- *Did you get some new inter-disciplinary perspectives on your work?*

I haven't been working with too much research yet, but I see how valuable collaboration can be. To bring different type of data together in to new ice and ocean models can be very important. Potentially working with marine measurement and control technology I think knowing about oil spill hazards can be smart.

- *General thoughts?*

The research school was fun, and I learned a lot that I will take with me further in my studies and later in my work life. It was well organised, and we always had everything needed.

Jan Michalek, Department of Earth Sciences, University of Bergen

- *What do you think about the program and the inter-disciplinary approach in this research school?*

There is definitely need for doing inter-disciplinary workshops. There are being developed new environmental research infrastructures and researchers need to be informed about other research fields/topics to be able to use such infrastructures. I think the program was organized well. It was the first such meeting and people need to be informed about each discipline and the amount of information was just fine.

- *Was the level of the presentations too low, too high or about right?*

The level of presentations was varying a bit but a bigger challenge is how to design the presentation for group with heterogeneous knowledge of the subject which depends on scientific background of each participant. I, as a seismologist, would appreciate more details about processing of acoustic signals because this discipline is actually very close to seismology (mechanical waves). On the other hand, the presentation/exercise about processing of satellite images was too detailed and I was not able to absorb all the information in such short time. It would be great to have more time for such exercise.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

For one-week workshop it was a good balance, I think. There could be more exercises if the workshop is longer. Practical demonstrations are nice and I like them but not sure if those are actually needed for the research as such. Might help to understand technical aspects of the research though. I think it would be nice to arrange one afternoon with various practical demonstrations also for non-participants of the workshop (public, researchers from hosting institution, students, representatives from municipality, …).

- *What has been the most interesting part of the research school for you?*

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To learn about other studies and methods people are using in the Arctic. For example problematics around oil spills or that temperature of sea can be measured by acoustics. Also, information about how the research activities are communicated to the public and how the public is perceiving research activities. Involving the community into solving the problems can break the barriers between science and public and actually increase the trust in science. Interesting were also the common dinners, of course, where I learned more the background stories leading scientists to various research fields.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

Having more exercises and work on individual projects.

- *Did you get some new inter-disciplinary perspectives on your work?*

From the perspective of natural hazard I realized that we should work towards a unified system for evaluation of risks across the disciplines. In Norway NVE is providing such service http://www.varsom.no/) but it is not directly connected to observations of earthquakes. EQs can actually trigger other hazardous events.

I realized that monitoring of permafrost state in Arctic is very important. Building multi-parametric observation stations will definitely improve the knowledge, reduce maintenance costs (especially at remote places) and possibly increase the success rate for getting permission for installation on Svalbard.

I got an idea about new approach for passive monitoring acoustics using whales as signal source. Deploying devices on various whales simultaneously could provide dense coverage of crossing paths and can provide much better picture about the structure of the water column (salinity, water temperature). Thanks to multiple observations in small area the travel-time tomography of sea could be made. Precise time-stamps (micro seconds for resolution of 1 deg C) to the acoustic recordings have to be made and precise position need to be known which might be challenging. Precise time and position can be retrieved from GNSS but there is only short time for that when the device is above water. Charging battery might not be a problem but data transmission/retrieval can. I have some ideas for design of such device so please let me know if you think that this is something useful.

- *General thoughts?*

It would be great if presentations of individual projects will include list of topics/issues which will help them to develop further.

We collected very useful feedback about the Enlighten-web tool during the natural hazard session. The feedback was already provided to the developers (NORCE) so I believe there will be new improved version available for next workshop. If there will be another UAK workshop and there will be wish to use the Enlighten-web again, I would be pleased to join as member of the organization committee (contributor).

Thanks for organizing the research school. It was a lot of new information from different disciplines and also seeing my own discipline from a new perspective.

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Sascha Schiøtt, Aarhus University

The Research School provided insights in different methods in studying different topics regarding the Arctic, and provided important contacts, that will be very useful during my Ph.d. It was refreshing to get out of my project topic, and get to see what else is out there of research in the Arctic. It also gave me new ideas of what to include in my project, which I might have overseen before, or did not think of. It was good to talk to other Ph.D. students that works with a similar subject to my own project, and to exchange new ideas, and how to deal with problems related to each of our own projects, and exchanging former experiences and knowledge regarding our topics.

The program was very inter-disciplinary, so I think 5 days is a little too short to get in depth with each topic, so it would have been nice to have more time to explore each area. The practical part of the topics would have also been nice to explore more in depth. Some subjects were challenging to understand, as I have a background in biology, with no former experience in seismology, geology or programming large templates, so more time would have provided me enough time to understand challenging areas.

I think it was fantastic that we got the chance to suggest a project together with Pedro about Sentinel-1 data, which I think will be very useful during my PhD. It would have been nice to see more of these types during the week, where each teacher or participant could suggest the option of collaboration and what they can contribute with in that collaboration. It would have opened up for important and useful collaborations.

One thing I would have liked to be included was a short field trip, as we travelled all the way to Svalbard and did not see much of the nature – but then it would have had to be during a different time of the year. But it made a huge impression to arrive to the polar night and actually see how dark it is, and what conditions animals and people live under, that high north. So that in itself was worth the trip up north, because you really have to be there yourself to see how dark it really gets.

The part about research data was also very useful, as I have never put that much thought into how my data should be, so it was good to know how important research data is, and how we can save our data better, and more accessible for other scientists. And also to find out that publishing data actually is a possibility. My overall experience from the week was good, and very good to hear about different subjects.

Samantha Jones, Department of Geography, University of Calgary

Thank you for an excellent week of learning. The **interdisciplinary approach** was very useful in highlighting the linkages between the four themes of the research school. I was able to learn from researchers with different areas of expertise and identify opportunities to apply different approaches to my work. Exposure to all four themes highlighted some of the challenges that the changing Arctic faces now and into the future. The broad nature of the workshop equipped me with the awareness and confidence to discuss these issues with others and to start thinking about how they interface with my research. The appearance of some topics, like data management, throughout the program illustrated the importance of the subject to all disciplines. The balance

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between the lectures and the exercises was appropriate and the technical level was accessible to a non-specialist audience.

The **most interesting parts** of the research school were the sessions relating to citizen science. I would like to continue to learn about engaging local community members to develop project scope and collect data that can contribute to climate projects like my PhD research. I am interested to explore how the citizen science methods and approaches discussed at the research school translate to the community where I work. Understanding the differences between citizen science and community based monitoring and the potential overlap between the two frameworks will be helpful in identifying future opportunities to work with local residents. I also enjoyed the town hall session where we met and discussed challenges and future development with local residents.

The formal sessions and the informal networking and discussions during the research school have **inspired several new ideas** for my project including **interdisciplinary perspectives** on how to address some of the challenges associated with my PhD program. I will implement some of the data management strategies to organize and preserve the longevity of the data that I have already collected and implement an improved DMP for the remainder of my program. I will also follow up on options to publish and archive my dissertation data for reuse once I finish my graduate degree. I will create a terminology and semantics glossary for a literature data compilation that I am working on to highlight equivalencies and document the assumptions involved in reusing published data and deriving new parameters. This addition, inspired by the discussions during the data management sessions, will improve clarity of my methods descriptions and improve reproducibility of my work. It will also provide a systematic framework that can guide collation of data from different sources.

During the five-day workshop, I discussed my ambition to incorporate citizen science contributions or local ecological knowledge into my PhD project. I was able to network with course instructors and participants to get ideas about how to best approach and recruit participants and how to frame the scope of work. During workshop program breaks, I worked on framing a small local knowledge-gathering project that I could implement during my fieldwork next year. The outcomes of this activity would provide novel perspectives on change in my study area and provide local context for anticipated vulnerabilities to future warming and change. Attendance at the research school allowed me to exchange ideas with faculty and participants to refine the scope of my proposed work and develop an action plan. The networking opportunities provided by the research school have strengthened my network and I look forward to working with these new colleagues in the future.

Oliver Bartlett, University of Exeter, UK

I found the program to be broad in content and highly interesting and engaging. The inter-disciplinary approach was consistent throughout all the days of the school, with a large part of this benefitting from having participants from a variety of nations and disciplines. Having the school take place at UNIS I felt added to the program as it put all of the course content into a local context which I feel added to the learning as well as the engagement with the program.

I personally found the variety of subjects, and the linkages between them were communicated well and at a level that was both sufficiently advanced but also easy to comprehend for complete

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outsiders to the various disciplines. The presenters all delivered quite advanced information at the right level of difficulty. Furthermore, I felt that the presentations were conveyed engagingly and continually linked back to the interdisciplinary focus of the school.

There was possibly an imbalance between the amount of the lectures and other work. Whilst the lectures were great for setting the scene and delivering important information there could have been more time devoted to exercises to put the information into practice. Having the mornings as entirely lectures with the afternoon solely practical exercises would have helped to reinforce the learning from the lectures and enabled us to work on a task more comprehensively, drawing from the varied experience in each working group. Additionally, the jupyter notebook lesson would have been great if we were able to follow along with the live demonstration rather than just watch.

For me, the most interesting part of the school was the community-based content. As an earth scientist, it was interesting to be exposed the impacts of climate change and how my research fits in at the community level. It has helped me frame my research and the importance of it at a more local scale and inspired me to think more about my research from an impact perspective.

Should the school have lasted another week it would have been good to have time to work on some projects. On the Friday of the first week, we could select a project we liked as a group to work on for the entirety of week two. So if someone in our working group had designed a project we liked we could put all of our varied knowledge and skills into intensively working on the project with an outputs presentation on the final day of week two. From this, I feel it would encourage interdisciplinary research as well as cement opportunities for future collaboration and developing each project forward.

I certainly gained new interdisciplinary insights into my work. The talks and activities at the research school highlighted to me that there are many ways I can look at the data I use and produce and this will certainly enhance the quality of my PhD thesis.

Overall, my experience of the UAK research school was a great one. I enjoyed the varied content and the interdisciplinary approach to the school. It was fantastic to network and socialise with a broad range of participants in terms of nationality and expertise. Going forward I would very much like to be involved in the project and contribute my expertise in GIS and geospatial data analysis to projects from any of the disciplines, as I feel this school was brilliant at exposing me to how I might work with a hazards and monitoring based focus.

Delphine Collin, Sorbonne University, France

I am currently in my first year of master in Geography. My principal field of study is the environment and natural hazards. I was interested in polar environment since a long time and when I did my application for the research school in Longyearbyen I was looking for an internship for the second semester as a part of my master. I though each topic were related to geography and bring me a lot for my studies. Next year I will have to write a master thesis and I wanted to find a topic about the thawing of permafrost which triggers destabilization of environment and increasing risks. My teacher Emanuele Costard- Gautier is a specialist of the Lena in Siberia and had topics for me in Siberia. The first thing I have learned in the research school is that I want to find an area in Svalbard

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or in Greenland, linked with the local population. Furthermore, thanks to the four different topics I learned various things:

Natural hazards. My master is about natural hazards and I also took a course about natural hazards in Utrecht University where I did an exchange last year. During the week we focused on hazards specially in the arctic and I learned that almost all type of hazards is occurring in Svalbard and in the arctic, like avalanches, landslides and earthquakes. I live in a big city therefore living for one week in a city which is enduring different types of hazards was interesting.

Community based monitoring. I was excited about this topic because it is fully a part of what we learn in geography. Geography makes the link between the environment and the society so we can draw a parallelism with the science which is a study of the environment and the local communities who are the society living in this environment. Geography therefore serves as the hinge linking these two. During my bachelor we talked a lot about empowerment of population but within developing countries dynamics. We studied American Indigenous people or women in South America for instance.

It was really interesting realizing that empowerment is also about communities in developed countries and making the link with politics and participation of citizens. Indeed, I learned of lot about citizen science. Nowadays population wants to take more and more control and to participate in their city-environment life. Politics is a key but also science and comprehension of the environment. The speech of Hilde Fålun Strøm was really touching and it was optimistic to see people involved in their environment. Also as a young researcher it was reassuring to see that science is not in its ivory tower anymore and it participates to the operation of societies. Nevertheless, I saw that there is still some communication or motivation lacks because there was not a lot of people during the dialogue café with the local communities and it is important to therefore improve this side.

Acoustics. This topic was the furthest of my study area but It was one of the most interesting because totally new. I studied sound dynamics within a physical prism in high school, but it was interesting to see that researchers are working on this topic. I am a musician, I play the viola and I liked to way of teaching us this topic. I also saw a link with my internship in Laval University next semestre because I will have to asses the quality of the Saint Laurent. Sounds is one aspect of the quality of environment I can assess. I therefore learned to use new tools.

Data management. It was really interesting and formative because bachelor is always more theoretical and learning how to collect data, use them and make them reusable is really interesting and useful for my thesis and my future. Indeed, I never studied how to deal with data. We are starting to study it more this year in master because we are starting to create our own data and using data of other scientists but never in a direct way.

Finally I learned that climate change is visible on a human scale and that the changes are faster in this part of the world. Climate change is leading to destabilization and therefore more hazards like avalanches and landslides. I did a hike after the research school and the guide showed me flows triggered by landslides that were not here last year. He also told me that flowers which grew on the mountain three years ago don't anymore because of the instability of the slope. To conclude it is important to share knowledge to mitigate the risks.

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Agata Grynczel, IOPAN, Poland

- *What do you think about the program and the inter-disciplinary approach in this research school?*

I think that the interdisciplinary program brings many benefits. Primarily, the opportunity of knowing the Arctic changes and hazards in the wider context. In addition, the interdisciplinary approach allows getting to know new data collections/database from other scientists and measurement campaigns. Which is extremely important from the point of view to understand the uniqueness of ongoing Arctic trends and put recent changes into a larger perspective and it presents projections for the future.

- *Was the level of the presentations too low, too high or about right?*

The research school has gathered scientists and people from various scientific fields, but in connection with the sufficient (right) level of presentations, the material was accessible and understandable.

- *How was the balance between lectures and other work (exercises, practical demonstrations, etc.)?*

Practical classes using available databases would bring more benefits. In my opinion, the program was overloaded with lectures, while not paid sufficient attention for practical exercises and work with datasets. Practical tasks could include data analysis (ice cover, oil spill, seismic, acoustic) from the Svalbard region in the Python or Matlab program.

- *What has been the most interesting part of the research school for you?*

The most interesting part of the research school was knowing about the seismological application/tool and investigating the possibilities of working on satellite SAR data applications for Arctic research. In addition, the conversation with the other participants allowed me to get to know new databases (for example: http://osisaf.met.no/p/ice/index.html) including the variability of sea ice in the of north of Svalbard region.

- *If the research school had lasted for one more week, what do you suggest that the content of the second week should be?*

I would suggest a more thematic division into groups and work on more specific issues. For example, groups dealing with the problem of decreased sea ice cover or the threat of oil spills could deal with the analysis of satellite data from available databases. On the basis of this analysis, we could try to investigate the potential of sea ice satellite products (like AMSR-E, MASAM2, SAR, Sentinel). At the same time, the creation of data analysis tools for the proposed changes (ice, spills) and it could help us to adapt satellite products for our needs. I would also suggest the possibility of performing acoustic measurements in the field.

- *Did you get some new inter-disciplinary perspectives on your work?*

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As of today, my work focuses on analysis and explanation the sea ice variability along main pathways of the Atlantic origin water (AW) in Fram Strait and north of Svalbard, based on the hydrographic data of conductivity-temperature-depth (CTD). Inspired by the possibilities of acoustic measurements, in the next step of my analysis, I would like to focus on data from Lowered Acoustic Doppler Current Profiler (LADCP) and Vessel-Mounted Acoustic Doppler Current Profiler (VMADCP) from Fram Strait and north of Svalbard. In order to examine the structure of the West Spitsbergen Current and describe the variability of the baroclinic flow field.

- *General thoughts?*

I consider extremely interesting and needed a panel including collaboration and communication between academic research and local communities in Svalbard.

Morgan Ip, Oslo School of Architecture and Design, Norway

I greatly appreciated participating in this research school, and learned a lot from the interdisciplinary model. The level of presentations was of high quality. However, as a designer and social scientist, the section on coding was lost on me, and it was very difficult to follow. I understood it better only through the exercise given afterwards with group participation and hands-on teaching. In this case, I would consider starting the lecture with active participation. On the other hand, learning about how low frequencies traverses waters, and the many variables that affect this in a lecture before seeing it in an exercise was incredibly clear and easy to follow. I would say, then, that the balance between lectures and workshops and exercises could have more strongly favoured the later.

Of particular interest was the workshop with community leaders and the discussion of how potential transdisciplinary datasets can influence evidence-based decision making. Although I understand that this is an on-going process, I think that this particular event should have been held on day one or two, so that there could have been greater back-and-forth between scientists and locals. Indeed, one more week would have greatly benefitted this community engagement and I suggest that the research group continue working with the community considering its particular relevance with the topics of climate and technological change.

There are a few logistical changes I would suggest for future local engagement and outreach activities. For example, how the working groups were delegated could have been pre-determined to persuade UNIS students who came for the lecture to participate in the workshops. I felt that there was confusion in the allocation of numbers and asking if people were staying individually that frightened some of them away. It might have been useful to present a series of questions that each working group could discuss, and have students and community members choose which to participate in. I understand that such workshops have to be adaptable, but by continued work on these events I am certain that future work in Longyearbyen can be more fruitful. Further, during these local events, a synopsis of hard physical data could be presented for greater awareness of the integration of the sciences and the holistic importance and relevance to the area.

As an Arctic urbanist, knowing more about the science that measures and documents the physical world is necessary to combine with the methods and discourses of socio-cultural research. Most

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importantly, how the combined datasets can be transmitted in a way that benefits both academic and real world, and that can determine how each supports the other is critical to ensure resilient and robust places for people to live. Knowing more about physical hazards in the Arctic is profoundly important for communities living in vulnerable conditions, and the lessons I learned in this research school will certainly carry on to my professional academic career in Arctic urban design, planning and architecture.

In general, I believe there is much potential in this research group that can continue with future endeavours and building a growing body of research as the Arctic undergoes massive changes. Maintaining Svalbard as a site of active local engagement will not only benefit the people of Longyearbyen, but set an example of good research ethics and principals throughout the region, and indeed across the globe.

Thomas Tuesen, Department of Earth Sciences, University of Bergen

I had a very good impression of the research school all together, and I think that the program was very interesting. It was an eye-opener when I realized how different our research topics were, and not the least how focused one can become within his/her own topic that you don't realize how many different types of science there are.

I will below go through each day as I experienced them, even though the scheduled changed a bit, I will address them as they are in the daily program of the research school. It's also important to know that I am seeing all the different topics from a geologist's point of view, and of course my own subjective view.

Day 1 – Natural hazards in the Arctic

Not surprisingly, I found discussing natural hazards in the Arctic very interesting, and I realized how important it is to share and publish data. During our stay in Svalbard I managed to get a hold of LiDAR data from the Norwegian Polar Institute from their websites, however, the data shared had a resolution of 5x5 meters. When I contacted the institute and asked if they had more data from Longyearbyen, they replied and said that they had even higher resolution, down to 1x1 meters, which means it is 5 times better than what's publically shared. Just this small experience with data sharing that I had during the Svalbard stay, made me realize how important it is to actually share data, and make it publically available.

Day 2 – Ice and oil spill related hazards in the Arctic

This was a very interesting topic and I have not realized how the melting ice will lead to more hazards. Having oil activity in areas that previously was not possible due to ice, is somewhat sad to think about. Basically our use of fossilized fuels has made it possible to extract more fossilized fuels. This was a very interesting and important topic to discuss.

Day 3 – The Ocean acoustic environment

I thought that this was the most interesting topic next to my own topic (natural hazards). Understanding that sound can be used to estimate temperature was very cool, and I learned a lot that I never knew from listening to the talks, and having the workshop. I especially liked the workshop in this topic, it was interactive, allowed the users to work with data that was given, and even the part about metadata was very interesting! Well done.

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Day 4 – Community-based observing and communication

This day was a very good day. Involving the community so that the narrow field that we research can be used to deal with day-to-day problems that communities face, is the reason I do research at least. I think it is very important that each researcher within hers/his field understands the applications of what they research.

If I were to add anything to this research school, I would very much like to include the local-community into the topics in a larger degree. I would very much like the local-community to specify a problem they have within Longyearbyen, and then the research group could come together and figure out solutions, or what to do next, in relation to that problem. I think that would make it very interactive, and very interesting as each person would need to apply their knowledge and way of solving a problem. That would be very interesting to see how people from different disciplines would approach a problem.

7. Conclusion of the research school

The overarching goal of the UAK project is to build and maintain strong partnerships between educational and research institutions in Norway, USA and Canada. The research school was a contribution to this partnership, addressing natural and man-made hazards, ocean acoustics, community-based monitoring, data management and communication. The Consortium partners are all active in research on these topics as well as in education of a new generation of scientists who will be engaged in Arctic issues in the coming years.

The research school had a multidisciplinary scope with focus on different topics each day. The morning sessions had mostly lecturers, while the afternoon sessions were a mix of exercises with tools and data, group discussions and one workshop with participants for the local community in Longyearbyen. The participants had quite different background, mainly in natural science, but also in social science and community-based research. In addition to lecturers form the consortium, it was also very fruitful to engage lecturers from UNIS and from the local community. The multidisciplinary content of the research school was challenging, because students are traditionally educated within traditional scientific disciplines. To learn about other scientific fields than your own may not seem very relevant for PhD and postdocs who expected to specialize in a narrow topic. Especially, when it came to more technical exercises, related to data management or use of instruments, some of the participants felt it was not relevant for them. Nevertheless, most of the participants found it interesting to learn about other Arctic disciplines. The workshop with the local community members gave the participants another perspective on science and how it is relevant for communities in the Arctic (see attachment).

After the end of the research school, the organisers received very good feedback from the participants, presented in section x. The feedback is useful for planning the follow-up by workshops in 2019 (Boulder) and 2020 (Manitoba), including a final synthesis workshop in Norway towards the end of 2020.

The lecture presentations and other material form the research school are available at the project website: https://uak.ucalgary.ca/svalbard-research-school.

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8. Appendix: Report from the Communication workshop

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Report from workshop

Communication between science and the local community in Longyearbyen

Thursday, December 6th 2018,
3:30-6 pm, UNIS, Longyearbyen

The aim of this workshop was to initiate a dialogue on knowledge, challenges and possibilities related to climate, nature, and the environment on Svalbard. A central question asked was how research on climate and the environment can be of use for the local community in Longyearbyen. Different local actors were invited to give short statements about what they see as the most important challenges and possibilities related to climate, nature, and the environment within their sector, as well as what knowledge is needed.

The workshop was prepared and facilitated by Lisbeth Iversen, Nersc on behalf of the UAK and INTAROS project, and Alexandra Meyer, University of Vienna on behalf of the NUNATARYUK project.

The workshop was organized by Nansen Environmental and Remote Sensing Center and collaborating partners under the project “Useful Arctic Knowledge: partnership for research and education” (UAK) in collaboration with the H2020 project Integrated Arctic Observation System (INTAROS), the H2020 project NUNATARYUK and the University Centre in Svalbard (UNIS).

In acknowledgement to the projects that has contributed to this workshop:

Background

The workshop was a part of Research school on cross-disciplinary science in the Arctic and collaboration with local communities, 02 – 07 December 2018, at UNIS, Longyearbyen, Svalbard This research school was organised by the Nansen Environmental and Remote Sensing Center under the project Useful Arctic Knowledge: partnership for research and education (UAK) funded by the INTPART programme 2018-2020 under contract no 274891. INTPART (International partnerships for excellent education, research and innovation) is funded by the Research Council of Norway and the Norwegian Centre for International Cooperation in Education. The project, which includes partners from Norway, USA and Canada, brings together leading researchers, educators and young scientists working on Arctic science topics described below. The research school is part of the H2020 project INTAROS –Integrated Arctic Observation System, contract no 727890 (http://intaros.eu, http://intaros.nersc.no).

Topics for the research school

(1) Studies of natural and human-made hazards in the Arctic addressing problems such as earthquakes, oil spills, slope failures and ice-related hazards. The studies include physical processes and causes behind the hazards, how they can be detected and monitored, and how risks can be minimized and impact mitigated.

(2) Status and change of the ocean acoustic environment is affected by increased shipping, tourism and exploitation of resources in the Arctic regions. The research school will demonstrate how acoustic data is collected, processed and used to study natural processes and human-induced noise.

(3) Cross-disciplinary data analysis and data management is important in order to and build knowledge from the increasing amount of data in the Arctic. The research school will have lectures and practical exercises based on data from topic (1) and (2), satellite data and other data proposed by the students.

(4) Community-based monitoring evolves as an important contribution to an integrated Arctic Observing System, with focus on collaboration and communication between academic research and local communities. The research school will have lectures on such activities in Canada, Alaska and Svalbard.

Workshop

The workshop was arranged as part of the research topic on Community-based monitoring, CBM. CBM evolves as an important contribution to an integrated Arctic Observing System, with focus on collaboration and communication between academic research and local communities. The research school will have lectures on such activities both in Canada, Alaska and Svalbard.

Thursday 06 December the research school had as an overarching topic: Community-based observing and communication at UNIS, Møysalen (auditorium).

Program December 6th

0900-0920	**Lecture:** Working with and knowledge exchange among types of experts and representatives from the Longyearbyen community, by Lisbeth Iversen, NERSC
0920-1940	**Lecture:** Communication and knowledge transfer to end users of information – types of communication media, cautionary use of certain media types, dealing with sensitive topics, by Maribeth Murray, University of Calgary.
0940-1000	**Invited lecture:** The role of information sciences in Arctic research and knowledge production, by Marthe Tolnes Fjellestad, University of Bergen, University library.
1000-1030	**Invited lecture:** A citizen science project in Svalbard, by Børge Damsgaard, UNIS
1030-1100	*Break*
1100-1130	**Invited lecture:** Examples of citizen science activities using NASA cloud observer and CASTAWAY CTD for temperature and salinity measurements, by Hilde Fålund Strøm, Hurtigruten Svalbard

The workshop “Communication between science and local community in Longyearbyen” was held in the afternoon session of the research school, on the 6.th of December.

The workshop started with thematic introduction by Maribeth Murray, University of Calgary, Canada and Mathilde Sørensen, University of Bergen followed by H2020 project introductions by Lisbeth Iversen, NERSC introducing the INTAROS project and Alexandra Meyer, University Vienna introducing the NUNATARYUK project. This was the first workshop collaboration between these two projects. The project presentations were followed by statements by local actors

- Longyearbyen Lokalstyre – Annlaug Kjelstad, Plan and Development Manager
- UNIS – Harald Ellingsen, Managing Director
- Arctic Safety Center – Ann Christin Auestad, Project Manager
- Svalbard Næringsforening (Chamber of Commerce) – Terje Aunevik, Manager
- Visit Svalbard – Ronny Brunvoll, Manager of Tourism and General Manager
- The Governor of Svalbard – Helle Hamnevoll, Advisor Civil Protection

The second part of the workshop was arranged as a dialogue café

Thematic introduction

Maribeth Murray, University of Calgary, Canada

There are different groups that are interested in the work they are doing in Canada.
- End users
- Stakeholders
- Rights-holders

Hopefully they will all be beneficiaries of the data the research project is gathering.
As a researcher, you cannot just do your work, write a report, and then go...

You have to think:

How can this research be used, returned to the community, and how can our data be translated so that it can be useful and used by different actors? Through her work and workshops she has revealed that there are different levels of knowledge between the actors in a local situation. They have various perspectives, experience, goals and roles, and this is all influencing how things are perceived, understood, how it matters for each actor, how it can help them. It is important how we write reports and articles, what words we are using. Language is crucial, terms change over time, and people have to use many words in search for data and information. This is an ongoing challenge, and something that needs to be addressed.

Mathilde Sørensen, University of Bergen

Natural Hazards in the Arctic

“Natural hazards become a problem when they interact with human infrastructure”

How can we prevent future disasters?
- Hazard and risk mapping
- Planning and mitigation measures
- Monitoring is crucial for adaptation and mitigation
- Are there conflicts between monitoring needs and environmental protection?

Community-based monitoring programs such as the community-based seismic network or the Global Weather Observation Network can be of vital importance. Online data platforms for environmental monitoring across the Arctic are developing. Scientific communication , media and direct presentations all contribute to the information people are getting. But the scientists should not only blame the media for bringing shallow information, or not be to precise, we could do a lot of effort in order to bring better information to the media, be more humble about uncertainties, but get out data and facts in an understandable and well illustrated way. How we communicate research and results matters.

Introduction of the projects H2020 projects

Lisbeth Iversen, NERSC: INTAROS project

INTAROS: Specific objectives

Knowledge-based planning of the future is required 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. The aim is to enhance community-based observing programs by further developing the capacity of scientists and community members, and improve the cost-effectiveness of data collection in support of economic and societal activities. In addition the project wishes to contribute to enhance the livelihoods of the indigenous and local communities.
Work Package 4-Enhance community-based observing, is especially relevant for the workshop
Finn Danielsen, NORDECO, is leading this worpackage with Lisbeth Iversen, NERSC as the co-leader
lisbeth.iversen@nersc.no

WP 4 Tasks:
Task 1. Survey and analyze existing community-based observing programs

Task 2. Advance tools for cross-fertilizing indigenous and local knowledge with scientific knowledge

Task 3. Pilot community-based observing to support decision-making processes

Task 4. Develop model of how community-based observing can cross-fertilize w/ scientist-executed observing and demonstrate use of the model

More information on the work in this workpackage can be found here:

CBM Library- Reports- and Workshop Proceedings:

CBM Survey Report;
https://intaros.nersc.no/node/657

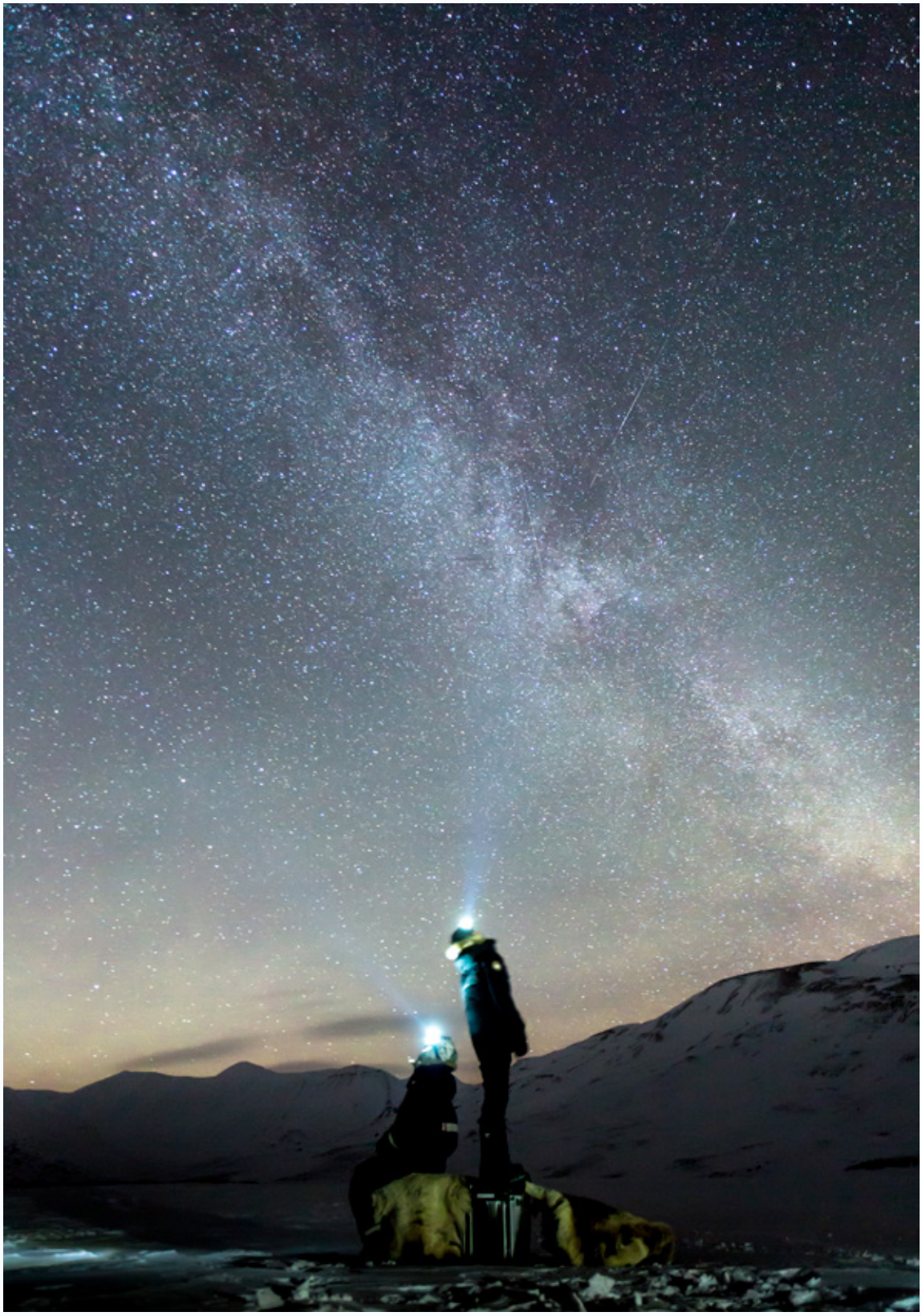
CBM "Library":
https://intaros.nersc.no/node/740

Proceedings CBM workshop Quebec City:
http://www.intaros.eu/news/recent-news/cbm-workshop-quebec/

Proceedings CBM workshop Fairbanks:
http://www.intaros.eu/news/recent-news/report-from-community-based-monitoring-workshop-in-fairbanks-alaska/

Alexandra Meyer, University of Vienna: NUNATARYUK project

The Horizon 2020 Project NUNATARYUK – Permafrost thaw and the changing arctic coast: Science for socioeconomic adaptation studies the impacts of thawing land, coast, and subsea permafrost on the global climate, the local natural environment, and on coastal communities. In Longyearbyen, studies will be carried out on health and pollution risks caused by permafrost thaw, on infrastructure and permafrost thaw, and on the societal impacts of and adaptation to permafrost thaw and climate change.



Statements by local actors

Longyearbyen Lokalstyre – Annlaug Kjelstad, Plan and Development Manager

Longyearbyen is undergoing great societal changes in addition to climate change. The town is transforming its economy, and there is a very high turnover of the population.

The planning and building law as it is practiced on the mainland is not effective on Svalbard. Planning and building is regulated through the Svalbardmiljøloven – the Svalbard environmental Law. Cultural heritage and environmental protection are important aspects of this law.

The main priority for areal and community planning in Longyearbyen is safe housing: to find safe areas for new homes, and to secure existing homes.

How to plan for the ongoing climate change?
• Areal planners cannot go out and do the research on the impacts of climate change, hence they are dependent on scientists to provide data, models, maps etc.
• Areal planning has to be based on existing reports/theses
• Often there are uncertainties regarding the rate and timing of environmental impacts
• Is it important for areal planners to know all about the cause of environmental changes if their effects and impacts are known?
• There is a need to know not only how climate change impacts infrastructure, but also how it affects us as individuals and as a society
• There is also a need for more technical information, updated reports and research

Some technical challenges for areal planning:
• It is a challenge to keep an overview and stay updated regarding the newest data, models, maps etc.
• Avalanches (snow and other) present a challenge for areal planning in Longyearbyen. Furthermore, avalanche risks and models are changing due to climatic changes
• It is challenging to build on permafrost
• Sea-level rise represents a challenge for future planning, and there is a lack of information, guidelines and standards regarding sea-level rise

How to approach (the need for) science?
• Analyzing the reports – the facts, the impacts, the effects, the consequences
• What do we know and what do we assume? Which "stories" do we tell – and how do we construct our analysis?
    - o People in town
    - o Scientists
    - o Politicians/administration in LYB
    - o The "Oslo-government"
    - o Tourists
    - o Others
• It is always a challenge to ask the right questions in areal and community planning!

Statements by local actors

Arctic Safety Center – Ann Christin Auestad, Project Manager

The Arctic is a very rapidly changing environment. “Old” experiences and knowledge may not hold true anymore.

Statements:
• Environmental changes increase uncertainty: A changing environment creates uncertainties and risks, and hence posit a challenge for safety.
• Dynamic population: With the high turnover of the population, valuable knowledge is lost. Also this posits a risk. Through seminars and courses, some of this knowledge can be secured and transferred.
• Data changes quickly: There is a lot of gathered data on the local environment on Svalbard. However, as the environment is changing, some of these data are outdated.
• Students and researchers in the field under conditions of change: With a changing environment, it has become more challenging to go out in the field to collect data.
• Accountability: who is responsible for safety in the field?
Under these challenging and changing conditions, the objective of the Arctic Safety Center is to contribute to a safe and sustainable human presence in the high Arctic, through knowledge exchange and competence building.

Visit Svalbard – Ronny Brunvoll, Manager of Tourism and General Manager

Tourism has become a main economic sector in Longyearbyen and there are currently 75 operating tourist companies in town. The tourist sector faces different challenges. In town, there are challenges related to housing, but the focus of this talk are the challenges that climatic changes pose for field activities.

Challenges related to climate change:
• The weather has become more unstable, which makes it more difficult to plan trips.
• More cancellations are effecting the reputation of the tourist industry.
•Less secure sea ice
• Avalanches and landslides present challenges to security in the field. This creates a demand for better safety routines and better educated guides.
• With erosion, less sea ice, challenging weather conditions etc. there are new restrictions on where the tourist companies can operate.
• Due to less sea ice there are more polar bears on land.
• The increasing regulations on traffic around Longyearbyen create challenges for the tourist sector as it restricts the areas for operation.
Climatic changes also create new possibilities for the tourist sector, however:
• With less sea ice, the season on sea is prolonged.
• The changing climate also has a positive effect on product development, as tourist operators are forced to develop more experiences and activities in proximity to Longyearbyen.
• Climate change also creates new visitors, who want to see the Arctic before it changes too much, to see the polar bears before they disappear etc. This increased tourism, however, creates more emissions, which in turn has a negative impact on the environment.

In times of a changing climate, the tourist sector needs good risk assessments, better weather forecast and an enhanced focus on security in the field.

It is a huge paradox that many tourist want to see the ice and glacers before they disappear…

Statements by local actors

The Governor of Svalbard – Helle Hamnevoll, Advisor Civil Protection

There are different departments at the Governor of Svalbard, probably with slightly different perspectives on the topic. The following statements attempt to present the perception of the governor in general.

Adaptation to climate change:

• There are many consequences of a warmer climate on Svalbard (such as heavy rainfall, heavy snowfall, thawing of permafrost, rain-on-snow events, decreased sea ice etc., closing down of the airport, challenges for wildlife and the local environment and infrastructure)
• Mitigation measures are central in adaptation to climate change. In civil protection, planning is highlighted as a primary tool for mitigation.

Greater uncertainty in planning:

A warmer and wetter climate creates greater uncertainties in planning. One instrument of planning in civil protection is risk and vulnerability analyses. The Sysselmann strives for a holistic approach to risk and vulnerability analyses, and a central aim is to involve local actors in town. This is done through a variety of fora, such as the preparedness council. The Governor also works closely with the Longyearbyen Lokalstyre (the local government)

In the context of climate change, there is a need for a common knowledge base.
Research needs from the perspective of the Sysselmann:

• The effects of climate change on critical infrastructure
• The effects of climate change on commercial activities (shipping and fisheries)
    o A changing climate leads to increased maritime activity in the Arctic. This may challenge the capacity of existing SAR (Search and Rescue) on Svalbard.
• The effects of climate change in wildlife and ecosystems. This involves humans as well.






Photo: Lisbeth Iversen

Questions to lead the discussion during the dialogue café:

• Which societal challenges and possibilities exist in relation to climate, nature, and the environment on Svalbard?

• Which societal domains on Svalbard are/ will be affected by environmental change?
• What do we need to know about climate and the environment on Svalbard in order to feel safe? What do we know, which knowledge gaps exist?

• How can/should knowledge about climate and the environment be made accessible for the local community and how can research projects facilitate this?

• Which actors are relevant and responsible for dealing with the social effects of environmental changes on Svalbard?

Summarized comments and new questions:

Which societal challenges exist in relation to climate, nature, and the environment on Svalbard?

Challenges related to climatic changes:

• Sea ice retreat -> more open water -> more shipping -> the local police needs to survey a larger area

• Increased access due to environmental changes, open sea -> more shipping -> higher chances for collisions etc. -> challenges for the local police

• Arrival of new species -> new parasites & threats to ecosystems

• Erosion

• Glacial loss

• Coastal runoff

• A changing environment presents challenges related to infrastructure

• Challenges to safe roads & buildings

• A changing environment challenges and changes the local identity

• A changing environment creates a sense of insecurity
    - o Sea ice
    - o Polar bears
    - o Avalanches

• Uncertainty of future events

• In LYB, a main challenge is to feel safe

• Long-term experience and knowledge is a challenge (because of the high turnover of the population)

• Currently, there is a good evaluation of risk in LYB

• How secure does the society feel?

• Svalbard is a lot about going out into nature (both for recreational purposes but also in relation to employment – tourism and research and higher education involves activities in the field). With a changing environment, there are more challenges related to professional and recreational field activities

• Polar bears numbers increase. This affects outdoor life

• Avalanche hazards increase -> uncertainty during fieldwork and sports activities

• The town is exoticized (“last-chance” tourism)

• A changing climate has an effect on all domains of society!

Challenges related to socio-economic changes:

• The socio-economic changes also create a sense of insecurity
    oFor example regarding jobs and employment

• The socio-economic changes impact local identity

• The shifting population presents a challenge, regarding life-time memory and the identification with place ("I'm only here for 5 years so why should I care?"). The shifting population is not conducive to long-term care and interest in long-term sustainability

• The settlement plan is outdated

• Energy is a main challenge. Excess energy generated in the summer needs to be stored through the winter.

• Challenges related to renewable energy: How much is actually possible in terms of renewable energy? Wave energy? Thermal energy? Solar energy? Cabled energy from mainland Norway is very expensive, but probably cleaner than other options.

• Community guidelines – when do people learn about these?

• Company responsibility and guide unions -> can add security

• A main aim of the Longyearbyen Lokalstyre is that people should feel safe and secure in Longyearbyen

• People need a sense of security, both in relation to their local environment and regarding jobs and a secure source of income

• With the high turnover and high influx of people, how can a local identity and the community be held intact?

Possibilities/opportunities related to these changes:

• Existing challenges could potentially trigger innovations and solutions that could be of use in other arctic localities
    oFor example regarding flexible housing (as a response to the housing crisis) or waste management

• A changing climate can lead to increased tourism, to longer tourist seasons -> more jobs

• Open sea -> more ships

• Cruise tourism has no positive impact, neither economic nor otherwise

• Climate change and a changing environment attracts more researchers to Svalbard

• Climatic changes can lead to a change of business (more fisheries)

• There are good technical solutions available to deal with the changes

• The environmental changes could lead to the development of more local databases

• But: for every possibility there is also a challenge!

What do we need to know about climate and the environment on Svalbard in order to feel safe? What do we know, which knowledge gaps exist?

• More local weather stations to improve weather forecast

• Monitoring of permafrost – is it stable or not?

• Analysis of sediments – the city is built upon sediments

• More data for long-term modelling (permafrost, analysis of sediments in basin)

Communication between science and the local community

• What is the role of UNIS and its impact on the local community?

• In general it is challenging to predict the risk of future events. Scenario building can be of use here

• Some research projects are interested in bigger issues than the local community!

• How available are data/maps/information?

• There is a need to inform the society continuously about the changes taking place

• By looking into the environmental consequences of climate change, science can assist communities in planning

• There is a good evaluation of the risks in the area around Longyearbyen. There are good available data and good maps. But these data have to be transferred to the local community.

• A main challenge is the lack of communication between researchers and the local community in Longyearbyen. There is to date no database where all knowledge about Svalbard is gathered. The local community should know what is being done regarding research on Svalbard and where to find it. This is essential for planning!

• Research and findings have to be communicated to the local community. People should know where to access the information

• Workshops should be organized regularly where scientific findings are communicated to the local community

Communication between science and the local community

• Portals are a good instrument for data dissemination!

• Scenarios are an effective tool for communicating scientific results to local communities. An example for how to use scenarios in science communication related to climate change is the SNAP project: Scenarios Network for Alaska + Arctic Planning (https://www.snap.uaf.edu/)

• Community members should also be involved in research whenever possible

• A challenge for community involvement in research is the high overturn of the population in LYB. How to get people involved when they only stay for a short while?

• The needs and concerns of the local community should be included more into research proposals. In many cases, community involvement is a prerequisite for receiving funding, but often researchers do not know how to do that. Creating a forum for identifying the needs and concerns of the local community and communicating these to researchers could be useful in this regard, and something that both the community and researchers would benefit from.

• There is a need for reliable sources of information (for example a list of serves)

• Better communication between society and science (having responsible persons for this, hold regular workshops)

• Research could be better coordinated so that people know who is doing what, where and when

• Better coordination between researchers (previous events – reference)

• Observational data for shipping and sea ice predictions

• How can resources be shared?

• In which language should the science be communicated to the local communities?

• Research could be better coordinated so that people know who is doing what, where and when

Other comments:

• Just because LYB exists now, should it always exist? Just because of strategic reasons?

Links:
UAK - Useful Arctic Knowledge: https://uak.ucalgary.ca/,
INTAROS: http://intaros.eu, https://intaros.nersc.no
NUNATARYUK: http://nunataryuk.org




Photo: Espen Storheim, the Nansen Center

Report from workshop
Communication between science and the local community in Longyearbyen

Report by Lisbeth Iversen, Nersc on behalf of the UAK and INTAROS project, and Alexandra Meyer, University of Vienna on behalf of the NUNATARYUK project

Thursday, December 6th 2018,
3:30-6 pm, UNIS, Longyearbyen