

NordForsk – Responsible Development of the Arctic: Opportunities and Challenges - Pathways to Action – Evaluation of Final Report

Observations and Comments from Science Advisory Board: Alice Crespi, Roland Pape, Andrés Cisneros-Montemayor, Susan Chatwood

Evaluation of the Final Report - CLINF Nordic Centre of Excellence in Arctic Research (Project leaders: Birgilla Evengård and Tomas Thierfelder)

Overall statement

The rate and magnitude of climate change are greater in the northern regions than elsewhere in the world. What happens in the Arctic will have an impact on the rest of the world, but with feedback mechanisms from the southern regions as well. In a changing climate, ecological alterations will affect the geographical boundaries of microorganisms with the capacity to cause infectious diseases in humans and animals. Most of such climate-sensitive infections are zoonoses – transmitted between animals and humans. Important vector and reservoir animals such as ticks, badgers, and roe deer are expanding their geographical distribution because of the direct and indirect effects of climate change as well as socio-economic changes such as management and policies. Many northern societies depend on animal husbandry, such as sheep and reindeer herding, hunting, fishing, and tourism for their livelihoods. Animals also play a central role in culture, art, and world views. Therefore, these societies will have to deal with the challenges that climate change poses concerning health but also the view of how to make their living and their cultural values.

The CLINF Nordic Centre of Excellence has addressed these threats by contributing valuable information on strategies for socio-economic development and viable communities in the North. Climate change's impact on the health of both humans and animals had not been fully studied previously. In CLINF, thirteen multidisciplinary research teams from eight countries focused on health. They analysed health statistics, potential changes in climate, hydrology, and landscape, as well as the associated migration of infectious diseases, risk perception, and societal cost; with adaptive capacity, gender effects, and traditional knowledge as integrating factors. CLINF investigated the effects of climate change on the prevalence of infectious diseases in humans and animals in the northern subpolar region, following the OneHealth concept. CLINF research covered the geographic area from western Greenland to Pacific Russia and set out to predict the impact that changed risks of infections may have on northern societies, their culture, and their economies. The overall aim was to provide incentives for harmonized OneHealth strategies across the North. CLINF had two main objectives, i) to contribute to strategies for sustainable development, and ii) to contribute to the development of surveillance programs for selected infectious diseases. In collaboration with the existing network of Arctic Field Stations, an early warning system for emerging infections at the local level was recommended for implementation throughout the North. Ecological changes may preclude infections in animals and humans. CLINF enhanced the performance of regional Earth-process models of climate change effects in the environment, developed an adequate assessment of societal risk, and produced a new map and data products of the current and projected geographic spread of climate-sensitive infections. These results are accessible to decision-makers, scientists, and the public and were disseminated in lay terms.



CLINF scientists aimed for an interpretation of nature to predict the conditions that may lead to outbreaks of climate-sensitive infections, and thus support evidence-based policy aimed at preventing or mitigating their associated consequences. CLINF researchers focused on infections that are potentially climate sensitive. Human and animal disease surveillance data was meticulously gathered from national databases of the countries in the CLINF study region. It was surprising to see how differently the data is collated and registered. One of the first tangible outcomes from CLINF work was the recommendation for more standardisation in this area to facilitate cross-border comparisons of health statistics as a basis for (international) strategies towards sustainable societal development in the North. Using traditional knowledge, the CLINF team revealed that reindeer herders in Nenets and Sapmi possess a reservoir of precaution and adaptation possibilities that are relevant to counteracting climate change. A documented prevention strategy from the last two centuries for avoiding disease (mainly digital necrobacillosis) is to move the reindeer to unused grazing land in early summer and to avoid staying too long on trampled and dirty grazing areas. Calf marking on snow patches or small glaciers is a part of this strategy. Narratives about disease prevention are still vital and seem to be incorporated in Sámi herders' cultural mentality: avoid unnecessary stress and do not keep the animals too close too long. Another finding from Sapmi and Nenetsk-Komi-Yamal was that outbreaks of anthrax and other climate-sensitive infections occurred during or after periods of anomalous weather. Supplementary feeding of reindeer emerges as an adaptation strategy but also increases the risk of disease. CLINF scientists studied the proxies for such diseases and their adaptive capacity. The team chose to more deeply consider tularemia, one of the most studied diseases in high-latitude regions, that recently caused large epidemics and that is likely to be affected by regional hydro-climatic changes. CLINF's newly developed methods for quantification of such shifts showed that tularemia outbreaks appear to be highly sensitive to certain combinations of hydro-climatic characteristics. By using projected hydro-climatic output scenarios from several global climate models in combination with statistical tularemia models, possible future trends could be identified. Internationally harmonized databases and forecasts like that for tularemia could lay the ground for policies aiming at keeping humans healthy and societies sustainable.



Highlights and main findings

CLINF explored the interconnections between climate change and the “societal, economic, political, and cultural effects” of changes in infectious disease prevalence. Northern climate-sensitive infections were explored through a literature review and statistical analysis of human and animal diseases in the northern Nordic region, potential landscape changes, and the migration of climate-sensitive infections. The data that was analysed provided important baselines for understanding climate-sensitive infections in the Arctic, and potential trends globally. The challenges of working with data gathered in different national contexts were highlighted. The importance of data harmonization in the Arctic was emphasized and contributions were made to the peer review literature highlighting the need for improvements in this area. The literature review and preliminary data analysis provided important baseline information and informed the overall study and collaboration. From here the research team conducted an analysis of human and reindeer serum which demonstrated the seropositivity of some CSI for the first time. This is a new and important contribution to understanding CSI in Arctic populations.

The CLINF team also explored the expansion of the tick population into Arctic regions and was able to identify the spread of some tick populations and pathogen loads. These findings are relevant to mitigation strategies that will address the spread of ticks and related pathogens in animal populations in the Arctic.

The team addressed the complexity of environmental factors that impact CSI in the Arctic. They developed predictive models that capture not only temperature and weather changes related to climate change but also changes to the land and cryospheric environmental variables. The team was able to develop modeling for these complex factors for specific CSI. Despite some challenges with land surface models, the team was able to measure some aspects of vegetation activity. This work provides an important baseline that can be built on as more data becomes available and models for the environmental factors improve.

The team also explored the impact of CSI in sheep farming and reindeer herding. This study was conducted in the context of the multiple stressors pastoralists are up against. These stressors include climate change, encroachment of pastures, predators, and fragmented national management strategies. While CSI are not yet directly impacting herding, the team was able to describe the changes occurring in the current stressors and challenges. These findings will contribute to future research and the ability to measure vulnerability to incoming CSI and factors that can be addressed and promote mitigation. Current mitigation strategies that were informed by herder traditional knowledge were highlighted. It will be important to continue supporting herders' contributions to research and understanding CSI in the arctic. Gaps between herders' knowledge and government decision-making and policy were highlighted. International case studies with countries that use co-management approaches to land and resource management (ie Canada), could bring some valuable perspectives to the work in Nordic countries.



Nordic added value

The CLINF centre has contributed to Nordic added value. The team is composed of established Nordic researchers and expanded the team to include Indigenous peoples and livelihoods impacted by CIS. The scientific quality was excellent and the research that was conducted has been peer reviewed and continues to be published. Through the center, a critical mass of knowledge on CIS has been established and is hosted on a public website. This work can also inform improvements to policy and strategies on climate change and CIS. This work will position Nordic countries as leaders in European arenas.

The centre was able to collaborate with other Nordic Centers of Excellence and share findings and look at the impacts of supplementary feeding through workshops. These interdisciplinary activities will inform the ongoing study and understanding of CSI in the Arctic. From a methodological perspective, the community-based research and citizen science approaches were important developments. Ongoing study and promotion of these methods will be important to ensure communities are engaged in research and informing the scientific knowledge and mitigation strategies for CSI.

An important area to develop is the direction for policy development and government strategies as a result of research findings. As such it will be important to continue engaging government partners and decision-makers in this work.

Implementation and impact

The CLINF research results provide important contributions to understanding CSI in the Arctic. This is an area that has not been extensively studied and the center's contributions bring Nordic perspectives to the International Arctic forum. The studies have not only established important databases but also promoted modeling that addresses the complexity of factors influencing CSI in the Arctic. Finally, the team engaged traditional knowledge holders and communities who are closest to the impacts of climate change. This is important work and partnerships should be continued as studies continue.

The public data repository is an important tool for decision-makers and can help inform policy development in the Nordic regions. The databases established are being combined with existing databases to ensure long-term storage and access. They have also partnered with providers of early warning systems to ensure community stakeholders can be notified of rapid changes or levels of CSI that may impact community or herd wellness.

The long-term impacts of the work done in CLINF are interconnected through the diversity of the team of researchers who have connections with longstanding research units with established partnerships with community stakeholders and decision-making bodies.

The media and public interest in the topic are noted by the team, this aligns with the increased awareness and impacts of climate change globally.

The impacts of climate change on Indigenous livelihoods and way of life are acknowledged. Further to this the epistemological malalignment between government/ national manage-



ment and Indigenous peoples' land use approaches. There is a need for further studies exploring decision-making scope and policy/strategy formulation that will consider the rights of Indigenous peoples and the alignment of International laws.

Publications and other output

The output of publications is excellent and demonstrated increased numbers as the studies progressed. In addition to peer review publications, the team also reached out through website development and public science forums.

Mobility, researcher training, and international collaboration (maximum 5000 characters)

CLINF provided an active and dynamic learning environment. The number of PhD students and post-doctoral students supported was outstanding. CLINF topics were also combined with teaching and the enhancement of existing curricula in graduate schools. These contributions are important in the development of upcoming scientists and researchers working in the area of CSI.

The scope of team interactions in the International community is impressive and Nordic representation would have been well-informed as a result of this research collaboration.

Sustainable development goals

CLINF provided comprehensive coverage of SDG and no gaps were found. The team addressed Sustainable Development Goal (SDG) **3 Good health and well-being**, **SDG 13 Climate action**, by pointing to the effects of climate change on grazing conditions and the spreading of CSI, and **SDG 17 Partnerships by emphasizing strong international collaboration for sustainable development**. The CLINF team emphasized the impacts of the multiple environmental stressors that were then compounded by “fragmented governance tools” which ultimately impact pastoralism and Indigenous peoples' ability to navigate the impacts of climate change. In some cases, Indigenous knowledge and way of life are threatened. This is an urgent area for further study. Indigenous knowledges and land use is directly linked to SDG 15 Life on land “to protect, restore and promote sustainable use of terrestrial ecosystems” and SDG 11 Sustainable cities and communities by strengthening efforts to protect and safeguard the world’s cultural and natural heritage. The work of CLINF highlights the breach of SDG 11 and 15 and the need to focus future action on the sustainable use of terrestrial ecosystems and safeguarding Indigenous cultures and heritage.

Research areas, interdisciplinarity, and research activity

CLINF is comprised of a well-rounded interdisciplinary team. The team included medicine, veterinary medicine, infectious diseases, microbiology, epidemiology, mathematics, statistics, biometrics, entomology, biology, social anthropology, sociology, environmental sociology, social philosophy, ecology, cultural and environmental history, resource economics, gender studies and subdivisions of these fields. As such the lens on CSI in the Arctic captured the complex and dynamic nature of factors at play. The plan for interdisciplinary research was outlined in the original proposal and the team was able to implement the work



successfully. Some challenges were acknowledged. This is to be expected in interdisciplinary work. There was a reflection on the scope and definition of interdisciplinary work, demonstrating that the team took opportunities to learn and improve how interdisciplinary collaborations are operationalized.

Have there been any major deviations from the centre's research plan since its start-up?

The main deviations to the center's research plan were a result of cuts to funding allocations. The team was able to reduce some of the areas identified in the sub-work packages that were informing policymakers. They were able to reduce the activities without impacting the overall quality of the work. Project management was supported by the team member's host organization and contributed to the success of CLINF.

Some of the work experienced delays due to COVID, however, the team is positioned to resume such work once the pandemic impacts are reduced and allow travel and movement without risk. It was noted that the pandemic had large impacts on travel and community relationships, especially with Russia.

The team has been successful in securing additional funding, these funds were accessed to support new and emerging lines of research.

Gender balance and perspectives

The team members all considered gender in the research and the research findings bring valuable perspectives on gender and CSI. They highlight the importance of further research and support for a gender-based lens on sustainability in Arctic regions.

The research team was balanced and had women and men represented in the team leadership. On the topic of leadership, none of the team leaders were identified as Indigenous. The inclusion of Indigenous leadership could be considered in future studies.

Are there deviations to the plan for Open access to the project's research results?

The CLINF research team did an excellent job in promoting open science and access to data gathered through a public data repository. The majority of the scientific articles published by the team have been open-access. The team can be commended for their commitment to data access and open access to research results.

Future perspectives and continuation of the research(maximum 5000 characters)

The CLINF research collaboration has continued through grant development and modifications due to the COVID-19 pandemic. It is encouraging to see further development of the themes that have arisen through work with Indigenous communities and pastoralists.

The team will continue to make contributions to interdisciplinary and transdisciplinary research on the interplay of environmental, ecological, and societal factors which interact with CSI in the Arctic.

