

Responsible Development of the Arctic:
Opportunities and challenges – Pathways to Action

Final Report

CLINF Nordic Centre of Excellence in Arctic Research

Climate change effects on the epidemiology of infectious
diseases and the impacts on northern societies



Report title	Final Report of the CLINF Nordic Centre of Excellence in Arctic Research
Date	April 2016 - March 2021
Coordinators of the NCoE	Birgitta Evengård and Tomas Thierfelder
Author(s)	Work package leaders Ann Albihn, Birgitta Evengård, Grete Hoveslud, Shaun Quegan, Jan Åge Riseth, Tomas Thierfelder, and Svenja Stöven as well as CLINF researchers Juha Lemmetyinen, Anna Omzic and Camilla Risvoll.

Executive Summary

The rate and magnitude of climate change is 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 disease 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 in the view of how to make their living and to 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 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 harmonised 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 new map and data products of current and projected geographic spread of climate sensitive infections. These



results are accessible for decision makers, scientists and the public and were disseminated in lay terms.

CLINF scientists aimed for an interpretation of nature so as 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 in order to facilitate cross-border comparisons of health statistics as 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 with anomalous weather. Supplementary feeding of reindeer emerges as an adaptation strategy but also increases risk of disease. CLINF scientists studied the proxies for such diseases and the 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.

Contents

Acronyms used.....	6
1. Highlights and main findings.....	7
1.1 The CLINF CSI and climate data repository	7
1.2 Evidence of CSI in the North	7
1.3 Projected CSI scenarios in the North up to 2100	9
1.4 The societal impact of CSI and needs for adaptation	10
1.5 The CLINF Geographical Information System	11
2. Nordic added value.....	11
3. Implementation and impact.....	13
3.1. Plans for implementation of CLINF research results	13
3.2. Expected impact of CLINF research results	14
4. Publications and other output	16
5. Mobility, researcher training and international collaboration.....	17
5.1. Young career scientist training	17
5.2. International collaboration and mobility	18
6. Sustainable development goals	19
7. Research areas, interdisciplinarity, and research activity.....	20
8. Major deviations to the centre’s research plansince start-up	22
9. Gender balance and perspectives.....	25
9.1. Measures for gender balance of the CLINF team and their effectiveness.....	25
9.2. Gender perspectives in CLINF research	25
10. Deviations to the plan for Open access to the project’s research results	27
11. Future perspectives and continuation of the research	28
Appendices	29

Acronyms used

CLINF	Climate change effects on the epidemiology of infectious diseases and the impacts on northern societies
CLINF-RII	Second CLINF extension project into Russia east of the Ural mountains, funded by NordForsk
CSI	climate sensitive infections
GIS	Geographic Information System
INTERACT	International Network for Terrestrial Research and Monitoring in the Arctic, European Union project under Horizon 2020, www.eu-interact.org
LSM	<i>land surface model</i>
NCoE	Nordic Centre of Excellence
PFT	plant functional type
ReinCSI	Reindeer herding adaptability to climate sensitive infections in Nenetsia and Sápmi
SDG	United Nations' global sustainable development goal
SLU	Swedish University of Agricultural Sciences
SVA	National Veterinary Institute, Sweden
UMU	Umeå University
TBE	tick-borne encephalitis
WP	work package

1. Highlights and main findings

CLINF has focused on the dynamically interlinked challenges from societal, economic, political and cultural effects of changes in infectious disease prevalence. CLINF researchers have address northern climate sensitive infections (CSI) through a combined analysis of health statistics (work package 1, WP1, Human and animal diseases in the northern Nordic region), potential landscape change (WP2, Climate change effects in the Nordic region) and the associated CSI migration (WP3, Depicting the geographic spread of CSI in the Nordic region), perception of risk and societal cost, adaptive capacity to cope with the risks and costs, and strengthening societal CSI infrastructures (WP4, Societal impacts and adaptation needs). Adaptive capacity, gender effects and traditional knowledge have been intended to work as integrating factors (WP5, Traditional knowledge, gender and local agency). New map and data products have been developed to depict the current and projected geographic spread of emerging CSI (WP6, The CLINF geographic information system, CLINF GIS).

1.1 The CLINF CSI and climate data repository

CLINF has collected retrospective human and animal data on the prevalence of 14 putative CSI in the Arctic region from Nuuk to Yakutsk and supplemented these with landscape and weather data for the same region and the same 30-year reference period. These data have been adapted to the spatio-temporal scales of the CSI data and all data has been compiled in the data repository that makes up the foundation of the CLINF GIS Public Data Repository (see section 1.5). Additional funding from the Nordic Council of Ministers for two Russian extension projects made data collection from Russia possible (CLINF-R and -RII).

While compiling the human CSI data the team struggled with varying reporting formats and data accessibility leading to a call for cross-border harmonization of recording practice between the Nordic countries (Omazic A. et al. 2019a). Our recommendation to decision makers for a harmonized CSI data collection could greatly facilitate cross-border CSI surveillance as climate change will continue to introduce new health hazards. With regard to the Russian CSI data we further recommend to register CSI data in a gender-divided way. Only then it will be possible to detect possible gender-specific CSI epidemiology (Orlov D. et al. 2020).

1.2 Evidence of CSI in the North

1.2.1 Climate-change effects on the geography of Northern infections

A comprehensive literature study aiming to identify potential CSI demonstrated that climate change may affect the epidemiology and geographical range of many infectious diseases. In particular, an increase in frequency and geographic area of arthropod vector-borne diseases such as borreliosis and tick-borne encephalitis (TBE) might be due to climate-induced change (Omazic et al, 2019b). This preparatory study determined the diseases that CLINF subsequently covered with data and demonstrated that there is an increasing awareness in the literature of the effects of climate change on infectious diseases. Based on the subsequently procured diseases data, Thierfelder et al. (manuscript in preparation)

demonstrated that out of the eight human infections covered with data, four zoonotic infections have responded to climate change. These are borreliosis, Q fever, TBE, and tularemia (see also van Oort et al. 2020).

1.2.2 Seroprevalence of putative CSI in humans and reindeer

In addition to the analysis of retrospective CSI data as collected from infectious disease registers the team analysed human serum samples from Greenland and northern Sweden for the presence of a number of CSI. The results demonstrate for the first time seropositivity for brucellosis, leptospirosis, rickettsioses and tularemia in Greenland, even though the figures for brucellosis and tularemia were as low as 1% of the tested samples. In West Greenland, the percentage of leptospirosis positive samples increased significantly from 2,5% in 1998 to 30% in 2013. Our findings provide new baseline data for human seroprevalence of rarely or not at all described CSI in Greenland and northern Sweden.

Reindeer from Iceland in the West to Yakutsk in eastern Siberia have been sampled. First, we investigated the seroprevalence of pestivirus. While 40-50% of the Swedish and Norwegian samples for seropositive, we found only very low values for samples from Iceland (1,6%), Finland (2,5%) and Russia (0%) (Omazic et al. 2019c). This unexpectedly diverse circulation of a yet uncharacterised pestivirus in the reindeer populations warrants further studies of pestivirus infection dynamics, effects on reindeer health and population dynamics.

Second, nose and rectal swabs were analysed with next generation sequencing in order to identify CSI pathogens. Various viruses, several of which have pathogenic potential for animals and/or humans were identified (Sanchez Romano et al. 2021, manuscript in preparation).

Under CLINF-RII, the Swedish-Finnish-Russian team initiated a study of brucellosis in Russian reindeer, where we compared samples from the Republic of Sakha (Yakutia) with those from the Tazov region of Yamalo-Nenets Autonomous District. Interestingly, our preliminary results indicate that *Brucella*-positive reindeer were found in two of the three studied herds in the Tazov region, while herds in Yakutia were negative for *Brucella* spp. antibodies. However, according to our CSI data repository *Brucella* infections are and have been circulating in humans and animals also in Yakutia (Omazic et al. 2021, manuscript in preparation).

1.2.3 Prevalence of ticks and tick-borne pathogens

Climate change both facilitates the expansion of ticks to higher latitudes and altitudes and causes an increase in their abundance. The tick campaign in northern Sweden during 2018 and 2019, where citizens were asked to send ticks that they had found on themselves or on their animals to the National Veterinary Institute (SVA), showed that ticks can be found in all counties in the North of Sweden (Norrland). *Ixodes ricinus* was the dominant tick species, but we could observe a spread of *I. persulcatus* compared to previous reports. A subset of ticks received in 2018 were analysed for their pathogen load; both *Rickettsia*, *Borrelia*, *Anaplasma*, *Neohhrlichia*, *Babesia*, and Uukuniemi-virus were found (Nuru N 2020; Öborn L

2020; Omazic et al. manuscript in preparation). In addition, analyses of ticks collected in 2019 is still ongoing. With this new knowledge, we can contribute to adaptation strategies and measures for minimizing the impact of tick-borne diseases on animal husbandry and northern human communities.

As a result of the tick campaign, two new tick species were identified in Sweden (*Hyalomma marginatum* and *H. rufipes*), which can potentially introduce new tick-borne pathogens to new areas and communities, and we suggest a risk assessment for Sweden and the nearby countries to this effect (Grandi et al. 2020).

1.3 Projected CSI scenarios in the North up to 2100

Climate change involves not only meteorological changes, but changes in many terrestrial, aquatic and cryospheric environmental variables that affect CSI. Forecasting the likely prevalence of CSI in the Arctic therefore requires observation and predictive modelling of these variables, together with knowledge of how they relate to the viability of CSI. Satellites provide frequent pan-Arctic observations of CSI-relevant variables, including soil moisture, land cover, snow cover and depth, and freeze-thaw events, which have been amalgamated into the CLINF GIS. An example, the timing and trends of snow mass over the northern hemisphere, is shown in Figure 1 in Appendix 1. Despite an overall stable trend in overall snow mass in Eurasia, trend patterns vary greatly with decreases in Scandinavia and an increasing trend in eastern Siberia. The presence and amount of snow cover are of relevance to tularemia, brucellosis, borreliosis and other CSI e.g. by affecting the survival of disease-carrying insects in winter. Such data are also important in driving and testing the land surface and hydro-climatic models used in CLINF to predict how environmental conditions will change. A key contribution of CLINF was to combine such models with a well-established statistical model for tularemia to investigate its sensitivity to hydro-climatic conditions (Ma et al. 2019). Tularemia was found to have high sensitivity to different combinations of hydro-climatic variables, and the probability of shifts in major disease outbreaks increases even for small changes from current conditions. Given hydro-climatic conditions determine an endemic level of tularemia, which will change as conditions change and may then exceed some accepted level, whereupon mitigation measures will be required (Fig. 2, Appendix 1). A key issue in CSI occurrence forecasting is uncertainty about changes in both climate and the CSI-relevant environmental conditions it drives. CLINF investigated this combined uncertainty using Global Climate Model predictions and models of land surface and hydro-climatic conditions. For example, a crucial factor in CSI prevalence is land cover, but predictions by different Land Surface Models of how land cover will evolve are quite different (Destouni et al. 2021, Fig. 3, Appendix 1). We were also able to quantify the different spatio-temporal uncertainty in vegetation activity, another CSI determinant, predicted by a set of leading Land Surface Models (Leibovici et al. 2020).

1.4 The societal impact of CSI and needs for adaptation

Through in-depth empirical case studies, predominantly in northern Norway we have studied the risks of CSI in sheep farming and reindeer herding. Climate change (locked pastures, vegetation change), encroachment of pastures (roads, railways, windmills, tourism), carnivores (lynx, wolverines, sea eagles), and fragmented national management (pastoralism, predators) are the multiple stressors pastoralists are up against and within which we have examined CSI. We have established the link between the current challenges in pastoralism and future CSI. This link is not obvious because CSI are not yet a threat to pastoralism (see Section 10) and is therefore not yet addressed by pastoralists (Hovelsrud et al. 2020). Therefore, we have studied the adaptive responses to current stressors that in the future we argue, will interact with CSI. We have identified an epistemological mismatch between national management and the empirical reality of pastoralists (Risvoll et al. 2021, manuscript in preparation). Exposure to CSI may potentially increase as a result of adaptation to other stressors. Pastoralists time-tested knowledge is not included in national management and decision-making thereby reducing their adaptive capacity. The main adaptive response to multiple stressors is supplementary feeding of the animals. While such feeding is agreed upon and necessary to alleviate starvation and to protect against predators, it will likely not be sustainable in the long run for livelihoods whose foundation is the utilization of natural grazing land. This is because such feeding will increase the exposure to infectious diseases such as CSI (e.g. Tryland et al. 2019; Hortskotte, Risvoll and Lépy 2020). It will affect the natural ability of reindeer and sheep to find fodder, lead to loss of traditional knowledge about grazing conditions, it is costly, and may well change the way decision-makers govern land-use.

An indication of the negative effect of supplementary feeding on reindeer health might come from our study into the presence of opportunistic eye and mouth infections. More than 200 reindeer were examined at slaughter. All sampled animals were examined *ante mortem* by an official veterinarian and assessed as healthy. Although, 101 pathological findings in the eyes and mouth were noted. More studies are necessary to investigate which agent(s) are causing the eye and mouth infections in reindeer (Jansson M 2019). One question is whether corralling the reindeer for supplementary feeding might cause stress and immunosuppression, thus increasing the risk of opportunistic infections to spread in the herd.

Taking ticks (*Ixodes ricinus*) as an example we have shown the climatic limitations for disease vectors and hosts. Environmental and societal/institutional conditions have a significant role in determining the spreading of CSI under a changing climate (van Oort et al. 2020). Management emerges as an important regulatory “tool” for tick and/or disease transfer. Given our findings that national management fails to address the current pastoralist challenges, we argue that managing CSI must be holistic, include local context, traditional knowledge about landscape and animal interactions, and the cultural foundations of the livelihoods. Only then will such management ensure sustainability.

We have tracked relevant parts of the environmental and cultural history of the Eurasian tundra reindeer, *Rangifer tarandus tarandus*. Documented back to the 18th century, intensive reindeer husbandry has promoted outbreaks of CSI (Riseth et al. 2020). Tømmervik et al. (2021) explored possible links between temperature anomalies and the severity of CSI outbreaks and found significant correlation between positive temperature anomalies in summer and the outbreaks of anthrax causing high mortality in reindeer. Eye-disease (infectious keratoconjunctivitis) and pasteurellosis showed similar trends. Outbreaks of reindeer pest (*Clostridium septicum*) and foot rot disease (necrobacillosis) were triggered by warmer springs and sunny summers. Mitigation measures, like stratified herding, rotation of milking grounds and summer pastures, extensive reindeer herding and vaccination have during the last century reduced mortality (Riseth et al. 2020, Tømmervik et al. 2021, Tryland et al. 2021). However, the increasing pressure from multiple stressors challenges this type of strategy. Due to lack of winter pastures typical actions today include increased use of supplementary feeding, which involves more gathering and handling of the reindeer and higher animal density. These practices challenge the hygienic conditions and create stress for the animals, which all contribute to increased risks of contracting and transmitting CSI (Riseth et al. 2020, Tryland et al. 2021). However, in Nenetsk and Yamal traditional mitigation strategies such as rotation of pastures, navigation to avoid outbreak areas, and a sustainable use of the grazing areas (summer ranges) are still in use and were instrumental in avoiding high losses of reindeer during the 2016 outbreak of anthrax (Ravna et al., manuscript in preparation).

1.5 The CLINF Geographical Information System

The public CLINF data repository (CLINF GIS: www.clinf.org) openly disseminates CLINF data products regarding diseases, weather, and landscape characteristics covering the thirty-year climate reference period studied in the CLINF enterprise. Alongside the data itself, thorough metadata are provided by Thierfelder et al. (2019a; 2019b; 2019c; 2019d). CLINF data, including maps and map-like animations, were made publicly available in 2020.

2. Nordic added value

The CLINF research area stretches from West Greenland to the Pacific Siberia, from 55 to 80 degrees North. Across this vast region, CLINF has procured high quality data regarding 18 mainly zoonotic infectious diseases alongside with all relevant data regarding weather, landscape characteristics and greening through the current 30-year climate reference period (Thierfelder et al., 2019a; 2019b; 2019c; 2019d). These data are potentially connected with global climate change, and CLINF data are very relevant for a wide community of international stakeholders that range from scientists to politicians and indigenous organisations. As an example, CLINF coworkers used CLINF data to conclude that hydrological change has an impact on local or regional outbreaks of tularemia (Ma et al. 2019). In another example, Leibovici et al. (2021) concluded that statistical relationships that link

weather and landscape variables to diseases incidences may be used to predict future scenarios of borreliosis and TBE across the CLINF study region.

Sápmi stretches across large parts of the Nordic countries and includes a large variation of natural geography, culture, and policy, implying large potential for comparative research. CLINF social scientists have investigated how pastoralists, mainly reindeer herders in various regions in Fennoscandia and Russia (Nenetsia, Yamal), perceive and deal with the risk of CSI in the context of multiple stressors. The possibility of comparing the conditions for reindeer husbandry in these regions has been very enriching. The productive dialogues and cooperations between pastoralists and researchers, different ways of knowing, across scientific disciplines (ecology, hydrology, climate modelling, veterinary science and social sciences) as well as across national borders are unprecedented and have generated new knowledge about the complex system from which we have to understand and to analyse CSI. These collaborations have promoted interdisciplinary understanding.

The international Workshop on Supplementary Feeding in Kiruna in March 2018 was a direct result of Nordic collaboration within the three Nordic Centres of Excellence CLINF, REXSAC and ReiGN. This would not have occurred without NordForsk funding. By comparing data and approaches in the Nordic countries we have increased our insights and understanding of the why's and how's of supplementary feeding of reindeer and sheep. We have also revealed the societal, economic, and cultural implications of such feeding, and how it will interact with CSI as these move northwards.

Our findings on the complex linkages between CSI, as an emergent issue in the Arctic, and the broader socio-economic conditions of pastoralists are of international interest. Our findings provide guidance on how to understand and adapt to an emergent and serious issue such as CSI. The indepth understanding of the Norwegian Nordland County context provides the team with transferable knowledge that is applicable to other parts of the Arctic, also beyond animal husbandry.

Our new understanding of the factors that need to be considered when management bodies are addressing new and emerging threats, such as CSI, strengthens the knowledgebase for Nordic policy development.

CLINF researchers have pointed out that the differences in monitoring and reporting of infectious diseases in Nordic countries are an obstacle for pan-Nordic infectious disease surveillance and climate change adaptation in terms of proactive decisions by policy makers (Omazic et al. 2019a). It was surprising to encounter these differences between countries with such a similar political and social system as the Nordic countries, and harmonization of infectious disease surveillance is asked for in order to improve public health preparedness and to counteract the increased risk of infectious diseases due to climate change.

Various CLINF studies on the prevalence of ticks and tick-borne diseases are of immediate value to the inhabitants of the Nordic countries, such as the northern expansion of ticks, their pathogen "load", or the finding of antibodies against TBE virus in unpasteurized milk. Such

findings may add to the knowledge base of public health authorities and help to update recommendations for vaccination of residents.

May be unsurprisingly, all our tick-related studies have led to massive media interest.

The citizen science study carried out in 2018 and 2019 also points at how readily citizens in the Nordic countries respond to a call from scientists, thus performing community-based science without much ado.

In general, the various CLINF social science studies have been performed in close cooperation with the studied societal groups. New knowledge was co-produced, to mutual benefit. Thus, new research insights were directly available to the stakeholders.

3. Implementation and impact

3.1. Plans for implementation of CLINF research results

CLINF has addressed a central issue in planning for responsible development in the North: understanding the impact of climate change on the geographical distribution and epidemiology of climate sensitive infections and the consequences for Arctic health, economies and societies. This is a neglected problem that is likely to have a profound effect on northern societies. It has been a key CLINF objective to clarify the effects on humans and animals, especially among animal husbandry households, which are particularly exposed and sensitive to such changes. As a result, CLINF has almost entirely been concerned with impact and has turned its new understanding into practical tools for decision makers responsible for the development of northern societies. With the CLINF GIS Public Data Repository in place, we are providing informative maps of CSI spread that are easily accessible. Currently, the repository is available through the www.clinf.org homepage. Towards the end of 2022 it will be transferred to the Swedish National Data Service (www.snd.gu.se) for storage and dissemination *ad infinitum*. In addition, the CLINF database will be disseminated via the INTERACT Data Portal ([Welcome - Interact Data Portal \(eu-interact.org\)](http://Welcome-InteractDataPortal.eu-interact.org)).

CLINF has a strong collaborator in the major European infrastructure project INTERACT, with which a bilateral Memorandum of Understanding has been signed. CLINF and INTERACT have jointly designed an early warning system for increased risk of CSI spread at the local level. This CSI Red Phone Alert will empower communities and decision makers to take cautionary action and may support them in their efforts for sustainable societal adaptation to climate change impact.

The findings from the international Workshop on Supplementary Feeding are expected to have an impact on policy development. The report from the workshop is available in Sámi, Finnish, Norwegian, Swedish, and English and has been distributed to all workshop participants, decision makers and additional stakeholders, both as a print version and in digital format. It has been announced in press releases and is publicly available through the webpages of the participating organisations and at clinf.org.

Apart from the above, CLINF's possibilities for directly turning new insights from the project into national or even international policies are limited. Among the Nordic CLINF partners are however several with national operational responsibilities, e.g. Statens Serum Institute (Denmark) and SVA (Sweden), and one regional university hospital (in connection with Umeå University), that could directly impact on national health-related policies. For example, following CLINF results on the prevalence of CSI in humans, there is now an awareness of possible leptospirosis in Greenland patients. The team at SVA contributed to an informative webpage on reindeer health that is run by Sámiid Riikkasearvi (Sami Reindeer Association), Sweden. CLINF findings have also emphasized the necessity for the authorities to manage the increasing threat from tick-borne pathogens and have increased awareness of the risk of Brucella infection from reindeer in some Russian regions.

CLINF partner The Finnish Meteorological Institute is the main provider of meteorological and satellite data services in Finland, and will facilitate the development, generation and distribution of novel satellite data products identified in CLINF, such as "Icy strata in northern snow packages". In the EU Horizon2020 project CHARTER CLINF researchers Jan Åge Riseth and Hans Tømmervik are continuing this research and extending it to the melting permafrost as a factor in anthrax outbreaks (Tømmervik et al., manuscript in prep).

3.2. Expected impact of CLINF research results

CLINF's possibilities for making an impact on societal and political decisions lies mainly in the realm of its scientific publications and its awareness-raising interactions with various stakeholders. Among the latter are the many collaborations in large parts of the CLINF research region with representatives of animal husbandry communities. Moreover, the engagement of several CLINF members in various national and international science policy initiatives may have a long-term impact on science policy and Arctic research (see Appendix 2 and 3). The best example of this is probably the new European Polar Research Programme that was issued in 2020 and to which CLINF coordinator Birgitta Evengård has contributed. Other examples from the last year of CLINF are Grete Hovelsrud's presidency of the Norwegian Scientific Academy for Polar Research 2020/21 (Birgitta was awarded membership in January 2020) and the fact that both Birgitta, Grete and Russian collaborator Yulia Zaika (University of Murmansk) are engaged in leading the research coordination network "Migration in Harmony", which is funded by the U.S. National Science Foundation (www.migrationinharmony.org). We have previously reported on Birgitta's role in a science policy workshop organized by the U.S. National Academies of Sciences, Engineering and Medicine (Nov. 2019). A report from this workshop was published in 2020 and rose considerable world-wide media attention, which also included interviews of Birgitta by high profile media with global coverage.

Furthermore, judging from the number of interview inquiries to Birgitta and follow-up articles after a Greenpeace news story from July 2020, there is also considerable interest from the general public in the matter of climate change and (re-)emerging diseases. For example, Birgitta has been contacted by a Swiss student at grammar school level as well as an Indian

student of journalism in this matter. In addition, CLINF researchers have regularly contacted by scholars at all levels from around the world regarding CLINF issues. Being engaged in international academic education at graduate and post-graduate levels, allows us to communicate CLINF issues to a young audience. This is probably a highly effective method of securing the engagement of future generations.

The intellectual property gathered by the CLINF team is not to be neglected. The CLINF GIS Public Data Repository with its geographical maps of diseases, climate, and environmental variables, as well as with projected disease scenarios, is perhaps the most concrete legacy of CLINF. It is a new and valuable asset and an infrastructure for future work of researchers, and it can inform political decisions. Our new map of wetlands around the Arctic did not exist before.

CLINF researchers have identified complex linkages between and among societal infrastructure (EU policy, national, regional, local and sectoral governing bodies, international agreements, family groups) that may affect the spreading of CSI. The analysis of these linkages will be communicated to relevant stakeholders as a foundation for adaptation measures. Further, CSI is a new management area, and from our studies we have a better understanding that we need to involve national decision-makers across sectors because such infectious diseases occur in the context of *inter alia* land-use, predators, agricultural practices, and Indigenous Peoples' rights. In addition, we have been able to suggest, when in the seasonal tick cycle, management interventions may be most beneficial (see Figure 4, Appendix 1, van Oort et al. 2020). This is of relevance internationally, and the research team will continue to communicate such findings to relevant stakeholders and decision-makers, through outreach activities, conferences and discussions. In fact, this is ongoing as the pastoralists are updated and informed about the new knowledge that has been co-produced. Additional outreach activities are planned. These findings are an important stepping-stone for further research, reflected in the number of new research proposals from segments of the CLINF consortium, and including stakeholders.

Increased risk of CSI due to climate change adds to the multiple stressors that impact on reindeer husbandry. The identified epistemological mismatch between national management and the empirical reality of the pastoralists makes this difficult (Risvoll et al 2021). This finding, supported by impact research, indicates that there is a clear need for reducing the total burden of external impacts on indigenous reindeer herders' land-use and life form. Further, this epistemological mismatch has wider policy implications. International law, such as the International Covenant on Civil and Political Rights, article 27, establishes a threshold for the legal level of total impact on reindeer herding districts: Nobody should be forced out of business. There is a clear need for developing monitoring and early warning systems to that end.

4. Publications and other output

The table below provides an overview of the scientific output throughout the funding period. See Appendix 3 for a list of scientific output 2020/2021 that was at least partially funded by the CLINF NCoE. For earlier publications etc. we refer to previous annual reports. A major initiative during the final year of CLINF was the special issue in the *International Journal of Environmental Research and Public Health* that focused on the link between climate change and infectious diseases and that was guest edited by the CLINF coordinators.

Scientific output in form of	2016	2017	2018	2019	2020/21
Peer-reviewed publications in scientific journals	2	7	6	19	14
Edited book chapters		2		4	8
Reports, theses etc.		4	4	6	4
Invited speaker at scientific conferences incl. panel participation	8	10	20	25	2
Oral presentations at scientific conferences,	8	14	7	16	20
Poster presentations at scientific conferences		6	5	2	2

The table below provides an overview of CLINF dissemination throughout the funding period. See Appendix 2 for a list of outreach activities towards the general public during 2020/2021. For earlier activities we refer to previous annual reports. In March and April 2021 the CLINF homepage was reorganized and equipped with a [popular science presentation](#) of project achievements. In June followed the publication of a [4-page popular science article](#) in the online journal [Research Outreach](#).

Outreach to the general public in form of	2016	2017	2018	2019	2020/21
Media appearances (radio, TV)	4	4	>100	Many	12
Press releases	2				2
Web pages, articles on other organisations's web pages (other than clinf.org)					12
Invited speaker/oral presentations at public events, fora with participation of policy and decision makers (non-academic)	8				4
Organisation of courses, conferences, workshops etc.				8	
Other outreach	2	11	12	8	

5. Mobility, researcher training and international collaboration

5.1. Young career scientist training

An overview of CLINF activities directed towards young career scientists is provided in the table below, covering everything from supervision of student theses to organization and lecturing at graduate student courses. With regard to course and seminar organization it has been our strategy from the beginning to rather join forces with other organisations and existing training initiatives than to organize CLINF-specific activities. CLINF researchers cooperated for example with graduate schools and incorporated CLINF-specific issues into already existing curricula and seminar series. This strategy was expected to support interdisciplinary training, to facilitate broader visibility and student participation as well as a more efficient use of resources.

All in all, NordForsk funding contributed to the PhD theses of 14 graduate students, who have worked to various extent within CLINF. Similarly, eight postdoctoral fellows have been involved in CLINF throughout the years; some of them advanced their careers and are now employed as faculty scientists.

Activities for young career scientists full- or part-time involved in CLINF research

Type of activity	2016	2017	2018	2019	2020/21
Supervision of M.Sc. students	2	4	2	3	2
Supervision of Ph.D. students		6	8	9	6
Supervision of postdoctoral fellows	1	6	6	2	1
CLINF involvement in courses, seminars, graduate or summer schools				>7	>4

5.2. International collaboration and mobility

CLINF researchers have been well connected within academia, with international interest groups and policy initiatives focusing on climate change or on related Arctic issues. Throughout the five-year funding period they have collaborated not only with each other (see section 7) but also with CLINF-external scientists at other universities or research institutes. They have collaborated (and are collaborating) in CLINF spin-off projects and proposals; they have co-organized international conferences and introduced CLINF themes into conference programmes. The latest example for this type of activity is the CLINF initiative for the NordForsk Session at the 2021 Arctic Science Summit Week with a joint application coordinated with NordForsk and the leaders of the other three NCoEs. Of the 26 abstracts submitted for this session 17 were contributed by CLINF researchers.

Under the CLINF-R and -RII extension projects as well as the ReinCSI project CLINF-specific workshops and seminars with international participation were organized (see 2019 Annual Report). These events facilitated information exchange, knowledge transfer regarding research approaches and techniques, and overall supported networking with Russian researchers. In fact, the outreach into Russia has been very successful, with several co-authored studies already published or still ongoing, and with Russian representation at a high-profile science policy meeting ([Intl. Workshop Understanding and responding to global health security risks from microbial threats in the Arctic](#), Nov 2019, Hanover, Germany) at the top of the list (see Appendix 4 for the final report on CLINF-RII).

As member of the INTERACT Transnational Access Expert Committee, Birgitta Evengård has been involved for several years in distributing European funds in form of access to INTERACT Field Stations to Arctic-relevant research including microbiology- and health-oriented projects (www.eu-interact.org). These access grants enable rich and diverse research

to occur in the northern region and are of utmost importance for bringing young scientists to the area. Tomas Thierfelder has been an original INTERACT principal investigator for many years, regularly attending both organisations and hence providing an overlap area of shared principals and ideas.

The Arctic Research Network for Diseases in reindeer related to husbandry and climate change (TARANDUS) follows in CLINF's footsteps and gathers reindeer researchers from SVA, Arctic University of Norway, Natural Resources Institute Finland and East Iceland Nature Research Centre. Together they will build a sustainable and interdisciplinary network with the aim to improve animal health and welfare through development of preventive management routines and optimal herding practices adapted to climate change for a sustainable reindeer herding with a low negative impact on the climate and environment.

CLINF researchers co-arranged a workshop in Kiruna 2018 together with researchers from the fellow NCoEs REiGN and REXAC. Invited participants were stakeholders and scientists from different disciplines across the Nordic countries. A process of knowledge co-production resulted in a published report that already has generated outreach and further collaborations in form of Nordic research projects, networks, presentations at local stakeholder and government seminars and media debates. Building on the report scientists across the three NCoEs are co-authoring a scientific article and four chapters on issues of high relevance for CLINF for a book that is planned by REiGN.

6. Sustainable development goals

CLINF has 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 pastoralists need to continuously buffer against the effects of multiple stressors, and the fragmented governance tools have instead of facilitating sustainable adaptation, created a situation of potentially counter-productive paths. These complex and mismatching interlinkages of pastoralism and national policies negatively affect pastoralists' adaptation options and their room to manoeuvre; this may eventually cause tipping points for the livelihoods towards a different practice. One possible scenario is that reindeer herding will transition into an agricultural practice, from semi-domestication to a fully domesticated practice. The sheep farmers are pressured to the point of having to quit altogether. The pastoralist livelihoods become compromised and potentially threatened because they are forced to respond in ways that they know are counter-productive in the long run. In this scenario we may lose knowledge and culture with deep roots and we lose the environmental and climatic benefits of grazing animals, e.g. they contribute to the albedo effect and thus aid to mitigate global warming. This 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. More diffusely, CLINF's work with advocating for the international harmonisation of national programs for diseases surveillance (Omazic et al., 2019), and for centralised storage and dissemination of the associated data, has a strong bearing on most SDGs'.

In line with **SDG 5 Gender equality** CLINF's work has been aiming at integrating gender analysis in all parts of the project. Throughout our activities we have acknowledged and provided gender-divided data in order to show the differential effects of climate change on the health of women and men as a consequence of complex social contexts and adaptive capacities. CLINF has advocated the difference of sex- and gender-segregated statistics insisting on the importance of both sets of data for the informed decision-making in the field of climate change and health (Rautio et al., 2021).

7. Research areas, interdisciplinarity, and research activity

CLINF has been a multidisciplinary project with the ambition to move towards integrative and interdisciplinary research. A number of disciplines have been participating, e.g. 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. Arctic diplomacy has been a part of the work for the management as establishing contacts with Russian authorities for getting relevant authorisations have had its obstacles. Personal connections from work in the Arctic Council have been a crucial tool for moving on and continue with collaborations in Russia.

The main method of synergistic integration across CLINF WPs and research teams has clearly been laid out in the original CLINF project plan. It consists of the consecutive sharing and refining of data and data products, from early inventory and acquisition to the public dissemination of maps and societal recommendations (see 'Predecessors'/'Successors' in Appendix 5). However, data acquisition has been more cumbersome than expected, involving contact with authorities in the respective countries, locating historical archives and on-site visits to hand-copy relevant information on reported CSI incidences. Harmonisation and integration of the CSI data, the landscape and climate data has also taken longer than expected. For these reasons some of the integrating activities, mainly concerning the modelling could not be performed as planned, while other lines of study have moved forward independently.

Once a first version of the CLINF CSI, climate and landscape database became available for the CLINF researchers (in Dec 2018) it could play its intended role as major integrator as CLINF members could utilize it for sharing data products and for joint data analysis. Successively produced maps of past and future CSI scenarios were intended to support the joint analysis. One product of such collaborative assessment engaging CLINF statisticians,

biologists/ecologists and forecast modellers are the inferential results on CSI geographies and their dependence on biological and environmental variables.

The importance of locked winter pastures for reindeer husbandry, information provided by the social scientist, and insight into how locked winter pastures can be considered in CSI models by integrating information on freeze-thaw cycles, e.g. rain-on-snow events, is another example of joint exploitation of the CLINF database. A third example is predictive modelling of future effects of selected CSI on animal husbandry.

CLINF researchers have found that CSI may exacerbate the current challenges in pastoralism (section 1). The methodological and analytical conundrum of cascading, interacting and cumulative effects of change in pastoralism is immense. It requires unprecedented openness and collaboration between the different scientific disciplines and practitioners. The co-production of knowledge between researchers and pastoralists combined with drawing on a range of scientific disciplines to understand the nature and effects of CSI has been successful and is still ongoing.

Literature and document reviews, database analysis for weather and climate data, modelling, participant observation, semi-structured interviews, informal conversations and workshop discussions, scenario development, mapping exercises, coproduction of knowledge across sciences and non-scientific experts have been a substantial part of the CLINF activities as well as training of graduate students, teaching on courses, speaking at conferences, and giving interviews to media representatives from all over the world. CLINF social scientists had successful interdisciplinary research cooperation with traditional knowledge holders, other social scientists, veterinarians and hydrologists as well as officials and activists in ecological movements.

Throughout the five-year funding period multi- and to some extent interdisciplinary collaboration across work packages and participating research groups has taken place in different forms and at different pace. After the kick-off meeting in 2016, CLINF organized annual project meetings in 2017, 2018 and 2019, intended for the entire CLINF team. At times, the CLINF OPEN Science Forum was well-attended, mainly by CLINF researchers from Umeå University (UMU), Swedish University of Agricultural Sciences (SLU) and SVA with the occasional participation from University of Sheffield, Stockholm University and Nord University (representing sub-WPs 1.1, 1.4, WPs 2, 3, 4 and WP6, respectively). In addition, sub-WP leaders were encouraged to organize subject matter work meetings, whenever they saw the need for in-depth scientific discussions across research teams.

Several published articles, book chapters and conference contributions bear witness to CLINF-internal cooperation across WPs and research teams, each involving several scientific disciplines. Joint applications for additional funding can also be considered as signs of synergistic collaboration within and beyond CLINF.

If we define “multidisciplinary” as different disciplines working together and each drawing on their disciplinary knowledge, and “interdisciplinary” as integrating knowledge and methods from different disciplines using a real synthesis of approaches, CLINF overall has

been a multidisciplinary project. We have made some small steps towards interdisciplinarity but it has been challenging. CLINF provided a great opportunity for addressing the complexities surrounding CSI, but the potential has not been fully realized because of challenges in finding common ground across disciplines. CLINF has not fully overcome a resistance of the quantitative scientific disciplines towards qualitative social science research, which employs an in-depth, empirical and bottom-up approach. Unfortunately, the social scientists have failed in convincing other members of the CLINF team that the findings generated from such an approach are transferable to other Arctic areas and cases.

Interdisciplinarity requires more than many scientific disciplines coming together to address a problem, and more than integration of data and findings. It requires interest and respect and a shared understanding of the task ahead. In hindsight, some of the challenges that CLINF encountered, could probably have been avoided by early discussions about what we as a group mean by interdisciplinary research and how to accomplish such a difficult task. It is certainly beneficial to do so at the start of interdisciplinary projects.

CLINF research team leaders are very experienced but also very specialized in their fields and at times it has been difficult to step outside their comfort zone, to *think outside the box*. This requires time, which is always scarce for seniors, and the young persons brought in to CLINF need to get an educational base in their own field eg a PhD for their careers before venturing into multidisciplinary and interdisciplinary research with integrative ambitions. Another reflection that might be considered for future project proposals is that the CLINF structure of sub-WPs has been synonymous with the individual research groups participating in the project. Although several of these research groups harbour multiple scientific disciplines or have drawn on their scientific networks for multi- and interdisciplinary collaborations, the project structure has not promoted interdisciplinarity.

8. Major deviations to the centre's research plansince start-up

Due to the initial funding cuts sub-work packages WP4.6 and WP4.7 were deleted. In contrast to the rest of WP4 work, which focuses on the individual and local/regional perspective, these two tasks intended to assess the direct and indirect costs of CSI on a national and policy level and to project the costs of national contingency planning and adaptation measures for changed CSI prevalence. As these two sub-work packages were complementary to the rest of WP4 and to the information that will be available to policy makers through CLINF GIS, their deletion did not affect the overall plan.

The reduced NordForsk funding together with the fact that costs for project management had not been allocated in the original budget and needed to be jointly covered by the three original coordinators, i.e. UMU, SLU and SVA, also reduced the resources available for some of the work planned in WP1.4, i.e. a questionnaire and interview study directed towards animal husbandry households concerning CSI and climate influence on animal health. Nevertheless, some information could anyways be collected through interviews in connection with the Workshop on Supplementary Feeding (Kiruna, March 2018) and in

connection with the study on anti-TBE antibodies in bulk dairy milk that we reported on in the 2019 Annual Report.

WP4 had to revise the planned approach for finding out how CSI would affect pastoralism, how the pastoralists perceived risks from such zoonoses, how they adapt to CSI and how these infections would affect their adaptive capacity. In the first round of interviews and document analyses, the team discovered that CSI were an emerging issue that had not yet manifested as a risk or in a need of adaptation. This insight meant that we had to approach the role of CSI in pastoralism through the study of proxies and cascading effects of multiple stressors and the role of national management pertaining to sheep farming and reindeer herding. This change did not have major implications for the study but was an important finding that only emerged through in-depth field work and data collection. Interestingly, other diseases such as Chronic Wasting Disease (not climate-related) emerged during our study and could partially serve as proxies for understanding the effects of CSI transmitted by ticks that we had identified as being particularly salient for CSI in northern Norway, i.e. anaplasmosis and babesiosis.

CLINF had chosen tularemia as a case study for detailed analysis of climate sensitivity and model testing for future disease distribution, i.e. WP1.3. The overall objective of this case study was to develop strategies and methods that can be applied to other putative CSI regarding the analysis of their links to abiotic and biotic factors, ecological habitats and questions. The team identified a number of endemic regions (in Sweden) as well as geographically neighbouring regions with similar population but only few tularemia cases. Based on landscape and hydrological characteristics of these areas, the intention was to identify variables that differ significantly between the endemic and the control regions. High resolution risk maps were produced for some of the endemic regions (parts of Dalarna, Örebro region, Boden region). With the help of these and detailed data on the 2014-2019 tularemia outbreaks in Norrbotten county (the Boden region) the team wanted to characterize endemic areas, in particular local hot spots, in order to be able to forecast future risk areas. However, first the ethical review for the intended data collection and interview study of patients took longer than expected and then the main required medical personnel could not start the work due to the CoVID-19 pandemic. We are still interested in pursuing this line of research as soon as the pandemic conditions allow it. A questionnaire was sent out to patients in January 2021, but it is unlikely that we will be able to complete the study before the end of the CLINF funding period.

During the last year of CLINF operations, i.e. March 2020 – March 2021, the CoVID19 pandemic has strongly impacted planned international and domestic travel for meetings and field work in general. Pandemic restrictions had the most far-reaching effects on our planned work in Russia and with Russian colleagues. None or very few of the workshops, research visits and conference contributions that were planned under CLINF-RII could be performed. This may, however, be corrected as described in section 11 below.

WP5 field work in Russia had to be transformed due to the pandemic and due to certain political developments in the study region. Initially, a pilot study with accompanying field

work in the Arkhangelsk region was carried out. But the continuation with data collection in Yakutia became impossible due to travel restrictions. Therefore, based on the Arkhangelsk data and in collaboration with partners from other WPs, the original questionnaire was further developed for an international survey. Additional funding will be applied for for the continuation of this line of work. At the same time CLINF required to focus more on communication with different stakeholders in the field of climate change and health. Thus, WP5 investigated the potential of Web 2.0 to serve as a social media platform for a dialogue between authorities and population. The context of the Arkhangelsk region has provided a very good case as the period of 2018 – 2020 became a period of «local ecological riots». This allowed us to focus attention on ecological justice issues from the viewpoint of participation, representation and distribution, departing from the ideas of distributive justice implementation and carrying out a survey among local residents, politicians and public service officers, on ecological issues. Our study showed that in an era when traditional media become less and less popular the main sources of information and communication move to Web 1.0 and Web 2.0 platforms. This change in source of information transforms the entire communication process, which bears consequences for possibilities of e-democracy implementation. This knowledge is important for CLINF in the process of dissemination of results and establishing dialogues with different actors to discuss the research results and to make informed political decisions.

Throughout the five-year period of CLINF team members have been successful in securing additional funding, which resulted in slightly changed or entirely new lines of inquiries (see also previous annual reports):

- Tighter connections with Russian researchers, access to Russian human and animal CSI data as well as the sampling of reindeer from herds in Russia was made possible by the CLINF-R and -RII extension grants from the Nordic Council of Ministers.
- CLINF researchers in Narvik and Tromsø were successful in retrieving funding from the Norwegian Fram Centre for a CLINF spin-off project called “ReinCSI”, which further extended the CLINF network into Russia.
- The role of supplementary feeding for the distribution of CSI could be studied more in-depth through “the Kiruna workshop” that was jointly organized with the ReIGN and REXSAC NCoEs in March 2018 and that received additional funding from NordForsk.
- The citizen science study on tick expansion in Sweden and the subsequent microbiological analysis of the collected ticks for the presence of (putative) CSI pathogens was a new and externally funded task under the CLINF umbrella.
- Similarly, the analysis of bulk milk from dairy cows, sheep and goats for evidence of TBE was made possible with other funding than NordForsk-funding.

9. Gender balance and perspectives

9.1. Measures for gender balance of the CLINF team and their effectiveness

CLINF did not see the need to implement specific measures for gender balance and has instead relied on that CLINF members follow the relevant policies of their home organisation when for example recruiting staff to their part in the project. Five of the 13 research team leaders are women and initially two of them, Birgitta Evengård and Ann Albihn, later only Birgitta have been engaged in coordinating the CLINF NCoE together with Tomas Thierfelder.

9.2. Gender perspectives in CLINF research

Gender has been a cross-cutting perspective for CLINF research and all team members have been asked to consider gender perspectives in their investigations.

Statistics is at the core of monitoring. For sustainable development, such statistics should be gender-divided. Men and women have to certain extent different gender socialization patterns, they attain different livelihoods and are exposed to different health hazards. Literature analysis allowed the CLINF team to conclude that, despite the formal recognition of gender 'lenses' being important for understanding Arctic human development, gender perspectives are seldomly represented in research and policies on climate change impact on public health, especially in the Arctic (Rautio et al., 2021). A discussion on differences between sex-segregated data and gender-divided statistics allows for the argument that gender analysis should be carried out as routine in human health research and healthcare, as it is not only a question of human rights, but also one of economic benefit for the society en large and of the quality of healthcare services. This is a statement that CLINF can put forward as an outcome. A systematic gender approach is more than a sophisticated way to investigate and develop human sustainability in the region. From these findings several recommendations can be concluded and addressed equally to researchers and decision makers, who are involved in human health issues:

- We see a need for common approaches to sex- and gender-specific data collection in order to organize gender mainstreaming processes in the Arctic Council activities.
- We suggest an umbrella network on gender equality in the Arctic region, gathering researchers, experts, non-government organisations and politicians.
- Gender equality should be included in all project, activities and decision-making in the Arctic Council.
- More funding is needed for gender research in the Arctic.

We consider this to be an important result for the Russian part of CLINF.

In many parts of the Arctic, economic cutbacks have had negative impact on rural and remote places, reducing the quality of life in various ways. Such negative development leads to increased perception of insecurity among women, for themselves and for their children, and it becomes one of the factors forcing women to leave their current place of residence

(Kukarenko 2019b). In addition, we observed a new migration pattern: elderly women leave their home communities in Greenland for Denmark or other countries to help their children's families with the grandchildren. As a result, 'male communities' emerge, without anyone to support them. This new migration pattern stands in contrast to the traditional way of the choice of residence being a once-in-a-life-time option. Today, men seem to be socialized into path dependency, i.e. having difficulties accepting change, while women appear to be more open for change. As a result, women are more mobile, both socially and geographically. In contrast, men maintain traditional professions, and these do not enable them to ensure the investments needed to modernize and expand their activities. Without a wife securing a second income, the investments are absent. At the same time, men also lack the education that might provide them with alternatives.

For sustainable development in the Arctic it is necessary not only to monitor environmental data, but also to monitor human health. As women tend to leave their rural Arctic communities, the shifting demography patterns in the Arctic impact already on the development of the region. The threatened sensitive ecosystems and the livelihood of indigenous peoples are directly affected.

The gender approach has allowed us to have a different view of the processes that are taking place in Arctic communities. Consequently, local development can be planned based on an understanding of who are the 'agents of change' and what kind of information these agents need for creating sustainability and adequate mitigation strategies.

To the extent possible, all human data in the CLINF CSI database are presented as gender-divided since this is the first step to gender analysis. Unfortunately, gender-divided data were not always available from the official statistics, e.g. in Russia. In our debate article, using incidence data for nine human infections with potentials to be CSI, this matter has been stressed (Omazic A et al. 2019a). Experts from different fields still do not seem to value this perspective, but CLINF has made a difference. CLINF coordinator Birgitta Evengård and CLINF research team leader Natalia Kukarenko actively engaged in sessions on gender and health at the 2018 UArctic conference, which resulted in review article by Rautio A et al. (2021).

CLINF social science studies were performed in a gender balanced way, i.e. both men and women involved in sheep farming or reindeer herding were interviewed. The data retrieved was not systematically analysed for gender differences, but a gender dimension was nevertheless noted.

CLINF research Natalia Kukarenko performed a series of interviews with officials and activists during the «ecological protests» in the Arkhangelsk region. One of the reasons for this study was to investigate dilemmas raised in ecological justice discussions, e.g. unjust distribution of ecological benefits and risks between different societal groups. In the Arkhangelsk Region, the authorities attempted to construct garbage landfills, for garbage brought to the region from the rest of the country, without any public discussions. This attempt rose an opposition among local residents. This case was a typical example of an

ecological justice dilemma, when a choice had to be made between economical benefit and ecological sustainability. In this situation the authorities and the residents stood opposite to each other and employed different lines of arguments. The demand for ecological justice pushed eco-protesters into organizing residents in online and offline activities, while the authorities turned down all discussions in social media and switched to the use of administrative resources (including the use of police) to shut down protests and criticism. From the CLINF point of view the study was useful from an e-democracy perspective and the potential that social media have in discussing ecological issues. Further, the motivation of women to participate and their role in the ecological rebellion as well as general gender differences in motivation and participation in ecological activism in the Russian North will be discussed in an upcoming publication (Kukarenko N et al., manuscript in preparation).

10. Deviations to the plan for Open access to the project's research results

CLINF has considered the establishment of a CSI infrastructure, in digital as well as in organisational terms, as one of its major objectives. CLINF has been a keen advocate of OPEN science and has aimed at following the recommendations of the [OpenScience Project](#) regarding OPEN actions in the development and utilisation of its infrastructure. The CLINF infrastructure and data policy plans were clearly outlined in the original application, and in previous annual reports. The CLINF GIS Public Data Repository has been publicly available at www.clinf.org since January 2021. The website will be up and running until the end of 2022; meanwhile the database will be moved to The Swedish National Data Service for storage and dissemination *ad infinitum*. In addition, the CLINF database will be disseminated via the INTERACT Data Portal. By these means the CLINF database will be OPENly accessible beyond the NordForsk funding period and for many years to come.

Communicating CLINF data products to the stakeholder community has been part of the CLINF objectives. Thus far, the database has only been announced on the website, but several publications are in preparation that will make the database known to a wider scientific audience. Presentations of CLINF achievements in popular science format, distributed through the website and other publication channels will further contribute to the outreach to other stakeholder groups.

Most scientific articles resulting from CLINF work have been and are published with OPEN Access. The major exception is probably the joint NCoE-book edited by Douglas Nord. The Open Access issue was never discussed, when CLINF members were asked to contribute chapters for the book. This was an oversight by everyone involved and had consequences for how we deviated from the plan.

One of the CLINF PhD theses is a monograph written in Norwegian and issued by Nord University. It will become publicly available in electronic format via the university library after the successful thesis defense. The findings from this thesis will also be further developed for international OPEN Access publications, well beyond the CLINF project period.

11. Future perspectives and continuation of the research

The negative effects of the Covid-19 pandemic on the Nordic-Russian collaborations planned for in the CLINF-RII project may be corrected with the new CLINF-RUS proposal that the CLINF coordinative team submitted to NordForsk in September 2021 (*Climate change and the transition of infectious diseases in the Nordic and Russian Arctic*; Application id 115346; Call: *Nordic-Russian call for networks for risk and crisis management*).

In various national and international cooperations CLINF researchers have submitted proposals for major research grants with the interest to follow up on many of the findings from CLINF.

New interdisciplinary and transdisciplinary collaborations have emerged between CLINF participants and pastoralists, which has resulted in the development of new project proposals, e.g. on the effects of land fragmentation on reindeer and reindeer herding, and further analysis of the health effects of supplementary feeding of reindeer.

The team at Nord University expects their new projects to produce important contributions to interdisciplinary and transdisciplinary research on the environmental, ecological and societal factors that will interact with CSI in the future. Findings from one of the CLINF PhD theses shed new light on how the colonial powers have shaped reindeer husbandry and the adaptive capacity into a national process that is pressuring herding towards agricultural practices. In an effort to understand the zoonotic infections in semi-domesticated animals the team is raising new and creative questions about the structure of society and the room for indigenous livelihoods in it. These questions will be pursued further as a result of CLINF. The WP5 team wants to follow up on the comparative Sápmi-Nenetsia research (Ravna et al. manuscript in preparation) by deeper comparative research on how landscape, cultural traditions, external impacts and technologies influence pasture use strategies and co-influence exposure and adaption to diseases and climate change effects.

There is a clear need to develop further research with a broad perspective on total impact including of developing monitoring and early warning systems.

The four zoonotic infectious diseases identified as being climate sensitive, i.e. borreliosis, Q fever, TBE, and tularemia, could be targeted in a systematic surveillance programme in northern regions. But it is evident that climate change can affect the epidemiology and geographical range of many other infectious diseases.

The CLINF data repository will be transferred to the Swedish National Data Service (www.snd.gu.se).

All issues regarding climate-change effects on the epidemiology of infectious diseases will be subject for increased educational efforts in international graduate and post-graduate education.

Appendices

Appendix 1 - Additional material (illustrations)

Appendix 2 - Outreach activities to the general public

Appendix 3 - Scientific output (publications, conference contributions)

Appendix 4 – CLINF-RII Final Report

Appendix 5 – CLINF GANTT table

Appendix 6 – Financial Report per partner organisation

Appendix 7 – Summary timesheet

Appendix 1 - Additional material (illustrations)

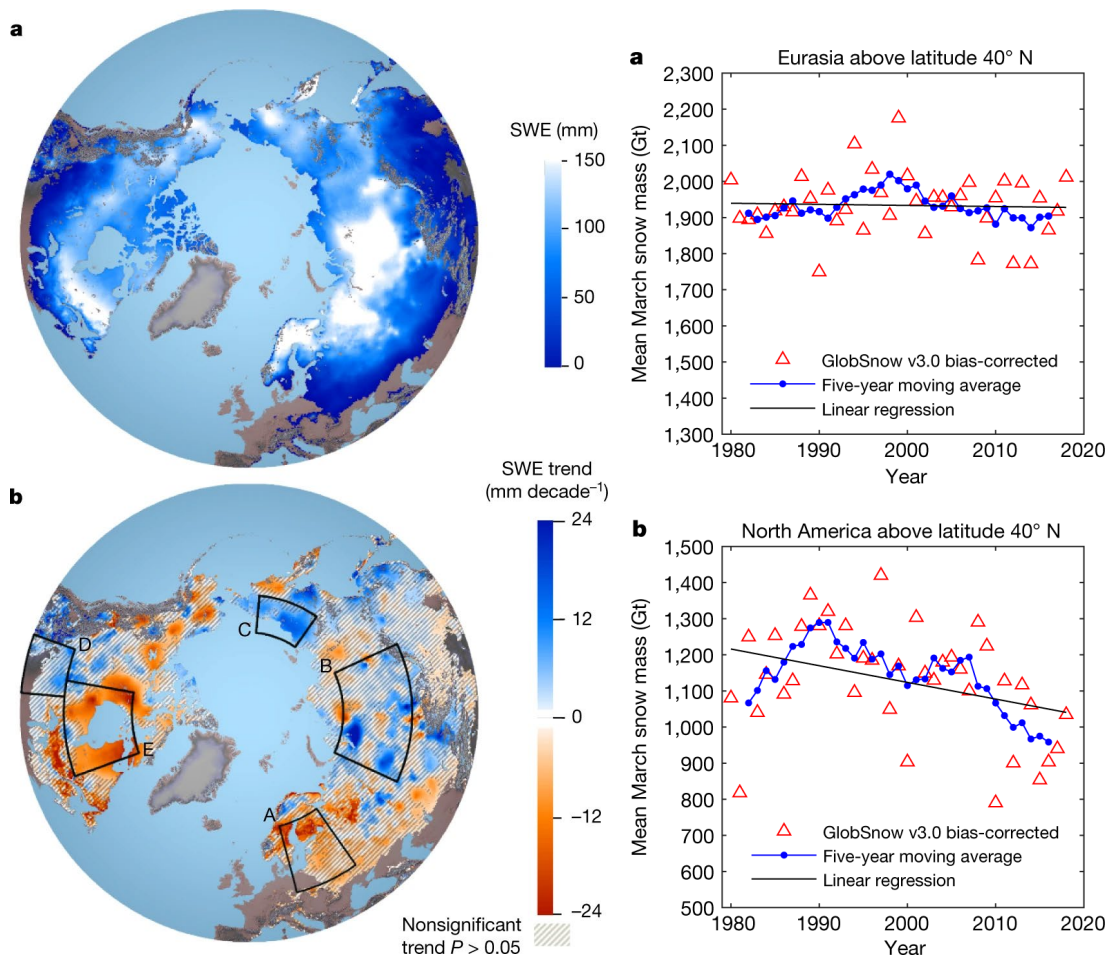


Fig. 1: Left: Average snow distribution during 1980–2018, given in terms of SWE (mm). **b**, Decadal SWE trend for the period 1980–2018. Right: Trend of snow mass in a. Eurasia and b. North America for the period of 39 years (1980–2018) (Pulliainen et al., 2020).

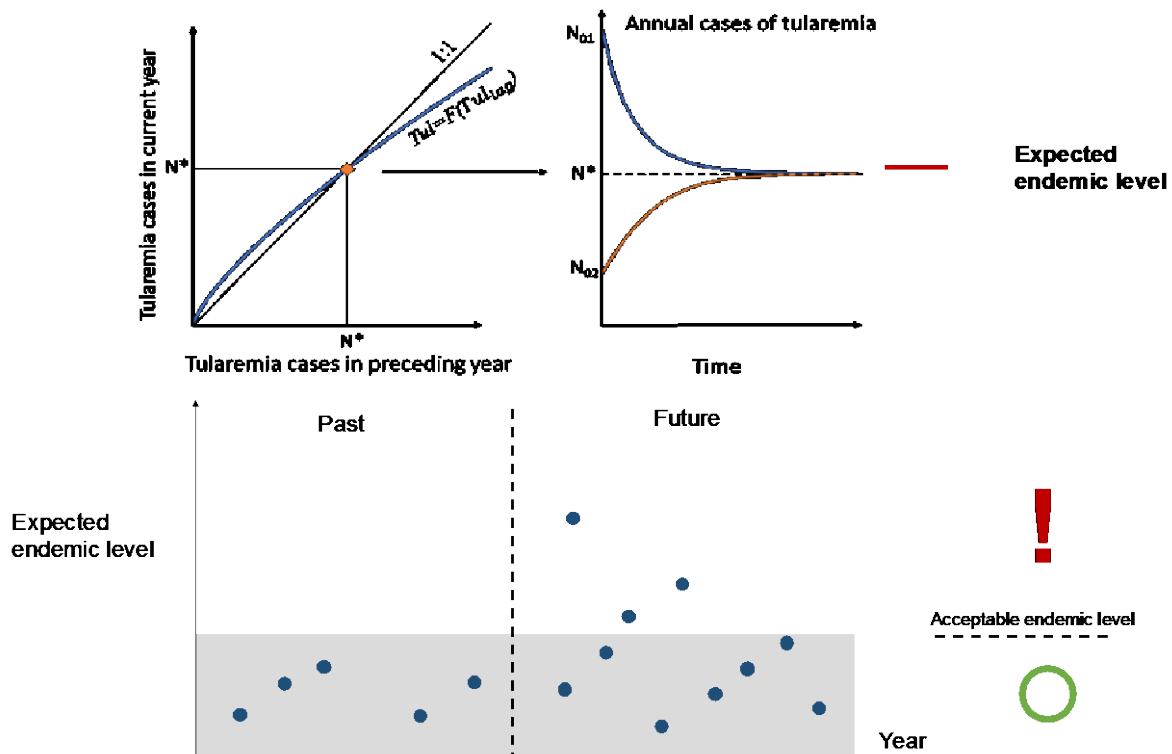


Fig. 2: Top: Schematic diagrams of how the number of tularemia outbreaks, under any given combination of disease-relevant long-term average hydroclimatic conditions, converges to an expected endemic level N^* : (top left) from each year to the next (blue line; the black line indicates the same number of cases in both years); (top right) over time, starting from any initial number of cases, N_{01} or N_{02} , the number still converges to the same N^* level (dashed line) for the same hydroclimatic conditions. Bottom: Schematic diagram of past and future values of expected endemic level, depending on prevailing/projected hydroclimatic conditions, which be compared with some societally accepted endemic level (dashed line), beyond which projected disease changes are unacceptable and mitigation measures are required. (Destouni et al. 2021)

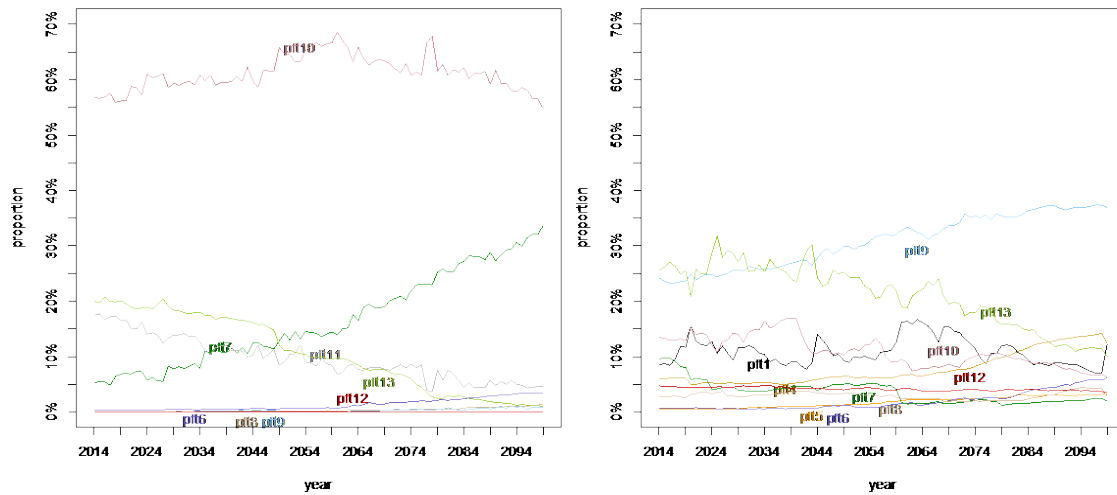


Fig. 3: Changes in the proportions of dominant plant functional types (PFTs) across the CLINF region as predicted over the 21st century by LPJ-GUESS (left) and ORCHIDEE (right). The pft numbering is as follows: 1: bare ground; 4: temperate needleleaf evergreen; 5: temperate broadleaf evergreen; 6: temperate broadleaf summergreen; 7: boreal needleleaf evergreen; 8: boreal broadleaf summergreen; 9: boreal needleleaf summergreen; 10: C3 grass; 11: C4 grass; 12: nonvascular moss & lichen; 13: boreal broadleaf shrubs; 14: C3 arctic grass. (Leibovici and Claramunt, 2019).

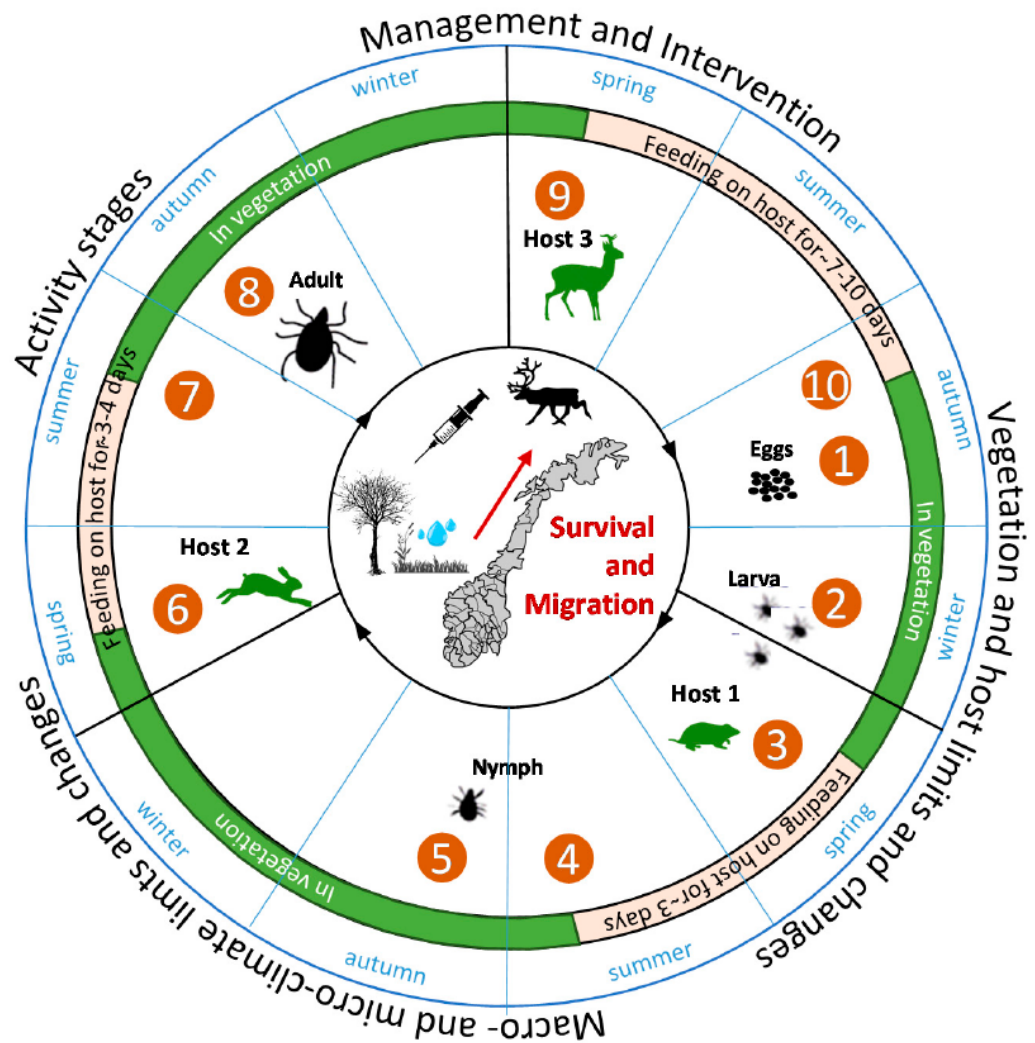


Figure 1. The *Ixodes ricinus* (tick) life cycle and linkages to its environment: Development, inactive (overwintering) and active (questing and on host) stages, climate limits and changes, preferred hosts and vegetation, and management and interventions all form boundaries for the survival and migration of ticks and the CSIs they carry. Descriptive cycle text nos. 1–10 based on www.cdc.gov/dpdx/ticks/index.html.

Fig. 4: The tick life cycle and linkages to its environment as well as suggested stages for management interventions (van Oort B et al. 2020).

Appendix 2 - Outreach activities to the general public



Title / Subject	Author(s)	Media channel	Type of activity	Open Access
Climate change, resilience and new pandemics in the Arctic – Nordic perspectives and solutions	Evengård B	Nordic COP26 pavilion, 31 Oct – 12 Nov 2021, Glasgow, United Kingdom	Panelist (on behalf of NordForsk)	
	Evengård B	Biology/Literature seminar series organized by students from the University of Glasgow, 10 Nov 2021, Glasgow, United Kingdom	Invited speaker	
Climate change and the rise of infectious disease: An Arctic perspective	Evengård B, Thierfelder T & Stöven S (2021)	Research Outreach, 122: 90-94 https://doi.org/10.32907/RO-122-1300470105	Popular science article	y
	Evengård B	X In4Med Medical Congress <i>Take the lead, risk to achieve</i> , organized by Coimbra's Medical Students' Association, April 2021, Coimbra, Portugal	Invited speaker	
Climate change and health: An evolving relationship	Birgitta Evengård	<i>Voices in Med</i> Special Issue, vol. 2 (4), 345 (April 9, 2021)	Debate article	y
Friska ekosystem ä ren förutsättning för människors hälsa	Birgitta Evengård, Tomas Thierfelder	<i>Läkartidningen</i> , the journal of the Swedish Physicians' Union, 14 Aug 2020 https://lakartidningen.se/opinion/debatt/2020/08/friska-ekosystem...manniskors-halsa/	Debate article	y
Animal health in the North in connection to climate change	Ann Albihn	Interview with national TV channel SVT Science 27 Nov 2020. <i>Wild animals in the North are more vulnerable to climate change</i> (in Swedish), https://www.svt.se/nyheter/vetenskap/vilda-djur-pa-norra-halvklotet-mer-sarbara-for-klimatforandringarna	Media appearance (radio/TV)	Yes

In connection with the ReinCSI Workshop	Zoia Ravna	Interview with BBC radio about Nenets reindeer husbandry, climate change, anthrax and the current situation Feb 2021). https://www.bbc.co.uk/sounds/play/p096ct71	Media appearance (radio/TV)	Yes
As tensions rise between Russia, NATO and China in the Arctic is a new cold war likely?	Zoia Ravna	Contribution to online news story of BBC's <i>The New Arctic</i> series (Feb 2021) The Compass - The New Arctic - The New Arctic: Power - BBC Sounds	Media appearance (radio/TV)	Yes
On the thawing permafrost and resurfacing of ancient pathogens	Birgitta Evengård	Participation in video news story on the internet channel MSN http://a.msn.com/04/en-us/BB10lrsX?ocid=se	Media appearance (radio/TV)	Yes
On the black death in the 14 th century	Birgitta Evengård	Participation in a podcast, 13 May 2020 https://shows.acast.com/pandemier/episodes/digerdoden	Media appearance (radio/TV)	Yes
	Birgitta Evengård, Tomas Thierfelder, Anna Omazic	Participation in <i>Klotet</i> (The Globe), a science broadcast on national radio channel 1 April 2020 https://sverigesradio.se/avsnitt/1472193	Media appearance (radio/TV)	y
On the issue of new tick-borne pathogens	Anna Omazic	Interview with national TV channel SVT 1 Feb 2020 https://svt.se/nyheter/inrikes/fastingar-med-borreliia-nu-i-hela-landet	Media appearance (radio/TV)	y
	Birgitta Evengård	Participation in <i>Kossornas planet</i> (The Cattle's planet) on national radio channel P4 6 Jan 2020 https://sverigesradio.se/avsnitt/1422196	Media appearance (radio/TV)	y

Influence of climate change on zoonotic diseases and research in this field	Birgitta Evengård	Climate Physics student at Utrecht University, course assignment, article for Dutch high school students to be published at Science to Be Tomorrow through the eyes of today (uu.nl)	Interview	y
On microbes re-appearing in the thawing permafrost.	Birgitta Evengård	Italian newspaper La Repubblica, 7 Dec 2020	Interview	
	Birgitta Evengård	French news agency AFP, 21 July 2020	Interview	
On microbes re-appearing in the thawing permafrost.	Birgitta Evengård	<i>Unearthed</i> , online media outlet of Greenpeace UK, 3 July 2020 The permafrost pandemic: could the melting Arctic release a deadly disease? - Unearthed (greenpeace.org)	Interview	y
On the links between climate change, biodiversity disturbance and emerging zoonotic diseases	Birgitta Evengård	by French filmmaker and writer Marie-Monique Robin in preparation for a book and a documentary, 15 June 2020 https://m2rfilms.com/espace-membres/fabrique-des-pandemies	Interview	y
On the links between climate change, biodiversity disturbance and emerging zoonotic diseases	Birgitta Evengård	<i>Carbon Brief</i> , an online publication on climate change based in the UK, 13 May 2020, for online article www.carbonbrief.org	Interview	y
	Birgitta Evengård	<i>Curie</i> , the journal of the Swedish Research Council, 7 April 2020, for online article 2 Sep 2020 Klimatförändringar påverkar forskningen Tidningen Curie	Interview	y
	Birgitta Evengård	Swedish organization for sustainable travel, 31 Mar 2020, for online article https://schystresande.se/artiklar/var-livsstil-bidrar-till-nya-pandemier/	Interview	?

	Birgitta Evengård	national newspaper <i>Aftonbladet</i> 23 Jan 2020, for online article	Interview	?
On the issue of anti-TBE antibodies in bulk milk of sheep and goats in Sweden	Ann Albihn	Journal <i>Land</i> , 28 Jan 2020, for online article https://www.land.se/mat-dryck/opastoriserad-mjolk-tbe/	Interview	y
Pastures – important for the climate and for Norwegian food security	Camilla Risvoll together with two local sheep farmers and a cattle farmer	Seminar on UN sustainability goals: Effects and possibilities for agriculture in Nordland, northern Norway, Bodö, 22 Jan 2020	Invited speaker	
In connection with the publication of the report from the Science Policy Workshop in Hanover, Nov 2019	Birgitta Evengård	Umeå University, 11 Sep 2020 https://www.umu.se/nyheter/ny-rapport-om-mikrobiella-hot-av-klimatforandringar_9576573/	Press release	Y
In connection with participation in <i>Klotet</i> (The Globe), a science broadcast on national radio channel	Birgitta Evengård	Umeå University, 1 April 2020 SR: Skövling av natur öppnar för nya smittor (umu.se)	Press release	Y
In connection with the publication by Riseth et al., <i>Intl J Env Res Public Health</i> 2020, 17(16): 6002	Jan Åge Riseth	Interview with FRAM Centre Media and with Forskning.no: Listen to experienced reindeer herders (In Norwegian), 4 Nov 2020 https://framsenteret.no/nyheter/2020/11/04/lytt-til-erfarne-reindriftssamer/ https://forskning.no/dyresykdommer-framsenteret-klima/lytt-til-erfarne-reindriftssamer/1766305	Web article	y
English and Sami translations released	Ann Albihn et al.	SSR's homepage with information for reindeer herders concerning challenges from climate change, 3 Mar 2020 https://www.sapmi.se/klimatanpassning/	Web page	y

How climate change could expose new epidemics	Birgitta Evengård	Cited in news post from the Manila Standard, 16 Aug	Web page	y
Picking up on the Greenpeace article from 2019	Birgitta Evengård	Cited in an online article (in a Chinese language) published by what appears to be the Ministry of Science and Technology of China. Autumn 2020 http://www.kepu.gov.cn/www/article/dtxw/873ad4bf075b484792c70daf8a795ca8	Web page	y

Appendix 3 - Scientific output (publications, conference contributions)



Title	Author(s)	Journal/Conference/Publisher, importantly: with NordForsk-funding acknowledged	Publication type	Open Access
Linking climate and infectious disease trends over the Northern/Arctic region	Ma Y et al. (2021)	Scientific Reports 11:20678 (2021) https://doi.org/10.1038/s41598-021-00167-z	Peer-reviewed journal article	y
Associating land cover changes with patterns of incidences of climate-sensitive infections: an example on tick-borne diseases in Nordic area	Leibovici DG et al. (2021)	Intl J Env Res Public Health 18,10963 (2021) https://doi.org/10.3390/ijerph182010963	Peer-reviewed journal article	y
Healthy ecosystems for human and animal health: Science diplomacy for responsible development in the Arctic	Evengård B et al. (2021)	Polar Records 57(e39): 1-7 (2021) https://doi.org/10.1017/S0032247421000589	Peer-reviewed journal article	y
Mapping the vulnerability of Arctic wetlands to global warming	Kåresdotter E et al. (2021)	Earth's Future, 9(5) e2020EF001858 (2021) https://doi.org/10.1029/2020EF001858	Peer-reviewed journal article	y
Climate change in the Arctic—The need for a broader gender perspective in data collection.	Rautio A et al. (2021)	Int. J. Env. Res. Public Health, 18(2):628 (2021) https://doi.org/10.3390/ijerph18020628	Peer-reviewed journal article	y
Healthy ecosystems are a prerequisite for human health – A call for action in the era of climate change with a focus on Russia.	Orlov D et al. (2020)	Intl J Env Res Public Health, 17(22): 8453 (2020) https://doi.org/10.3390/ijerph17228453	Peer-reviewed journal article	y
Study of the relationship between the average annual temperature of atmospheric air and the number of tick-bitten humans in the North of European Russia.	Tronin A et al. (2020)	Intl J Env Res Public Health, 17(21): 8006 (2020) https://doi.org/10.3390/ijerph17218006	Peer-reviewed journal article	y

Emerging natural focal infectious diseases in Russia: A medical-geographical study.	Malkhazova S et al. (2020)	Intl J Env Res Public Health, 17(21): 8005 (2020) https://doi.org/10.3390/ijerph17218005	Peer-reviewed journal article	y
Implications of projected hydroclimatic change for tularemia outbreaks in high-risk areas across Sweden.	Ma Y et al. (2020)	Intl J Env Res Public Health, 17(18): 6786 (2020) https://doi.org/10.3390/ijerph17186786	Peer-reviewed journal article	y
Spreading or gathering? Can traditional knowledge be a resource to tackle reindeer diseases associated with climate change?	Riseth JÅ, Tømmervik H & Tryland M (2020)	Intl J Env Res Public Health, 17(16): 6002 (2020) https://doi.org/10.3390/ijerph17166002	Peer-reviewed journal article	y
A mini-review of <i>Ixodes</i> ticks climate sensitive dispersion risk in the Nordic region.	Van Oort, BEH et al. (2020)	Intl J Env Res Public Health, 17(15): 5387 (2020) https://doi.org/10.3390/ijerph17155387	Peer-reviewed journal article	y
Lethal outcome of leptospirosis in southern Russia: Characterization of <i>Leptospira interrogans</i> isolated from a deceased teenager.	Samoilov AE et al. (2020)	Intl J Env Res Public Health, 17(12): 4238 (2020) https://doi.org/10.3390/ijerph17124238	Peer-reviewed journal article	y
Patterns and trends of Northern hemisphere snow mass from 1980 to 2018.	Pulliainen J et al. (2020)	Nature, 581: 294-298 (2020) https://doi.org/10.1038/s41586-020-2258-0	Peer-reviewed journal article	n
Spatio-temporal variations and uncertainty in land surface modelling for high latitudes: Univariate response analysis.	Leibovici D et al. (2020)	Biogeosciences, 17: 1821-1844 (2020) https://doi.org/10.5194/bg-17-1821-2020	Peer-reviewed journal article	Y
CLINF: Climate change effects on the epidemiology of infectious diseases, and the associated impacts on northern societies.	Evengård B & Thierfelder T (2021)	Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action. Ed. Douglas C. Nord, Springer 2021	Peer-reviewed book chapter	N
CLINF: An integrated project design.	Thierfelder T & Evengård B (2021)	Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action. Ed. Douglas C. Nord, Springer 2021	Peer-reviewed book chapter	N

Modeling climate sensitive infectious diseases in the Arctic.	Destouni G et al. (2021)	Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action. Ed. Douglas C. Nord, Springer 2021	Peer-reviewed book chapter	N
Reindeer herding and coastal pastures: Adaptation to multiple stressors and cumulative effects.	Hovelsrud G et al. (2021)	Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action. Ed. Douglas C. Nord, Springer 2021	Peer-reviewed book chapter	N
Working together: Reflections on a transdisciplinary effort of co-producing knowledge in supplementary feeding in reindeer husbandry across Fennoscandia.	Horstkotte T, Lépy E & Risvoll C (2021)	Nordic Perspectives on the Responsible Development of the Arctic: Pathways to Action. Ed. Douglas C. Nord, Springer 2021	Peer-reviewed book chapter	N
Pastures under pressure – Cumulative effects of other land users in a comparative approach	Horstkotte T et al. (2021)	Pastoralism in a changing Arctic – Complex challenges for people, reindeer and landscapes. Routledge EarthScan 2021	Peer-reviewed book chapter	y
Chapter on <i>Gender and Security</i>	Co-author Kukarenko N	Update of the Pan-Arctic Report <i>Gender Equality in the Arctic</i> , Icelandic Arctic Cooperation Network https://arcticgenderequality.network/gea-panarctic-report	Report	y
Supplementary feeding in reindeer husbandry, Results from a workshop with reindeer herders and researchers from Norway, Sweden and Finland	Horstkotte T, Lépy E & Risvoll C (2020)	Umeå University 2020, ISBN: 978-091-7855-421-8	Report	n
A possible role for ticks in the spread and transmission of tularemia and other pathogens in northern Sweden?	Nuru N	Umeå University, Sweden	M. Sc. Thesis	

Molecular detection of Babesia spp. in Swedish ticks collected from the environment or from the hosts: validation of a high-throughput PCR system by conventional PCR.	Öborn L	Uppsala University, Sweden	B.Sc. Thesis	
cancelled	Evengård B	SECNET workshop Altai mountains, Sep 2020	Invited speaker	
cancelled	Evengård B	Vaccinsymposium, Mar 2020	Invited speaker	
Spreading or gathering? Can traditional knowledge be a resource to tackle reindeer diseases associated with climate change?	Riseth JÅ, Tømmervik H & Tryland M	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Linkage between temperature anomalies and outbreaks of CSI in Arctic reindeer herds	Tømmervik H et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Climate sensitive infections in Greenland and northern Sweden: a serological study	Koch A et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Virome in Eurasian tundra reindeer (<i>Rangifer t. tarandus</i>) in Norway, Sweden, Finland and Russia – Evidence from Next-Generation-Sequencing	Albihn A et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Ticks on the move – Increased risk for zoonotic infections in the North	Omazic A et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Societal infrastructure and climate sensitive infections: The complexity of climate change adaptation in Arctic pastoralism	Baczynska B, Hovelsrud GK & Risvoll C	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	

Climate sensitive infections will exacerbate current challenges in reindeer herding: A case from northern Norway	Hovelsrud GK & Risvoll C	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Ecological justice in North-West Russia: Experiences of communication between authorities and locals in the Arkhangelsk Region, Russia	Kukarenko N	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
On incidence patterns of two tick-borne human diseases in the Nordic area and vegetation changes	Bylund H et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Supplementary feeding and animal wellbeing	Paulsen M, Risvoll C & Hovelsrud GK	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
The geography of northern infectious diseases, with particular emphasis on climate change effects	Thierfelder T et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Climate change will increase the risk for infectious diseases in the mouth and eyes of reindeer in the Nordic countries	Rockström U et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
First record of adult <i>Hyalomma marginatum</i> and <i>H. rufipes</i> ticks in Sweden demands monitoring of new pathogens into previously free areas and communities	Grandi G et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Arctic wetlands threatened by permafrost thaw in a warming climate	Kåresdotter E et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
Climate change and human health – Social science approach (some results from CLINF project)	Kukareno N	Global Problems of Arctic and Antarctic. All-Russia Science Conference, 2-5 October 2020, Arkhangelsk, Russia	Oral presentation	

Seroprevalence of pestivirus – a potential viral health threat to semi-domesticated and wild reindeer in the Nordic countries and Russia	Sánchez Romano J et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Poster presentation	
Quantifying hydroclimatic change effects on infectious disease spreading	Ma Y et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Oral presentation	
<i>Brucella</i> spp. infection – A neglected zoonotic disease and a threat for reindeer herders in northern Russia	Egorova I et al.	Arctic Science Summit Week, 19-26 March 2021, www.assw2021.pt	Poster presentation	
Environmental rebellion in Shies (Arkhangelsk, Russia): gendered focus	Kukarenko N	Intl. Congress of Arctic Social Science, 17-22 June 2021, https://icass.uni.edu/	Oral presentation	y
Evaluating spatial and temporal fragmentation of a categorical variable using new metrics based on entropy: Example of vegetation land cover	Leibovici DG, Claramunt C & Quegan S	Conference Entropy 2021 “The scientific tools of the 21 st century”, 5-7 May 2021, Porto, Portugal (postponed from 2020)	Oral presentation	
Mapping the vulnerability of Arctic wetlands to global warming	Kåresdotter E et al.	Workshop on resilience and management of Arctic wetlands, Nov 2020	Oral presentation	
The need for Arctic Diplomacy	Evengård B et al.	III. International Conference “Problems of health maintenance and sanitary-epidemiological well-being provisions of Arctic population”, 21-22 Oct 2021, St. Petersburg, Russia	Oral presentation	
Falling between the cracks of the governing system: Risk and uncertainty in pastoralism in northern Norway.	Risvoll, C, Hovelsrud, GK & Riseth, JÅ	<i>Weather, climate, and society</i> . Special Collection.	Manuscript Peer-reviewed journal article	y

The geography of northern infectious diseases, with particular emphasis on climate change effects.	Thierfelder T et al	Intended for <i>Philosophical Transactions of the Royal Society B</i> or <i>Intl J Env Res Public Health</i>	Manuscript Peer-reviewed journal article	y
Climate sensitive infections in Greenland and northern Sweden: a serological study	Koch A et al.	Manuscript in preparation March 2021 Possibly <i>Intl J Env Res Public Health</i>	Manuscript Peer-reviewed journal article	
Metadata concerning the human diseases data stored under the directory "Human CSI" of the CLINF GIS Public Data Repository under www.clinf.org	Thierfelder T, Berggren C, Omazic A & Evengård B	Intended for <i>Journal of Open Health Data</i> Available since 2019 in CLINF GIS	Manuscript Peer-reviewed journal article	y
Metadata concerning the animal diseases data stored under the directory "Animal CSI" of the CLINF GIS Public Data Repository under www.clinf.org	Thierfelder T, Omazic A, Berggren C, & Albihn A	Intended for <i>Journal of Open Health Data</i> Available since 2019 in CLINF GIS	Manuscript Peer-reviewed journal article	y
Metadata concerning the CSI climate and landscape data stored under the directory "Climate and landscape data/Reference period" of the CLINF GIS Public Data Repository under www.clinf.org	Thierfelder T, Larsolle A, Leibovici D, Ikonen J & Juval C	Intended for <i>Journal of Open Health Data</i> Available since 2019 in CLINF GIS	Manuscript Peer-reviewed journal article	y
Metadata concerning the CSI GIS materials stored under the directory "GIS materials" of the CLINF GIS Public Data Repository under www.clinf.org	Thierfelder T, Berggren C, Omazic A, Larsolle A & Evengård B	Intended for <i>Journal of Open Health Data</i> Available since 2019 in CLINF GIS	Manuscript Peer-reviewed journal article	y

	Sanchez Romano et al	Manuscript in preparation April 2021	Manuscript Peer-reviewed journal article	y
	Ravna Z et al.	Manuscript in preparation 2021	Manuscript Peer-reviewed journal article	
A comparative paper on Reindeer Herders' Traditional Practical Knowledge: Survival Strategies and Disease Handling in progress.	Jan Åge et al	As a result of the ReinCSI workshop in Fall 2019	Manuscript Peer-reviewed journal article	
	Kukarenko N	Two publications co-authored by Natalia and Anastasya are expected to come 2021.	Manuscript Peer-reviewed journal article	
	Omazic A et al	Manuscript in preparation April 2021	Manuscript Peer-reviewed journal article	y
Husbandry and diseases of semi-domesticated Eurasian tundra reindeer in Fennoscandia.	Tryland, M., Nymo, I H, Romano, JS & Riseth, JÅ	The management of enclosed and domesticated deer: International husbandry systems and diseases. Springer. Ed. John Fletcher, Springer 2021	Manuscript Peer-reviewed book chapter	

Climate change in northern regions	Van Oort B, Tronstad Lund M & Brisebois A	Chapter for new book on Arctic health, edited by Morten Tryland	Manuscript Peer- reviewed book chapter	
3 more chapters in ReiGN book	CLINF co-authors (from WP4/WP5 mainly?)		Manuscript Peer- reviewed book chapter	

Appendix 4 – CLINF-RII Final Report



CLINF-RII Scientific report (Sept 2018 – Dec 2020)

The main achievements

The main objectives for this second Russian extension of the CLINF Nordic Centre of Excellence were 1) to bilaterally organize a series of collaborative workshops between CLINF partners and Russian colleagues, and 2) to produce a White Paper with recommendations for the establishment of strategic CSI (climate-sensitive infectious diseases) infrastructures that can sustainably support the joint combat of emerging infectious diseases.

With regard to the **first objective**, CLINF-RII has succeeded in connecting with Russian researchers and supported the exchange of experiences and points of view by means of various CLINF meetings (Abisko/Dec 2018, Moscow/May 2019, Uppsala/Sept 2018, May and Nov 2019), at least six joint publications thus far and eight conference contributions.

CLINF-RII has extended the network of CLINF connections into Russia beyond the original group of cooperating partners from Russian. Importantly, CLINF-RII facilitated Russian representation at an [international expert and science policy meeting in Hanover, Germany in November 2019](#), arranged by the National Academies, Washington and the European Academies Science Advisory Council, which was much appreciated by the organizers. Vice versa, at two international conferences in Russia (Tomsk/Oct. 2019, St. Petersburg/Nov. 2019) CLINF coordinator Birgitta Evengård talked to Russian scientists from the whole country about the need for harmonization of infectious disease data.

This latter activity leads over to the **second objective** concerning recommendations for strategic CSI infrastructures. Following Birgitta's seminar at the conference in St. Petersburg, CLINF researchers and Russian colleagues published a review article entitled *Healthy Ecosystems Are a Prerequisite for Human Health – A Call for Action in the Era of Climate Change with a Focus on Russia* (Orlov et al., *IJERPH* 17(22):8453 (2020)). This work further resulted in an initiative by four Russian colleagues for a Special Issue in *Polar Records* (Cambridge) on *Arctic Diplomacy*, where they have recently invited abstracts. CLINF has submitted a manuscript with 24 co-authors from the Arctic including representation from Lomonosov Moscow State University, Dept of Geography, the Institute of Economic Forecasting and the Central Institute of Epidemiology in Moscow.

In addition to the achievements above, CLINF-RII has facilitated joint research efforts. CLINF-RII partners FRCVM, YSIA, LUKE and SVA have collected samples

from reindeer in Yakutia and the Yamalo-Nenets Autonomous District and analyzed these for the presence of CSI. Several joint manuscripts have been published or are in preparation presenting results regarding the circulation of *Brucella* spp. infections and of potentially pathogenic viruses in the sampled reindeer herds.

Further, Russian colleagues from FRCVM provided invaluable support with retrieving retrospective data regarding animal CSI from Russia for the CLINF GIS Public Data Repository.

Potential impact of CLINF-RII achievements and Nordic-Russian added value

CLINF-RII activities have contributed to capacity building concerning CSI both in Russia and in the Nordic countries. Particularly, the conference contributions and joint publications, aid the information exchange between East and West beyond the valuable personal connections established within this project. These activities are potentially important for opening up the wealth of Russian data and expertise to scientists and decision makers in the West.

The Russian contribution to the CLINF Special Issue of the *International Journal of Environmental Research and Public Health*, with at least four publications, is an effect of the successful collaboration between Nordic and Russian colleagues in CLINF-RII. Supported by scientists from different parts of Russia, CLINF coordinator Tomas Thierfelder supplemented the CLINF Public Data Repository with comprehensive CSI data for both animals and humans. While compiling this retrospective CSI data in the CLINF Geographical Information System, a recurrent theme has been the need for sex-disaggregated data (from Russia) as well as the need for harmonisation of CSI reporting formats for humans and animals across countries. Our recommendation has been well-received, but it is difficult to know if there will be any changes. Our joint research regarding reindeer CSI strengthens the knowledge base for Russian policy development concerning the handling of *Brucella* infection among reindeer and people.

Gender balance of the project group

All meetings have been in a 40-60 balance.

Deviations from the project plan

For 2020 additional mutual research visits and workshops had been foreseen in the original plan. However, these plans had to be cancelled due to the ongoing CoVID19 pandemic.

CLINF-RII in [NOK]

	Sept 2018 - Dec 2020								NordForsk funding	
	UmU		SVA		SLU-ET		LUKE		budget	actual costs
	budget	actual costs	budget	actual costs	budget	actual costs	budget	actual costs		
distributed funds:		205 832 NOK		515 795 NOK		278 023 NOK		95 435 NOK		
<i>Salaries & fellowships</i>										
Personnel costs	166 332	78 323	175 860	399 350	223 523	168 687	108 713	40 632	601 650	686 992
indirect costs		13 036		109 422		82 656		37 382		242 496
<i>Project Costs</i>										
Data collection and analysis	0		130000	45 316	0		10000	3890	140 000	49 206
Office and laboratory	0		40000		0		10000	3657	50 000	3 657
Other project costs	5 000	1440	40000	2 735	5000		5000	1 123	55 000	5 298
Activities: mobility and networking	0		0		0				0	0
Travel and meeting costs	30 000	96701	30000	6 613	45000	29327		30000	135 000	141 183
Dissemination and publication	4 500		4500	12 655	4500		4500		18 000	12 655
indirect costs		16332	0	18 445	0				0	34 777
redistributed travel costs May 2019 incl. OH		-9397				9397				
TOTAL pr INST	205 832	196 435	420 360	594 536	278 023	290 067	168 213	95 227	999 650	1 176 265

LUKE has a total of NOK in salary costs, of which 72 778 NOK is in kind and 35 935 108 713 NOK is in NordForsk contribution. Thus,

LUKE has a total of NOK in NordForsk contribution. This contribution is transferred to SVA as 95 435 cooperating partner in CLINF.

Appendix 5 – CLINF GANTT table



Aktivitet	Baseline Finish	Duration	Start	Finish	% Work Complete	Predecessors	Successors	Resurser in	Resurser ut	Notes
CLINF	NA	65 mons?	Fri 16-04-01	Thu 21-06-24	69%					Climate-change effects on the epidemiology of infectious diseases and the impacts on Northern societies
WP1 Human and animal diseases in the Nordic region	NA	62,1 mons	Fri 16-04-01	Wed 21-03-31	54%					Retrospective data processing and modelling of future scenarios for locally applicable alert systems for CSI.
WP1.1 Descriptions of official data on prevalence and incidence of relevant climate sensitive infections	NA	27 mons	Fri 16-04-01	Mon 18-06-04	100%					lead: Birgitta...
CSI inventory	NA	15 mons	Fri 16-04-01	Thu 17-06-15	100%		5;13;12;46	official data, literature study	Collation of CSI data	
D1-1 CSI database	Sat 17-09-30	6 mons	Fri 17-06-16	Fri 17-12-08	100%	4	6;42	Collation of CSI data	CSI database - CLINF GIS	
D1-2 Publication on CSI prevalence based on official historical incidence data	Sat 18-03-31	6 mons	Mon 17-12-11	Mon 18-06-04	100%	5		CSI database	CSI publication	
WP1.2 Generating serological baseline data on CSI in the study region	NA	58,52 mons	Fri 16-04-01	Wed 20-12-16	97%					lead: Anders Koch/SSI...
Serum bank inventory	NA	18 mons	Fri 16-04-01	Tue 17-09-12	100%		9	biobanks	Collation of serum data	
Analysis of sera	Sat 18-03-31	34,5 mons	Wed 17-09-13	Tue 20-06-23	100%	8	10	Collation of sera data	Laboratory analyses	Delayed: due to late acquisition of sera and longer time in laboratory than expected, will be finished by 1st half of 2020.
D1-3 Sera database, integrated with CLINF database	Sun 18-09-30	1 dy	Wed 20-01-01	Tue 20-06-23	95%	9	11	Sera analyses	Sera database	delayed until 19 April 2021, originally due Sep 2018
D1-4 Publication on sero-prevalence based on own analyses	Sun 19-03-31	6 mons	Wed 20-06-24	Wed 20-12-16	75%	10		Sera database	Report on sera analyses	submission planned for end of April 2021, manuscript in preparation Oct 2020
WP1.3 Provision of in-depth data regarding human tularemia	NA	26 mons	Mon 19-02-25	Mon 21-03-29	9%	4;17				Lead: Anders Sjöstedt, UMU...
Modelling tularemia	NA	8 mons	Mon 19-02-25	Wed 19-10-16	30%	4;17	14	Input data from WP1.4	Tularemia models	Delayed due to CoV1D19 pandemic until further notice: collection of data on the 2019 tularemia outbreak in northern Sweden. Whole sub-WP needs probably to be cancelled, might not happen before project ends. Data collection on the 2014-2019 tularemia outbr-
D1-5 Projected distribution of tularemia	Sun 19-03-31	12 mons	Thu 19-10-17	Fri 20-10-02	0%	13	15	CSI data and models	Projected tularemia data products	
D1-6 Publication on tularemia models	Mon 19-09-30	6 mons	Mon 20-10-05	Mon 21-03-29	0%	14		Projected tularemia data	Tularemia report	
WP1.4 Changing geographic distribution of CSI and the associated effects on future sheep and reindeer herding	NA	62,1 mons	Fri 16-04-01	Wed 21-03-31	40%					Lead: Ann Albihn, SVA...
Husbandry CSI assessment	NA	26 mons	Fri 16-04-01	Fri 18-05-04	100%		18;12;13;46	Empirical inventory	Collation of husbandry CSI data	one publication (literature study) accepted in Nov 2019...
D1-7 Husbandry CSI database	NA	23,5 mons	Mon 18-05-07	Thu 20-03-26	100%	17		Collation of husbandry CSI data	CSI database - CLINF GIS	extended; new Russian data recieved in Dec 2019 (Clnf RII) and sent to Tomas, all other data was sent to Tomas in March 2019. A publication is ongoing (Jan 2020) together with Tomas and others.
Reindeer husbandry interview study (including interviews and integration with traditional knowledge) (cancelled)	Mon 19-12-31	52,76 mons	Fri 16-04-01	Tue 20-06-30	20%	20SS;22SS		In collaboration with WP5.2	Husbandry questionnaire	Aug 2020: task cancelled due to lack of resources; ...
included in ID19: Husbandry CSI interviews (cancelled)	NA	28 mons	Thu 18-03-08	Tue 20-06-30	0%	19SS	21SS	Empirical interviews	Empirical baseline information	Aug 2020: task cancelled due to lack of resources;
Husbandry CSI modelling	NA	26 mons	Fri 19-01-18	Fri 21-02-19	30%	20SS;22SS		Input maps from WP3.1	Projected husbandry CSI scenarios	included in D1-7: develop models to predict effects of climate change on "selected" CSI with relevance for future food-producing animals and the society at large.
Included in ID19: Integration husbandry CSI vs TK	Wed 20-09-30	18 mons	Fri 19-01-18	Tue 20-06-30	20%	19SS	21SS	WP5.2	Integrative TK/CSI models	included in D1-7
D1-8 Publication on models predicting the future effects of CSI on sheep and reindeer herding	Tue 19-12-31	5 mons	Thu 20-11-05	Wed 21-03-31	0%			input from WP3.1	Husbandry CSI publication	

Sampling of reindeer at slaughter (Iceland, Norway, Sweden, Finland, Russia)	NA	46 mons	Fri 16-04-01	Fri 19-12-13	100%		25			extended; additional sampling in Russia was performed in Nov 2019 (CLINF-RII)
Sample analysis and data collation	Sat 18-03-31	3 mons	Mon 19-12-16	Wed 20-03-11	100%	24	26			finished March 2021, delayed due to Corona analyses at the SVA lab
D1-10 Publication on the presence of pathogens in reindeer	Mon 18-12-31	10 mons	Thu 20-03-12	Wed 20-12-30	90%	25				March 2021: Two publications submitted on "NGS" resp. "Brucella". One publication published on "Pestivirus"
new task 2018: Collection of ticks from humans and animals (Sweden)	NA	33 mons	Mon 18-04-16	Wed 20-12-09	100%		28SS+4 mons			extension; to evaluate the geographical distribution of some vector species and of tick-borne infections. Collection performed in Sweden 2018; collection in Sweden and Finland 2019 ongoing as well as morphological and microbiological analyses (Fluidigm) performed and a publication in preparation
new task: Microbiological analysis of tick specimen	NA	32 mons	Fri 18-08-10	Mon 21-03-08	90%	27SS+4 mons				extension; screening for presence of CSI etiological agents, microbiological analyses (Fluidigm) performed and a publication in preparation
new task 2019: Analysis of TBE virus in bulk milk (dairy cows, sheep, goats)	NA	18,71 mons	Mon 19-04-01	Wed 20-09-30	90%					delayed due to Corona analyses at the SVA lab...microbiological analyses performed and a publication in preparation
WP2 Climate change effects in the Nordic region: Procuring data and modelling future scenarios	NA	62 mons	Fri 16-04-01	Mon 21-03-29	93%					Lead: Shaun Quegan, UoS
WP2.1 Landscape-scale terrestrial processes	NA	62 mons	Fri 16-04-01	Mon 21-03-29	98%					Lead: Shaun Quegan, UoS...
Defining input Earth data products	NA	23 mons	Fri 16-04-01	Tue 18-02-06	100%		33;47;51;42	FMI in collaboration with SLU	Dataset of terrestrial data products	
Defining terrestrial landscape models	NA	5 mons	Wed 18-02-07	Tue 18-07-03	100%	32	34	UoS standard sources	Set of suitable models	but still hoping to get input from the LPJ Model from Lund University (feb 2019)
D2-1 Projections of terrestrial change	Sun 19-03-31	10 mons	Wed 18-07-04	Tue 19-04-23	100%	33	35;48	Combination of data and models	Projected landscape scenarios to CLINF GIS	Model outputs on projected landscape changes into year 2100...
D2-2 Publication(s) on terrestrial modelling	Wed 21-03-31	24 mons	Wed 19-04-24	Mon 21-03-29	95%	34		In collaboration with SU	Output publication	Joint paper with SLU in prep for IJERPH, expected submission end of Jan 2021...
WP2.2 Water-borne spreading pathways and hydro-climatic change	NA	61 mons	Fri 16-04-01	Fri 21-02-26	100%					Lead: Georgia Destouni, SU...
Defining input Earth data products	NA	14 mons	Fri 16-04-01	Wed 17-05-17	100%		38;47;51;42	FMI in collaboration with SLU	Dataset of hydrological data products	
Defining aquatic landscape models	NA	6 mons	Thu 17-05-18	Thu 17-11-09	100%	37	39	SU standard sources	Set of suitable models	
D2-3 Projections of aquatic change	Sun 18-09-30	12 mons	Fri 17-11-10	Mon 18-10-29	100%	38	40;48	Combination of data and models	Projected landscape scenarios to CLINF GIS	All basic WP2.2 results and tools are ready for this task, and results on their way to publication/submission (see task ID 38, feb 2019). Interactions are ongoing regarding specific hydro-climatic projection results that may be relevant and available for
D2-4 Publication(s) on aquatic modelling	Wed 21-03-31	29 mons	Tue 18-10-30	Fri 21-02-26	100%	39		In collaboration with UoS	Output publication	New paper submitted: Kåresdotter et al., Mapping the Vulnerability of Arctic Wetlands to Global Warming, Earth's Future 2020. publication: Ma Y., Bring A., Kalantari Z., Destouni G., Potential for Hydroclimatically Driven Shifts in Infectious Disease Outb
WP2.3 Biological/ecological processes	NA	38,57 mons	Wed 18-02-07	Tue 21-03-16	72%					Lead: Christer Björkman, SLU...
Biological/ecological proxy assessment	Sun 18-09-30	22,57 mons	Wed 18-02-07	Mon 19-12-02	95%	32;37;5	43	CSI and landscape information	Downscaling recommendations	Discussions about CSI data bases with externals and WP2.1 on models and spatiotemporal scales for the assessment of CSI & proxys. Included in ms landcover, see below. Tularemia -Sweden application -not finished partly due to the pandemic and lack of time.
D2-5 Publication on ecological downscaling (bio/eco proxy)	Wed 21-03-31	16 mons	Tue 19-12-03	Tue 21-03-16	95%	42		In collaboration with WPs' 1, 2 and 3	Publication on ecological downscaling	In prep: 1. Associating land cover changes with patterns of incidences of climate sensitive infections: an example of tick-borne diseases in Nordic area(to be subm March 2021) 2.Tularemia alone with the same approach to IJERPH but not ready yet (plan March? 2021). Abdala-Roberts et al. ?
WP3 Depicting the geographic spread of CSI in the Nordic region	NA	36,1 mons	Mon 18-05-07	Wed 21-03-31	65%					lead: Tomas Thierfelder, SLU

WP3.1 Synthesising climate-change scenarios of diseases, disease habitats, and societal infrastructures	NA	36 mons	Mon 18-05-07	Mon 21-03-29	60%						lead: Tomas Thierfelder, SLU...
Collation of CSI data	NA	7 mons	Mon 18-05-07	Tue 18-11-27	100%	4;17	47;56	CSI data from WP1	CSI database		Complementary work with Russian data still prevails, but is made in CLINF-RII
Statistical CSI inference	Sun 19-03-31	9 mons	Wed 18-11-28	Mon 19-08-19	100%	46;32;37	48;51	WP2 landscape data	Statistical CSI models, output to WP4		
D3-1 CSI projections	Mon 19-09-30	9 mons	Tue 19-08-20	Fri 20-05-08	50%	47;34;39	49;57	WP2 projections	CSI projections		input from WP2 required. Input from WP2.2 linked with CSI (tularemia) projection provided in new manuscript in review for journal publication: Ma et al., 2019 (see task 48).
D3-2 Publication(s) on CSI projections	Wed 21-03-31	11 mons	Mon 20-05-11	Mon 21-03-29	10%		48	In collaboration with WPs' 1 and 2	Publication on future CSI scenarios		input from WP2 required...
WP3.2 Uncertainty and risk	NA	20,1 mons	Tue 19-08-20	Wed 21-03-31	65%						lead: Dietrich von Rosen, SLU...
Spatial error assessment	NA	9 mons	Tue 19-08-20	Fri 20-05-08	80%	32;37;47	53	All CLINF CSI and landscape data	Spatial expression of CSI uncertainty		linked to the inference of CSI data
Spatial assessment of societal cost	NA	1 dy	Mon 21-02-01	Mon 21-02-01	0%	76;65;67;71;75	53	WP4	Uncertainty of societal CSI cost		Aug 2020: Lacking input from WP4
D3-3 Probabalistic risk model	Wed 20-09-30	1 mon	Tue 21-02-02	Tue 21-03-02	0%	51;52	54	Combination of CSI and societal models	Spatial expression of CSI risk		Aug 2020: Lacking input from WP4...
D3-4 Publication of societal CSI risk model	Wed 21-03-31	1 mon	Wed 21-03-03	Wed 21-03-31	0%		53	In collaboration with WPs' 4 and 5	Publication of societal CSI risk model		Aug 2020: Lacking input from WP4
WP3.3 Geographic projections of migrating CSI	NA	29 mons	Wed 18-11-28	Mon 21-03-29	75%						lead: Tomas Thierfelder, SLU...
D3-5 Production of empirical maps	NA	9 mons	Wed 18-11-28	Mon 19-08-19	100%		46	58	CSI and landscape data	Publication at CLINF GIS	linked to the inference of CSI data
D3-6 Production of projection maps	Wed 21-03-31	9 mons	Mon 20-05-11	Thu 21-01-28	50%		48	58	Landscape and CSI projections	Publication at CLINF GIS	input from WP2 required; Oct 2020: Helena and Didier are working on the projections
D3-7 Publication about CSI maps	Wed 21-03-31	2 mons	Fri 21-01-29	Mon 21-03-29	70%	56;57			Map materials	Journal publication	
WP4 Climate sensitive infections: Societal impacts and adaptation needs	NA	62,09 mons	Fri 16-04-01	Wed 21-03-31	97%						Lead: Grete Hovelsrud, NU...
WP4.1 Selection of case studies	NA	23 mons	Fri 16-04-01	Tue 18-02-06	100%						Lead: Bob van Oort, CICERO & Grete...
In-field interviews	Sat 18-03-31	23 mons	Fri 16-04-01	Tue 18-02-06	100%		63FS-6 mons	Empirical	Preparatory assessment of CSI vulnerability		Interview guide in Norwegian. Different interview guides for sheep farmers and reindeer herders. The PhD students have used separate interview guides. The interviews are transcribed and stored ...
Literature review	NA	21 mons	Fri 16-04-01	Fri 17-12-08	100%		63FS-6 mons	Empirical	Preparatory assessment of methodologies		baseline societal standard data from literature, newspapers with focus on climate/weather effects on health of humans and animals...
Selection of case-studies	NA	3 mons	Tue 17-08-15	Thu 17-11-09	100%	62FS-6 mons;61FS-6 mons	65;67;71;75;76;85;92;97;102;72	Empirical	Selection of case-study areas and subjects		
WP4.2 Assessment of societal infrastructures that may spread CSI	NA	36,95 mons	Fri 17-11-10	Fri 20-10-30	100%						Lead: Grete...
Case-study interviews human CSI	Sun 18-09-30	36,95 mons	Fri 17-11-10	Fri 20-10-30	100%		63	68;52;80	Empirical	Case-study materials	Oct 2020: Ongoing - but we are wrapping this up - Barbara is done with her field work. Majken is finalizing her PhD thesis. Please note that the interviews span the different sections in this document...
WP4.3 Description of human-nature interactions in animal husbandry households	NA	37 mons	Fri 17-11-10	Tue 20-11-03	100%						Lead: Camilla Risvoll, NRI...
Case-study interviews animal CSI	NA	32,76 mons	Fri 17-11-10	Tue 20-06-30	100%		63	52;80	Empirical	Case-study materials	iterative process ongoing such is the social sciences; before thought to be finished by June 2019

Integrative CSI assessment	Sun 19-03-31	1 dy	Mon 18-10-01	Mon 20-11-02	100%	65	69	Human and animal CSI materials	Integrative case-study documentation	Oct 2020: Assessment is done...	
D4-1 Publication (s) on linkage between human-nature interactions and CSI	Wed 21-03-31	1 dy	Mon 20-11-02	Tue 20-11-03	100%	68				2 chapters published in the joint NCoE book, and the two PhD theses will also be relevant to this deliverable. PUBLICATION 3 and 4. COMPLETE	
WP4.4 Identification of local adaptation strategies and needs	NA	41,95 mons	Fri 17-11-10	Fri 21-03-26	96%					Lead: Grete...	
Case-study CSI adaptation interviews	Sat 18-03-31	32,76 mons	Fri 17-11-10	Tue 20-06-30	100%	63	52;80;72	Empirical	Case-study materials	Oct 2020: We are done with the interviews, now that Barbara is back and is done with hers. A combined list of interviews is being prepared...	
Integrative CSI adaptation assessment	Tue 20-03-31	109,5 dys	Wed 19-04-24	Mon 20-11-30	70%	63;71		73	CSI adaptation materials	Integrative case-study documentation, to WP5	Oct 2020: The analysis is ongoing and will be published in a paper to be submitted by 31 December 2020....
D4-2 Publication(s) on links between animal husbandry, adaptation and CSI	Wed 21-03-31	4 mons	Tue 20-12-01	Fri 21-03-26	40%	72				Kiruna report on supplementary feeding- and associated publications (our participation co-authorship in 3 chapters in book lead by ReiGn (Camilla Risvoll author)	
WP4.5 Perception of risks and security for humans and animals from the spread of CSI	NA	40,29 mons	Fri 17-11-10	Mon 21-02-08	95%					Lead: Grete...	
Case-study CSI risk interviews	Sat 18-03-31	37,95 mons	Fri 17-11-10	Mon 20-11-30	100%	63	52;80	Empirical	Case-study materials	Oct 2020: Here we have also included material from reindeer herder workshops on risk and preparedness, in addition to what comes out of the interviews. ...	
CSI risk literature review	Sat 18-03-31	40,05 mons	Fri 17-11-10	Fri 21-01-29	90%	63	77;52;80;93	Empirical	Assessment of risk methodologies	ongoing work, which will feed in to a manuscript by Risvoll, Hovelsrud et al., before expected to be finished by Aug 2019...	
Integrative CSI risk assessment	NA	1 dy	Tue 18-10-30	Mon 21-02-01	90%	76		78	CSI risk materials	Integrative case-study documentation, to WP5	Oct 2020: Risk material collected - analysis ongoing...
D4-3 Publication(s) on how the threat of CSI is reflected upon locally, and the extent to which this influences the overall sense of ontological security human-nature vs. CSI	Sun 19-03-31	1 wk	Mon 21-02-01	Mon 21-02-08	40%	77				Oct 2020: Article lead by Camilla on risk and preparedness -with sheep farmer and reindeer herder as co-authors deadline 31.12.20 for submission to Weather, Climate and Society Special Collection. ...	
WP4.8 Adaptive capacity in animal husbandry	NA	9,33 mons	Wed 20-07-01	Wed 21-03-31	21%					Lead: Grete...	
Integrated study of strategies for CSI adaptation	Tue 20-03-31	1 dy	Wed 20-07-01	Mon 21-02-01	60%	76;65;67;71;75		81	Input case-study materials	Summary of WP4 case-studies	Oct 2020: Here we identify barriers and enablers for current adaptive capacity across scales and sectors. We are looking at how we can understand CSIs through proxies. Majken's PhD thesis covers some of these aspects as well, and we will prepare a publica
D4-5 Recommendations concerning CSI adaptation and husbandry strategies	Wed 21-03-31	2 mons	Mon 21-02-01	Wed 21-03-31	20%	80			Summary of WP4 case-studies	Integrative recommendations document	Oct 2020: To be addressed at stakeholders/policy makers, and will include input from practitioners. We envision that this will be a fact sheet or summary of key factors to consider....
WP5 Traditional knowledge and local agency	NA	62,05 mons	Fri 16-04-01	Tue 21-03-30	30%					Lead: Jan Åge Riseth, NORUT	
WP5.1 The spread of CSI and everyday life with a gender perspective	NA	62 mons	Fri 16-04-01	Mon 21-03-29	7%					Lead: Natalia Kukarenko, NARFU...	
Selection of case-studies	NA	3 mons	Fri 16-04-01	Tue 16-06-28	100%		85;91;96;101	Empirical, in collaboration with WP4	Selection of case-study subjects		
Case-study interviews "CSI and everyday life"	NA	27 mons	Fri 17-11-10	Mon 20-01-13	0%	63;84	87;93;98;103;86	Empirical	Case-study materials	Field work is post-poned due to COVID for summer 2021 and impossibility to travel to Yamal.	
Literature review "CSI and everyday life"	NA	3 mons	Tue 20-01-14	Thu 20-04-09	85%	85		87	Empirical	Preparatory assessment	existing policy documents, results from previous WPs and material from other projects relevant to detecting vulnerable groups of population in the Barents region; the data is collected, prepared in a form of a manuscript to be published spring 2021 (in Russian)
Integrated cross-sectional vulnerability assessment	Wed 20-09-30	5 mons	Fri 20-04-10	Thu 20-09-03	60%	85;86		88	In collaboration with WP4	Integrated (across WPs) materials, to WP6	The interviews with local authorities and officials were carried out; the data is being analysed and will feed in two articles by Natalia Kukarenko and her PhD student at NARFU on communication; also a presentation at ASSW2021

D5-1 Publication on vulnerability	Wed 21-03-31	7 mons	Fri 20-09-04	Mon 21-03-29	90%	87		Collected materials, with WP4	Documentation "CSI and everyday life"	Publication is being underways to be published in Russian in a manuscript by Natalia on results of CLINF project (in Russian), expected in summer 2021 by NarFU publishing House	
WP5.2 Everyday practices, traditional knowledge and their resilience potential, with a gender perspective	NA	61,6 mons	Fri 16-04-01	Wed 21-03-17	70%					Lead: Jan Åge...	
Literature review "TK resilience potentials"	NA	21 mons	Fri 16-04-01	Fri 17-12-08	100%		91	Empirical	Preparatory assessment	historic experiences with animals, reindeer in particular, and diseases and how indigenous and local people handle and adapt to diseases	
Selection of case-studies	NA	3 mons	Mon 17-12-11	Wed 18-03-07	100%	90;84		92	Empirical, in collaboration with WP4	Selection of case-study subjects	
Case-study interviews "TK resilience potentials"	NA	31 mons	Thu 18-03-08	Thu 20-09-03	100%	91;63	93;98;103	Empirical	Case-study materials	Fulfilled and reported i publication "Spreading or Gathering " article in speial issue of IJERPH	
Integrated assessment	Wed 20-09-30	1 dy	Mon 21-02-01	Mon 21-02-01	100%	76;92;85		94	In collaboration with WP4	Integrated (across WPs') materials	Publication with Morten Tryland et al. "Husbandry and diseases od semi-domesticated E. tundra reindeer in Fennoscandia" (submitted); Aug 2020: Publication planned for August 2021; scale up local knowledge to regional level and gendered effects to the communities; perform cross-sectional vulnerability assessment
D5-2 Publication on the role of traditional knowledge in providing resilience to the effects of CSI spreading	Wed 21-03-31	1,5 mons	Tue 21-02-02	Wed 21-03-17	100%	93			Collected materials, with WP4	Documentation "TK resilience potentials"	Publication with WP4 "Falling between the cracks" submitted for Weather Climate and Socity
WP5.3 Local environmental and health policies, with a gender perspective	NA	59,05 mons	Wed 16-06-29	Tue 21-03-30	24%						Lead: Natalia...
Selection of case-studies	NA	3 mons	Wed 16-06-29	Fri 16-09-23	100%	84		97	Empirical, in collaboration with WP4	Selection of case-study subjects	
Case-study interviews "local health policies"	NA	37 mons	Fri 17-11-10	Mon 20-11-02	100%	96;63	98;103	Empirical	Case-study materials	Publication planned summer 2021 by NarFU publishing house. The interviews with local authorities and officials were first impossible due to the COVID situation and at later stage the previous governor (Orlov) resigned and until the elections on 13.09.2020 officials refused to get in contact and later the new elec	
Integrated assessment	Wed 20-09-30	1 dy	Tue 20-11-03	Tue 20-11-03	80%	85;92;97		99	In collaboration with WP4	Integrated (across WPs') materials	Publication planned summer 2021 by NarFU publishing house. Identification of how health rights and health security perceptions by different social groups, main actors and stakeholders, drive local health and environment policies;...
D5-3 Publication on linkage between traditional knowledge, CSI, gender, power and access to information"local health policies"	Wed 21-03-31	5 mons	Wed 20-11-04	Tue 21-03-30	80%	98			Collected materials, with WP4	Documentation "local health policies"	Publication planned summer 2021 by NarFU publishing house.
WP5.4 Risk management in a gender perspective	NA	59 mons	Wed 16-06-29	Mon 21-03-29	13%						Lead: Natalia...
Selection of case-studies	NA	3 mons	Wed 16-06-29	Fri 16-09-23	100%	84		102	Empirical, in collaboration with WP4	Selection of case-study subjects	
Case-study interviews "CSI risk management"	Sat 18-03-31	37 mons	Fri 17-11-10	Mon 20-11-02	80%	101;63		103	Empirical	Case-study materials	Publication planned summer 2021 by NarFU publishing house based on interviews with experts and researchers. Aug 2020: paper is under review, deadline extended with 2 months; May 2019: expected by July/Aug 2019...
Integrated assessment	NA	0,5 mons	Tue 20-11-03	Tue 20-11-17	80%	85;92;97;102	104FS-12 mons		In collaboration with WP4	Integrated (across WPs') materials	Publication planned summer 2021 by NarFU publishing house.
D5-4 Dissemination seminars, round table discussions and meetings with local stakeholders and national/regional authorities	Tue 20-03-31	6 mons	Wed 19-09-18	Wed 20-03-11	100%	103FS-12 mons		105			Conferences 2021
D5-5 Publication(s) on good practice for decision making regarding CSI and risk communication and on adaptation strategies for local communities"CSI risk management"	Wed 21-03-31	13 mons	Thu 20-03-12	Mon 21-03-29	80%	104			Collected materials, with WP4	Documentation "CSI risk management"	Publication planned summer 2021 by NarFU publishing house.
WP6 The CLINF geographic information system (GIS)	NA	27 mons	Fri 16-04-01	Mon 18-06-04	98%						Lead: Tomas Thierfelder, SLU...

CLINF stakeholder identification	NA	6 mons	Fri 16-04-01	Fri 16-09-23	100%		108	Empirical	Depiction of CLINF stakeholder organisations	
CLINF GIS specification	NA	6 mons	Mon 16-09-26	Mon 17-03-20	100%	107	109	Empirical	System specification	
CLINF GIS development	NA	6 mons	Tue 17-03-21	Tue 17-09-12	100%	108	110	CLINF GIS specification	CLINF GIS source code	
CLINF GIS implementation	Thu 17-11-30	6 mons	Wed 17-09-13	Wed 18-03-07	100%	109	111	CLINF GIS source code	Up-and-running CLINF GIS	
D6-1 CLINF GIS documentation	NA	3 mons	Thu 18-03-08	Mon 18-06-04	100%	110		CLINF GIS source code	CLINF GIS on-line documentation	

Appendix 6 – Financial Report per partner organisation



Appendix 7 – Summary timesheet





CLINF Summary Timesheet

Project effort per staff member/function and work package [in person months]

1720 hours/year

hours/month:

143,3

Personnel	Affiliation	Function	WP1 person months	WP2 person months	WP3 person months	WP4 person months	WP5 person months	WP6 person months	WP7 person months	sum:	percentage NordForsk financed
SE	Birgitta Evengård	UMU	Prof./Research team leader	7,6					7,6	15,20	100%
SE	Anders Sjöstedt	UMU	Prof./Research team leader	1,4						1,40	100%
DK	Anders Koch	SSI	Prof./Research team leader							-	
SE	Ann Albihn (+ time in CLINF-RI SVA		Assoc. Prof./Research team leader	1,5						1,53	0%
UK	Shaun Quegan	UoS	Prof./Research team leader		1,2					1,23	30%
SE	Georgia Destouni	SU	Prof./Research team leader		1,2					1,20	0%
FI	Juha Lemmetyinen	FMI	Prof./Research team leader		0,6					0,56	100%
SE	Tomas Thierfelder	SLU	Assoc. Prof./Research team leader			1,3		0,2	0,5	1,99	80%
SE	Tomas Thierfelder	SLU	Assoc. Prof./Research team leader						0,1	0,10	0%
NO	Grete Hovelsrud	NU	Prof./Research team leader				4,2			4,21	0%
RU	Natalia Kukarenko	NARFU	(Assoc.) Prof./Research team leader					4,9		4,93	44%
NO	Jan Åge Riseth	NORUT	(Assoc.) Prof./Research team leader					2,6		2,61	62%
sum (Assoc.) Prof./Research team leaders:			10,52	2,99	1,33	4,21	7,54	0,21	8,16	34,96	
NO	Camilla Risvoll	NFORSK	senior researcher/Assoc. Prof.				2,6			2,56	0%
NO	Bob van Oort	CICERO	professor/senior researcher				0,5			0,46	0%
NO	Hans Tømmervik	NINA	senior researcher					2,7		2,70	47%
NO	Bernt Johansen	NORCE	senior scientist					0,9		0,87	0%
NO	Bård Helge Kårtveit	NORCE	senior scientist					1,1		1,13	0%
sum senior researchers:			-	-	-	3,03	4,70	-	-	7,72	
SE	Zahra Kalantari	SU	postdoctoral fellow		1,2					1,20	0%
SE	Anna Omazic (+ time in CLINF-RII)	SVA	postdoctoral fellow	3,4						3,36	0%
UK/SE	Didier Leibovici	UoS/SLU	postdoctoral fellow		7,7					7,74	100%
sum postdoctoral fellows:			3,36	8,94	-	-	-	-	-	12,31	
FI	Juval Cohen	FMI	Ph.D. student		3,2					3,23	100%
NO	Majken Paulsen	NU	Ph.D. student				1,5			1,50	0%
SE	Yan Ma	SU	Ph.D. student		3,0					3,03	100%
SE	Elisie Käresdotter	SU	Ph.D. student		4,4					4,44	100%
sum Ph.D. students:			-	10,70	-	1,50	-	-	-	12,20	
SE	Carmen Prieto	SU	other/research engineer		1,2					1,20	0%
sum other academic personnel:			0,04	1,20	-	0,03	-	-	-	1,28	
SE	Svenja Stöven	UMU	project manager (Assoc. Prof.)						9,5	9,50	100%
SE	Veronica Häggström	UMU	financial officer						1,4	1,40	81%
sum auxiliary personnel:			-	-	-	-	0,00	-	10,90	10,90	
sum:			13,93	23,83	1,33	8,78	12,24	0,21	19,05	79,37	