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CLINF Stakeholder Analysis

Inferring the network of CLINF stakeholder organisations - from Nuuk to Yakutsk

Sepp Böhme

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SLU, Swedish University of Agricultural Sciences
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Author: Sepp Böhme

Supervisor: Tomas Thierfelder, Department of Energy and Technology, SLU
Examiner: Anders Larsolle, Department of Energy and Technology, SLU

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Abstract

With climate change, habitats suitable for organisms transmitting southerly infectious diseases are expected to migrate towards the North, and tackling them will require joint action and awareness shared across national borders. In the present study, experts representing different scientific backgrounds supplied contacts and information regarding societal groups (stakeholders) potentially vulnerable to climate sensitive infections (CSI), and their associations with each other. From standardized questionnaires and open-ended interviews, the study infers a "stakeholder network" which identifies not only potential stakeholders, but also the underlying network implied by administrative stakeholder relations. The administrative and social depths of such relations were estimated with associative correlations whereupon a cluster analysis was performed with results depicted on a geographic map that covers the entire project-area from Greenland to Eastern Siberia (combining multivariate statistical methods with geographic information systems). As a result, stakeholder patterns across the geographic expanses from Nuuk to Yakutsk seem to be clustered into five relatively independent groups, covering topics from health sciences and governmental health authorities to organisations dealing with reindeer herding and indigenous cultures. The two latter topics of reindeer herding and indigenous interest are strongly correlated across national borders, and particularly provide a rather rare bilateral connection across northern Russia and western Europe. In contrast with associations across national borders, institutions, companies, and authorities related to reindeer meat/food production, land-use, and tourism seem to be relatively confined within national borders. If and when a pan-northern organisation from Greenland to Eastern Siberia is constituted to tackle CSI threats, it should encompass member organisations representing each of the five identified CSI stakeholder clusters, where the most central organisations of each cluster may be identified by means of maximum associative depth.

Keywords: climate sensitive infections, stakeholder network, pan-northern organisation.

Sammanfattning

Prevalensen av nordliga infektionssjukdomar som är känsliga för klimatförändringar kommer sannolikt att påverkas när klimatet förändras, och bekämpningen av dessa sjukdomar kommer att kräva gemensamma åtgärder och gränsöverskridande beredskap. I föreliggande studie har ledande experter från flera olika ämnesområden bidragit med kontakter och information rörande intressenter av potentiellt klimatkänsliga infektionssjukdomar (CSI – climate sensitive infections) och deras kopplingar med varandra. Intressenterna är i det här fallet institutioner och organisationer vars intresseområden kan påverkas när den samhälleliga exponeringen mot CSI:er förändras. Studien har använt standardiserade frågeformulär och öppna intervjuer för att identifiera nätverket av sådana intressenter i området ”från Nuuk till Yakutsk”, dvs. över i stort sett hela den norra delen av Eurasien. Nätverket identifierar inte bara potentiella intressenter, utan också de underliggande associativa kopplingar som impliceras av intressenternas administrativa relationer. Styrkan av dessa administrativa kopplingar mäts i termer av ”associativt djup” (socialt djup) där kopplingarna kvantifieras med skattade korrelationskoefficienter. Baserat på den resulterande korrelationsmatrisen använder studien multivariata statistiska metoder och geografiska informationssystem för att kartlägga hur intressenterna fördelas i relativt oberoende intresseområden. Resultaten indikerar att nätverket av CSI-intressenter kan beskrivas med fem relativt oberoende kluster, geografiskt fördelade från Nuuk till Yakutsk, där hälsovetenskaper, statliga hälsovårdsmyndigheter, internationella renskötselorganisationer och inhemska folkgruppers intresseorganisationer uppvisar starka gränsöverskridande förbindelser. Den sistnämnda kopplingen, mellan renskötselorganisationer och inhemska folkgruppers intresseorganisationer, utgör en av få administrativa kopplingar mellan norra Ryssland och Västeuropa som har identifierats i föreliggande studie. Institutioner, företag, och myndigheter med anknytning till livsmedelsproduktion (renkött), markanvändning och turism ser däremot ut att vara mera nationellt begränsade. Om och när en Eurasisk organisation bildas för att ta itu med det nordliga CSI-hotet, så bör den inkludera medlemsorganisationer från vart och ett av de identifierade klusterna. Enskilda organisationers lämplighet att representera sina respektive kluster kan mätas i termer av maximalt associativt djup.

Nyckelord: klimatkänsliga infektionssjukdomar, nätverk av intresseorganisationer, nordliga Eurasien.

Popular Science Summary

Man-made CO_2 emissions have changed global temperatures since the end of the last century. Changes in the climate system, and the associated impacts on ecosystems and people, are likely to increase when this process continues. According to the World Health Organisation, direct climate change causes already today over one hundred and fifty thousand deaths per year. This number is expected to increase dramatically by the middle of this century due to, amongst others, climate change impacts on diseases like malaria and diarrhoea. Infectious diseases that are sensitive to climate change (CSIs') are spread increasingly through new northern territories. Climate change-induced northward shifting of living environments for organisms that carry such diseases are one potential driver for this development. Since this is a process that operates across national borders, international collaboration is needed to face the situation. At the moment, however, neither adequate policies nor an organisation is in place to face the CSI threat.

This study has focused on identifying a selection of organisations from Greenland to Eastern Siberia that may have stakeholder interests in the emerging CSI threat. For example, targeted organisations represent indigenous peoples of the North, human and animal health-related governmental and scientific institutions, and private entrepreneurs engaged in reindeer meat production and tourism. Information about the organisations was provided by experts from different (scientific) backgrounds.

Besides an identification of these "CSI stakeholder' organisations", this study also analysed their inter-organisational administrative relations. Results suggest that the CSI stakeholder organisation network from Nuuk to Yakutsk may contain five relatively independent groups with quite different characteristics. Organisations dealing with reindeer herding and indigenous interest organisations seem to be well connected across national borders. However, governmental authorities, institutions and companies associated with reindeer meat production and tourism, seem to be more confined within national borders.

The findings derived from this analysis can be used to gain knowledge about how CSI stakeholder organisations are connected through the vast geographic expanses from Nuuk to Yakutsk. Differences in the degree of administrative connectivity between the organisations can provide decision support for better networking. Furthermore, this knowledge can be useful for an establishment of an international organisation dealing with CSI issues across national borders. For this purpose, the best-connected organisations within each of the five identified groups should be chosen to represent their groups' characteristic interests.

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Glossary and abbreviations

ACIA	Arctic Climate Impact Assessment
AMAP	The Arctic Monitoring and Assessment Programs
CLINF	Climate-change effects on the epidemiology of infectious diseases and the impacts on Northern Societies
CSIs'	Climate sensitive infectious diseases
EVIRA	Food Safety Authority, Finland
GCHR	Greenland Center for Health Research
GPP	Global Public-Policy
ICR	International Centre for Reindeer Husbandry
ICS	The International Circumpolar Surveillance of Emerging Infectious Diseases
IPCC	Intergovernmental Panel on Climate Change
IUCH	International Union for Circumpolar Health
NCoE	NordForsk Nordic Centre of Excellence
NRL	Reindeer Herders' Association of Norway
PCA	Principal component analysis
SDWG	The Sustainable Development Working Groups
SNA	Social network analysis
SPR	Sami Parliament of Norway
SSR	National Association of Swedish Sami
VAS	Visual analogue scale
WHO	World Health Organisation

1 Introduction

Background

The Human influence on present climate change is an undeniable fact and directly associated with the recently highest anthropogenic emissions of greenhouse gases in history. The global surface warming since the late 20st century was decisively determined by cumulated CO_2 emissions (IPCC, 2014). Long-lasting changes in the climate system along with irreversible impacts on ecosystems and people are likely to occur in the case that the emissions of greenhouse gases continue. Direct impacts of climate change i.e. changed patterns of diseases, effects on agricultural production and extreme weather events account for over 150,000 deaths annually (WHO, 2017b). 250,000 additional deaths per year are expected to be caused by malaria, diarrhoea, malnutrition and heat stress as a consequence of climate change from the year 2030 to 2050 (WHO, 2017a).

Further, climate change is expected to favour a northward migration of suitable habitats for organisms that transmit infectious diseases (CLINF, 2017). Hence, climate change is likely to affect the prevalence of climate sensitive infectious diseases (CSIs') throughout the North. Only supra-national organisations are capable of tackling such supra-national social-environmental dilemma, i.e. making the necessary public health investments. At present, there is neither such a supra-societal agenda for targeting CSI existing, nor are sufficient necessary organisational infrastructures in place.

In the Arctic, which covers a considerable part of the northern part of the northern hemisphere, international collaboration and cooperation regarding human health is not a recent invention. In fact, these organisations i.e. the International Union for Circumpolar Health, Circumpolar Health Research Network, and the Arctic Council have been in place for a substantial period of time. The five circumpolar health organisations that constitute the International Union for Circumpolar Health have their origins even in the 1960s (Evengård *et al*., 2015).

In the year 2010, an ICS[1] Climate change and Infectious disease working group specialized on information-sharing of climate sensitive infectious diseases in the circumpolar North was formed (Parkinson *et al*., 2014).

However, the existing infrastructure of collaboration networks does not particularly address the prevalence of CSIs' in the North. The variety of (smaller, mostly national) stakeholder organisations that may hypothetically be affected by such diseases can be taken as a first approach towards the description of the actual variety of the generic CSI stakeholder organisation population. The units targeted in this study are such stakeholder organisations, and their relations with each other.
The infrastructure of organisational networks extends thematically from indigenous peoples of the North, multiple governmental and scientific institutions dedicated to human and animal health (e.g.), environment and culture, and municipalities and private entrepreneurs engaged in reindeer meat production and tourism. The study area covers the vast northerly expanses from western Greenland to eastern Siberia, i.e. "from Nuuk to Yakutsk".

A network analysis concerning this vast array of stakeholders has the potential of revealing underlying patterns regarding organisational grouping/clustering, reflecting how the sampled organisations are administratively related to each other. With N organisations sampled, $(N\text{-}1)^2$ relations exist. Information regarding administrative stakeholder patterns is important in the process of detecting communicational shortcomings across stakeholder organisations, and when a supra-national organisation is constituted to meet societal CSI threats.

In similar research, like in the fields of designing public administrative and governance networks (Kapucu, 2015), the social network analysis (SNA) has been widely used to examine policy issues and management problems (Provan & Lemaire, 2012; Hu, 2015). Both quantitative and qualitative approaches from SNA deliver a wide range of tools to describe and interpret networks. The potential of SNA methods has yet not been applied to uncover the existing network of stakeholders threatened by CSIs'. An analysis of the CLINF stakeholders and their corresponding connections, across the geographic expanses from Nuuk to Yakutsk, may provide pivotal information regarding the design of an eventual pan-northern[2] organisation tailored to meet the requirements of a CSI mitigation strategy.

1. ICS: "The International Circumpolar Surveillance of Emerging Infectious Diseases" system was initiated in 1998 as joint project from the IUCH and Arctic Council (Zulz *et al*. 2009; Parkinson *et al*. 2008).
2. Pan-northern organisation refers to the corresponding borders of the CLINF project area from Nuuk in Greenland to Yakutsk in Eastern Siberia.

1.1 Purpose

The aim of this master thesis is to identify and depict the network of CSI stakeholders that corresponds to the northerly study-area from Nuuk to Yakutsk, and to estimate administrative inter-organisational network linkages. By implementing an interactive depiction of this network as a web-service (at www.clinf.org), this would facilitate mutual identification of fellow stakeholders within the organisational network itself, which would provide a fundamental incitement to the constitution of a pan-northern CSI organisation. With such an important organisation largely missing, we hypothesise that stakeholders still remain mutually unfamiliar.

1.2 Delimitations

This study will try to identify and depict a representative sample of stakeholder organisations from Nuuk to Yakutsk, where the selection of organisations is based on the best of the CLINF contact persons' knowledge. The inferred network of organisations will simply represent a judgmental sample[3] of all potential CSI stakeholders, no attempts have been made to infer how the sample reflects the generic existence of individual organisations. It is, however, assumed that the generic population of all CLINF stakeholder organisations may be comparable by terms of their network characteristics. This assumption is motivated by the semi-randomization performed when organisations were chosen by experts, where the sample network characteristics are principally bound to reflect the generic network by some well-defined probability not estimated in this (masters) study.

3. Judgmental sampling is a type of semi-randomized sampling based on the choice of an expert.

2 Theory

2.1 Climate sensitive infections'

Climate change may be considered as a temporal process where climate characteristics are geographically reallocated. According to the latest scenarios of the Intergovernmental Panel on Climate Change (IPCC), climate change is likely to alter precipitation and temperature in northern regions: IPCC's climate models predict an increase in temperature between 1.4 and 5.8 °C by 2100 in the Arctic. This will likely result in loss of sea ice cover, warmer winters and summers, increasing precipitation, and melting of permafrost (IPCC, 2013).

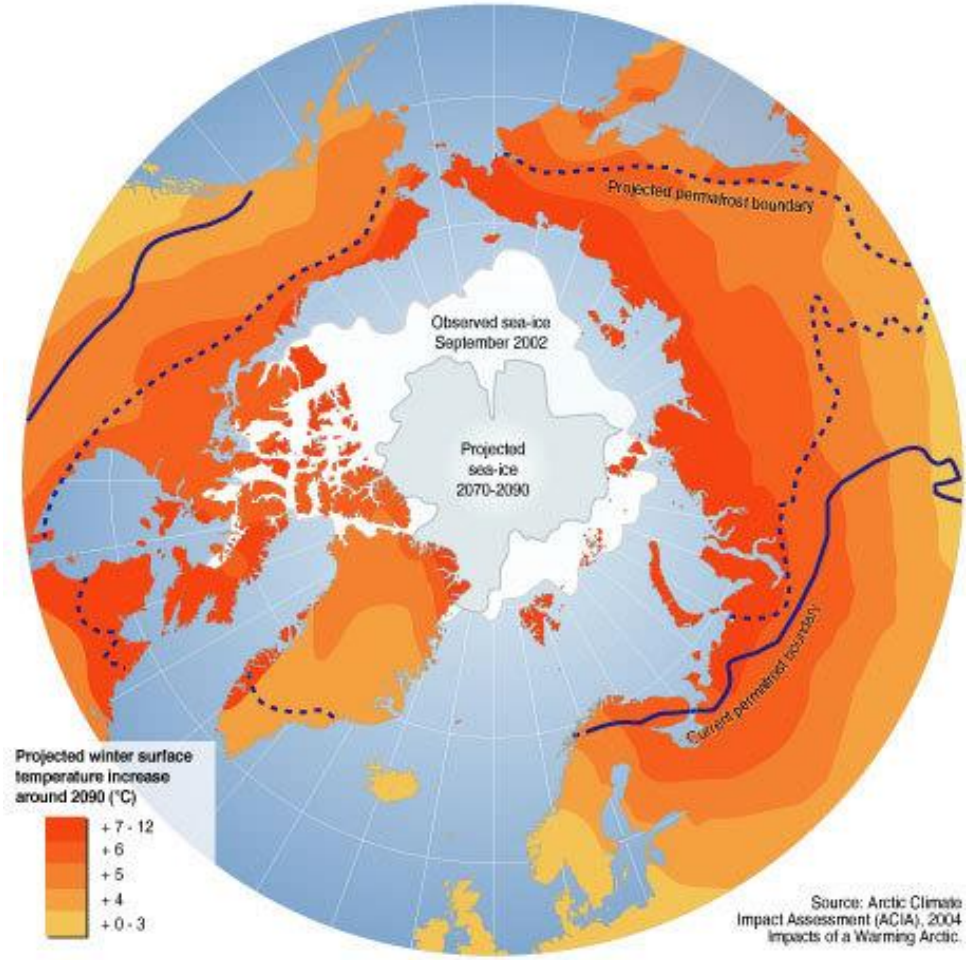

Figure 1. [Projected changes in the Arctic climate, 2090](https://www.grida.no/resources/7748) [map] (free to use: https://www.grida.no/resources/7748); this figure has been graciously provided to be used by Hugo Ahlenius, UNEP/GRID-Arendal (CC [BY-NC-SA 2.0](BY-NC-SA 2.0)); 2010.

Other scenarios, like those depicted in Figure 1 from the Arctic Climate Impact Assessment (ACIA, 2004), predict even higher temperature increases especially for wintertime in the Arctic.

Climate change is expected to introduce vast ecological consequences regarding the geographic distribution of biota (Berggren *et al*., 2009). With many infectious diseases being carried and transmitted by vector and reservoir organisms, a northward shift of habitats for animals, insects, and plants is likely to change the epidemiology and ecology of infectious diseases (Evengård *et al*., 2015). Within the CLINF NCoE, climate sensitive infections (CSIs') are defined as infectious diseases carried by organisms that migrate with climate change[4]. When vectors and reservoir organisms expand their habitats towards the North, CSIs' are able to

4. The term 'climate-sensitivity' has been used before by the WHO, referring to the importance of meteorological information to explain the prevalence of certain diseases (WHO, 2012).

migrate alongside. As a result, it is commonly assumed that weather/climate plays a generally important role as spatio-temporal[5] determinant of the geographic distribution of organism species (Cross *et al*., 1996).

At southern latitudes, numerous vector borne diseases like malaria, Rift Valley Fever, plague and dengue fever are highly climate and weather dependent in terms of their distribution and occurrence (Semenza and Menne 2009; WHO, 2013). Other infectious diseases that represent food- and waterborne diseases, like West Nile virus, Ebola haemorrhagic fever, and the Hantavirus, are also influenced by weather/climate (Pinzon *et al*., 2004; Brookes *et al*., 2004; Haines *et al.*, 2006; Dearing and Dizney, 2010; Money *et al*.,2010).

The health of indigenous peoples of the circumpolar area has improved throughout the last 50 years (Evengård *et al*., 2015). However, rates of many infectious diseases such as tuberculosis, viral hepatitis, invasive bacterial infections, sexually transmitted diseases and certain zoonotic and parasitic infections are higher amongst Arctic indigenous people as compared with corresponding national population rates (Koch *et al*., 2008).

With a majority of climate sensitive infections being vector-borne (CLINF, 2017), the CSIs' chosen for the CLINF NCoE largely comprises vector-borne zoonotic diseases, i.e. diseases capable of being transmitted both-ways between animals and humans. They therefore constitute a considerable threat for northern societies that depend on animal husbandry, where livestock exposure to CSIs' is added to human exposure. In addition, income related activities such as hunting, fishing, and tourism are affected. Most commonly affected are the poorest population parts and indigenous people as their way of living involves a certain proximity to nature. Regardless if in the tropics or Arctic regions, this way of living is thus most likely accompanied by a higher vulnerability to climate variability and its influences on infectious diseases (Evengård *et al*., 2015).

As exemplified with northwest Alaska, it becomes clear that the previously described warming trends in the Arctic already have led to changes in multiple pivotal sectors; influences not only on ecology, but also socio-economic effects have been documented here already, e.g. through thawing of permafrost, shoreline erosion, flooding, and loss of protective sea ice (Brubaker *et al*., 2011).
All of this none withstanding, very little is known about the impact of climate change and the risk and distribution regarding infectious diseases in the Arctic (Hueffer *et al*., 2011; Revich *et al*., 2012; Revich and Podolnya 2011). In Table 1, a selection of potential climate sensitive infections that could be relevant for the

5. Spatio-temporal: comprising both space and time.

Northern region is presented. The listed diseases affect either humans or animals, and in most cases both of them (zoonotic diseases).

Table 1. *Potentially climate sensitive infections adapted from CLINF, 2017.*

Potentially climate sensitive infections	Humans	Animals
Alphaherpesvirus infection		•
Anaplasmosis	•	•
Anthrax	•	•
Babesiosis	•	•
Bluetongue disease		•
Borreliosis	•	•
Botulism	•	•
Brucellosis	•	•
Campylobacter infection	•	•
Clostridiosis	•	•
Cryptosporidiosis	•	•
Echinococcosis	•	•
Elaphostrongylus rangiferi		•
Erysopelotrix	•	•
Fascioliosis	•	•
Gammaherpesvirus		•
Giardiasis	•	•
Leptospirosis	•	•
Listeriosis	•	•
Necrobacilliosis	•	•
Nephropathia epidemica	•	•
Parapoxvirus (Orf)	•	•
Pasteurella		•
Pestivirus		•
Q-fever	•	•
Rabies	•	•
Salmonella	•	•
Schmallenberg virus (SBV)		•
Setaria tundra		•
Sindbis fever/Pogosta/Ockelbo	•	•
Tick Borne Encephalitis (TBE)	•	•
Toxoplasmosis	•	•
Trichinellosis	•	•
Tularemia	•	•
West Nile Fever	•	•
Vibrio vulnificus	•	
Vtec/EHEC	•	•

2.2 The CLINF project

CLINF (www.clinf.org) is a NordForsk (www.nordforsk.org) Nordic Centre of Excellence (NCoE) dedicated to "Climate change effects on the epidemiology of infectious diseases and the impacts on Northern societies". The geographic distribution of CLINF stakeholders ranges from Nuuk in western Greenland to Yakutsk in Eastern Siberia. The purpose of the NCoE is to investigate the effects of climate change on the epidemiology and geographic distribution of human and animal infectious diseases in the pan-northern region, with special focus on societal effects. One of CLINFs' objectives is to deliver an early warning system for climate sensitive infections (CSIs') at the local level based on an understanding of the CSI epidemiology and its geographical distribution (CLINF, 2017).

CLINFs' measures to examine the CSI scenario will be:

- Inventory of existing human and animal diseases
- Analysis of potential landscape change and the associated probability for CSI migration
- Assessment of risk-perceptions, adaptive capacity, and societal costs

Expected project outputs:

- Map the geographic distribution of emergent human and animal CSIs' from Nuuk to Yakutsk
- Enhance regional Earth-process models regarding environmental climate change effects
- Developing methodologies for adequate assessment of societal CSI risk and adaptive capacity
- Develop and implement an early warning system regarding "emerging infections on local level" (CLINF, 2017)

2.3 Present Arctic network co-operations'

Arctic countries have a long history of international collaboration in managing environmental issues, including health problems, in their communities (Evengård *et al*., 2015). However, as indicated in Table 2, at present state there is no overarching organisation in place that covers the identified risk regions from Greenland to Russia that includes the necessary array of stakeholders in order to meet the emerging CSI threat.

Table 2. *Present Arctic network co-operations' adapted from Evengård et al., 2015; Parkinson, 2010.*

Organisation	Purpose
International Union for Circumpolar Health	- Non-governmental Organisation consisting of 5 different circumpolar health organisations - Cooperation on human health by means of 13 working groups, one on infectious diseases
Circumpolar Health Research Network	- Network of researchers, research trainees, indigenous peoples' organisations and regional health authorities - International cooperation in health research for improvement of health of residents of the Arctic region
Arctic Council	- Ministerial intergovernmental forum promoting cooperation among 8 Arctic states - Topics: sustainable development/ environmental protection - Two human health related working groups: ▪ The Arctic Monitoring and Assessment Programs (AMAP) ▪ The Sustainable Development Working Groups (SDWG)

2.4 Stakeholders and extent of the CLINF-"study area"

The CLINF network of stakeholders consist of a wide range of different organisations with different thematic backgrounds and with different societal groups represented. All stakeholders have in common that they may be influenced to a greater or lesser extent by emerging CSIs' in the pan-northern region from Greenland to Eastern Siberia. See Appendix B for the complete list of the examined stakeholders.

The 146 stakeholder organisations may be assigned to the following thematic categories:

1) Indigenous reindeer herders
2) Municipal
3) Advocacy groups[6]
4) Cultural advocacy groups
5) Economic advocacy groups
6) Environmental advocacy groups
7) Health advocacy group
8) Governmental
9) Scientific institutions

Since CSIs' comprise infectious diseases that may affect both humans and animals, governmental authorities for human health and veterinary medicine, as well as relevant research institutions provide stakeholder organisations for CLINF to consider. Food safety and environmental surveillance authorities, as well as municipalities and tourism companies' in the North, may be considered as stakeholders: Food safety is important since CSIs' are mainly zoonotic diseases, and since an infection may occur both ways between human and animals. Environmental surveillance authorities are included in the CLINF project because emerging CSIs' may have a pivotal impact on habitats and organisms besides climate change itself. The municipalities of the North are, in most cases, the establishments that will have to handle the direct consequences in case of CSI occurrence. Tourism companies specialized on experiencing e.g. nature and culture of indigenous people may also be influenced by an altered presence of infectious diseases and, are therefore potential stakeholders.

2.4.1 Importance of Sami and reindeer within network

Although only 10 % of the 4 million inhabitants of the Arctic are indigenous, these groups tend to depend more on nature with activities like e.g. fishing, hunting and reindeer herding. This dependency makes them more vulnerable to consequences of climate change than other inhabitants of the Arctic. Locally, at the scale of single countries, this percentage varies greatly, ranging from only 2 % in the Khanty-Mansi Autonomous Okrug of Siberia, to a clear majority of inhabitants in, for example, Greenland. The Russian Federation provides a home for over 40 Northern indigenous groups, such as the Sami, Inuit, Nentsy, Khanty, Mansi and numer-

6. Advocacy group…refers to groups or organisations representing their members' interest and seeking to influence government policy (Young *et al.*, 2011). In case of the CLINF NCoE, for several stakeholders the term "interest groups" may be more applicable, because there is not always an intention to influence government policy.

ous others. The Sami is an indigenous group of people within Sápmi, an area covering parts of northern Norway, Sweden, Finland, and Russia (Evengård *et al*., 2015). The map in Figure 2 depicts the geographic distribution of the Sami and other indigenous people of the Arctic.

Figure 2. Demography of indigenous peoples of the Arctic based on linguistic groups [map] (free to use: https://www.grida.no/resources/7744); this figure has been graciously provided to be used by Hugo Ahlenius, UNEP/GRID-Arendal (CC BY-NC-SA 2.0); 2010.

Over thirty indigenous cultures of the Arctic practice reindeer herding. Together they constitute a fundamental traditional economy and ancient practice that is conducted all across the Arctic as well as in China and Mongolia until today. Only the nation of Island lacks reindeer herding activities. Especially the Sami are well known for their characteristic relation to their reindeer (Evengård *et al.*, 2015).
According to Löf, (2014), there is a fundamental need for improved dialogue, action, and political awareness to strengthen the position of reindeer herders in order for them to meet negative climate change effects and improve their conditions for practicing their occupation. Relevant information about the Sami and reindeer herding in Norway, Sweden and Finland is presented in Table 3.

Table 3. *Sami in numbers adapted from Evengård et al., 2015.*

	Norway	Sweden	Finland
Sami	50,000-65, 000	20,000-40,000	8,000
Reindeer herders	2,700	2,000	500
Reindeer	200,000	250,000	200,000

2.5 Multi-stakeholder networks

Multi-stakeholder networks combine governmental and/or supranational actors of civil society and business institutions with the purpose of identifying a common approach for a shared and complex issue that cannot be addressed unless without collaboration (Roloff, 2008). The United Nations Global Compact is a typical example of a multi-stakeholder network, with the purpose of supplying global economy (Annan, 1999) with a number of principles in order to advance e.g. policy making and collaboration (Kell *et al*., 2003). Another example is the Global Public-Policy (GPP) project promoted by the United Nations, which is based on the principles of network building and involvement of states, international societies, and the corporate sector in order to address opportunities and risks presented by globalization (Reinicke *et al*., 2000). The potential of these networks lies in their capability of providing coordinating mechanisms for social dilemma situations, e.g. institutional arrangements for environmental protection (Streck, 2002). Further examples of multi-stakeholder networks have been described e.g. by Hajer *et al*., (2003); Reinicke *et al.*, (1998) and Reinicke *et al*., (2000).

In international governance, a current trend points away from the traditional intergovernmental activities. Similar to the concept of a northern overarching organisation to meet CSIs' threats, it addresses multi-sectoral partnerships. Such partnerships connect different sectors and levels of governance by the involvement of international organisations, civil society, corporations, and governments with each other. This indicates a shift towards increased participatory action including a less traditionally formal governance approach (Streck, 2002).

A pan-northern organisation designed to meet CSIs' threats would most likely benefit from GPP-like principles since the prevention of disease may be considered as being a classic subject of public good where non-collaborative assessment by individual stakeholders and/or national organisations probably would lead to social dilemma (Barrett, 2010).

2.6 Social network analysis

The term "social network analysis" (SNA) represents a set of tools and methods that can be used to examine social structures and the interactions within them as well as relational processes and their resulting outcomes (Scott, 2013; Borgatti, Everett, & Johnson, 2013; Wasserman & Faust, 1994). Within this thesis, SNA facilitates a quantification of the strength that keeps organisational structures together in meeting external mechanisms such as the CSI threat. There are actually both quantitative and qualitative approaches in the field of network analysis. Qualitative approaches can be utilized for observing networking behaviour, describing network processes and patterns. Further, qualitative approaches enable exploration of the underlying reasons for the network tie formation and dynamics, as well as decoding of actors' perceptions and interpretations of networks (Hollstein, 2011). Quantitative approaches are mainly applied in order to investigate large-scale network structures and formations, explaining network patterns and testing theories formed through qualitative analysis. The simultaneous application of qualitative and quantitative network analysis is referred to as "mixed-method network analysis", which is designed to deliver additional information regarding e.g. the "quality," "meaning" and "content" of network ties[7] (Edwards, 2010). Within the CLINF NCoE, SNA is used for the identification of administrative relations across the identified sample of networked stakeholder organisations.

7. Ties are the connections and relationships between nodes in a network (graph). Synonyms: edges, links or connections (Pinheiro, 2011; Cherven, 2015)

3 Material and Methods

3.1 Data acquisition

The data collection was conducted as a mixed method design and consisted of a series of steps. Prior to SNA, a selection of suitable experts from different societal sectors ranging from Nuuk to Yakutsk were contacted and asked for collaboration.

Table 4. *CLINF NCoE contact persons.*

Name	Institution	Country
Auður Arnþórsdóttir	Icelandic Food and Veterinary Authority	Iceland
Grete Hovelsrud - Camilla Risvoll	Nordland Research Institute	Norway
Juha Kantanen	Natural Resources Institute Finland	Finland
Anders Koch	State Serum Institute	Denmark
Gert Mulvad	University of Greenland	Greenland
Dieter Müller	Umeå University	Sweden
Maria Nesterenko	Northern (Arctic) Federal University named after M.V. Lomonosov	Russia
Anna Omazic	Swedish National Veterinary Institute	Sweden
Jan Åge Riseth	Northern Research Institute	Norway
Florian Stammler	University of Lapland	Finland
Birgitta Åhman	Swedish University of Agricultural Sciences	Sweden

These experts are referred to as "CLINF NCoE contact persons" (see Table 4); they recommended the following organisational themes to be covered as being potentially vulnerable to CSIs':

-Human health and veterinary medicine

-Governmental authorities: health, food safety, and environment

-Reindeer herding, Sami, and other indigenous people

-Municipalities of the North

-Tourism companies

In the next step, the CLINF NCoE contact persons were asked to exemplify each of the suggested organisational themes with sample organisations. This leads to actual data collection where, in the first step, CLINF NCoE contact persons provided the CLINF project with a number of stakeholder organisations according to their best knowledge and individual field of expertise. This first step of actual data acquisition may be considered as being the *qualitative* part of the sampling procedure, and was complemented by expert interviews with the purpose of estimating the strength of network associations. Since this requires information that is far from common, held by a handful of experts, the methodological assumptions of *judgmental sampling* are fulfilled. Since there is no standardized sampling frame available for stakeholder organisations, expert judgment seemed the only feasible way of receiving information regarding the intrinsic characteristics of the CLINF stakeholder network.

In the second *quantitative* step of sampling the generic network, the CLINF NCoE contact persons were asked to provide an estimate for the collaborative associations across their suggested stakeholder organisations. The process of identifying estimates regarding associative strength was supported by usage of close-ended survey questions. The advantages of allowing both an easy response for the interviewee and standardized data processing made this measurement technique the most feasible, especially taking into account information simplicity in combination with large amounts of requested information (Glasow, 2005).

Every CLINF NCoE contact person was asked to estimate the strength of collaborative associations between all stakeholders on a visual analogue scale (VAS) ranging from 1 to 10. The survey was conducted by using a correlation matrix implemented in an interactive Excel sheet. This format was suitable because it is easy to interpret for the respondent, but also easy to export into feasible data formats for further use with statistical and geographic software. The wording of the Excel questionnaire emphasized "collaboration" as referring to "a process of joint

decision-making among key stakeholders" of a "certain domain of shared interests", where the collaborative process aims at "the future evolution of their collaborative domain" (Gray, 1989; p.11). Less abstractly speaking, our definition of "collaboration" may be interpreted as the quantifiable degree of administrative interaction across two organisational institutions.

3.2 Statistical analysis

The algorithms implemented in the respective software packages of STATISTICA[8] and Gephi[9] differ with respect to their statistical approach to determining structures (such as clusters) in sample data. Gephi estimates structures with help of a modularity statistic that groups individual nodes[10] according to their shared characteristics. The overall network measures by which the modularity clustering statistics algorithm combines single nodes with similar characteristics are i.e.: diameter[11], average path length[12], eccentricity[13], edge betweenness[14], centrality[15] and how single nodes are individually connected to the entire network (Cherven, 2015).

In order to detect clustered groups of stakeholder organisations, the network was partitioned into communities of densely connected nodes, whereas nodes that belonged to different communities indicated just a weak linkage (Blondel *et al*., 2008). The quality of community detection algorithms is measured by the modularity of the partition. This modularity of partition is expressed by a scalar value ranking between -1 and 1 that measures the density of inside the community directed links in ratio to the inter-community links. (Girvan *et al*., 2002; Newman,

8. STATISTICA is an analytics software package; ver. 13 software.
9. Gephi is an open source software for analyzing and displaying networks graphically (Bastian *et al*., 2009).
10. Nodes: term for i.e. actors, sample elements or subjects in the network data (Hanneman *et al.*, 2005).
11. Diameter "maximum number of connections required to traverse a graph" (Cherven, 2015; p.182).
12. Average path length "provides a measure of communication efficiency for an entire network, by measuring the shortest possible path between all nodes in a network" (Cherven, 2015; p.183).
13. Eccentricity "refers to the number of steps required for an individual node to cross the network. [...] Eccentricity can help provide some context to assess the relative position and influence of nodes within a network" (Cherven, 2015; p.183).
14. Edge betweenness "provides a glimpse into how often specific edges reside within shortest paths between network nodes" (Cherven, 2015; p.185).
15. Centrality "provides i.e. information on how central a specific node is relative to the entire network" (Cherven, 2015; p.185).

2006). Given that the present network is a weighted network[16], the modularity of partition can be defined as (Newman, 2004):

$$Q = \frac{1}{2m}\sum_{i,j}\left[A_{ij} - \frac{k_i k_j}{2m}\right]\delta(c_i, c_j),$$

...where A_{ij} is the weight of the edge between i and j, and where $k_j = \sum_j A_{ij}$ represents the sum of weights of the edges attached to the vertex i; c_i stands for the community that the vertex i is assigned to, and δ(u,v) has the value 1 if u = v and otherwise the value 0; $m = \frac{1}{2}\sum_{ij} A_{ij}$ (Newman, 2004).

The analysis in STATISTICA utilizes the correlation matrix to perform a standard principal components analysis (PCA) where organisational clusters are defined as having a significantly stronger within-group correlation as compared with the correlation across groups (Everitt *et al*., 2001; Abdi *et al*., 2010). With PCA, organisational clusters were identified and characterized with respect to their unique organisational profile. Gephi utilizes binomial associations, whereas STATISTICA works with correlations in order to estimate network statistics. Binomial associations assess the general relationship between two variables, whereas correlations measure the strength of the relationship between two variables. The necessity of utilizing both methods is motivated by combing the benefits of different statistical approaches to explain relationships between statistical variables and test for empirical patterns in the data.

3.2.1 Social network analysis and visualization with Gephi software

Networks provide a natural way to display social (Mislove *et al.*, 2007) or information (Flake *et al*., 2000) systems. For a variety of reasons (Yang *et al*., 2012), nodes in these networks may organize into closely linked groups, referred to as clusters or network communities (Girvan *et al*., 2002). Clustered data can be divided into meaningful groups in accordance with some underlying "natural structure". This method is widely used in e.g. social science, biology, statistics, and data mining to understand and classify objects into groups according to commonly shared characteristics (Tan *et al*., 2005). A common procedure to isolate clusters from an undirected network, like the CLINF stakeholder network of organisations, is to use a scoring function, e.g. the modularity of partition, that quantifies to which degree communities correlate to densely linked node sets. In addition, a procedure can be applied in order to detect sets of nodes with high values of the

16. Weighted networks state the intensity of each interaction explicitly by a weight (Blondel *et al*., 2008).

scoring function, needed for the identification of clusters in networks (Karypis *et al*., 1998; Dhillon *et al*., 2007; Schaeffer *et al*., 2007; Fortunato, 2010)

The CLINF stakeholder network of organisations was statistically examined with respect to associative depth and associative clustering with Gephi software. These statistical characteristics are determined by applying different algorithms with Gephi. The algorithm "Force Atlas" was chosen for its suitability to display small to slightly larger datasets and examine associations and clustering. The algorithm is a classic force-directed approach using principles of repulsion, attractions, and gravity in order to supply a high degree of accuracy. It is commonly used for network discovery, -analysis and in order to measure network behaviours (Cherven, 2015). The partition of the stakeholders or nodes into clusters was carried out in a second step, after the visualization with the "Force Atlas" algorithm, by applying the above-mentioned modularity statistic on the network data. The partition of the stakeholder into clusters was supported by assigning different colours, depicting the belonging of each stakeholder to one of the clusters. All nodes were ranked according to their degree[17]-value, the size of each node corresponds to the importance of the respective stakeholder referring to this statistical parameter.

17. Degree: number of connections to other nodes

4 Results

4.1 CLINF stakeholder network analysis with Gephi

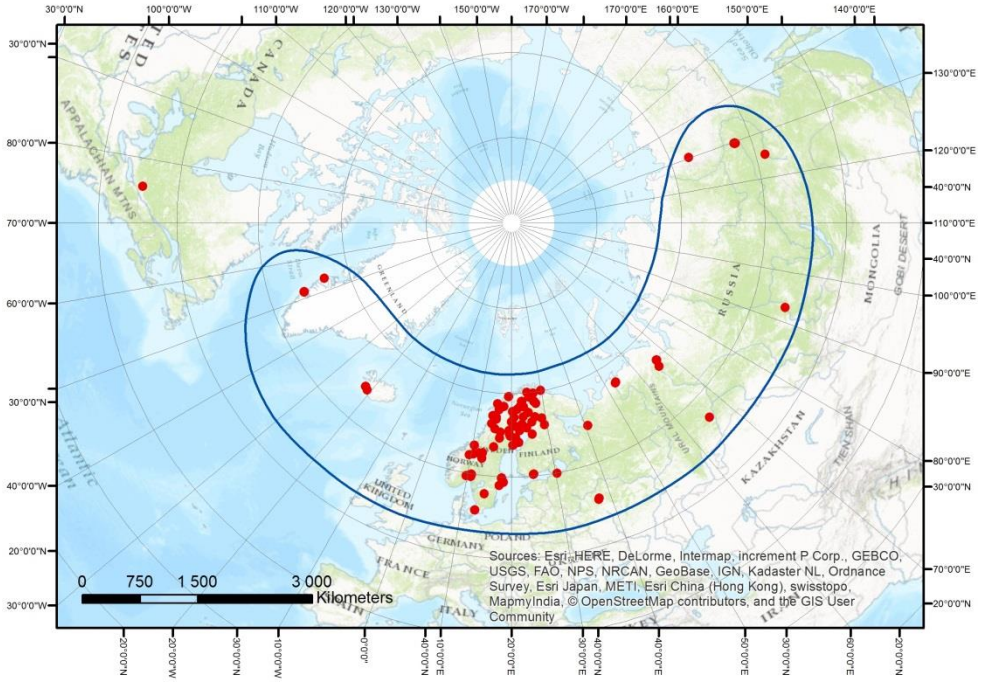

Figure 3. Northern distribution of CLINF stakeholders. Each red point refers to one or multiple CLINF stakeholder organisations. The blue line provides an approximate outline of the CLINF project area from Nuuk to Yakutsk.

The map in Figure 3 depicts the geographic distribution of the 146 CLINF stakeholder organisations addressed in this study, and illustrates the approximate borders of the project area. A number of Greenlandic organisations have close associations to the Inuit Circumpolar Council in Ottawa, Canada. For this reason, that stakeholder is part of the CLINF network even though the western boundary of the project area is actually represented by Greenland.

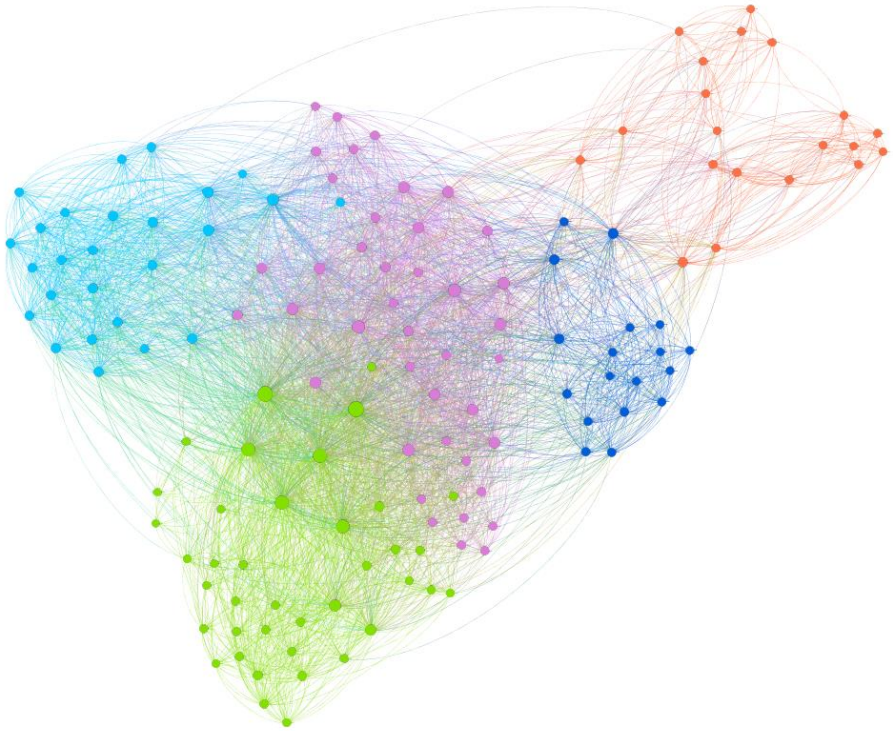

Figure 4. Visualization of CLINF stakeholder organisations with associative network and clustering. Each node is representing a single organisation, and the size of nodes is proportional to its number of associations to other organisations. Five main clusters, associative coordinates.

The network visualized in Figure 4 was mapped in accordance with collaborative associations across the CLINF network of stakeholder organisations, where each node corresponds to one organisation. The size of each node refers to its number of associations to other nodes in the network (degree value). With help of the modularity statistics, the network can be subdivided into five clusters. According to the calculations with Gephi, the CLINF stakeholder network has a modularity value of Q = 0.293. Commonly, 0.3 is considered the cut-off value for significant communality formation.

Cluster Legend:

Figure 5. Cluster 1.

Cluster 1:
The first cluster encountered could best be described as “Russian-dominated”, but links into a quite international group of organisations oriented towards public health issues. It mainly links to governmental health authorities, predominantly from Sweden, Island, and Greenland. Other organisations associated with this cluster are research institutions with a focus on medical sciences, diseases prevention, veterinary medicine, and Arctic sciences. It also includes the international Nordic collaboration panels Arctic Council and the Nordic Council of Ministers. The dominating country within this cluster is Russia. In terms of climate sensitive infections, it therefore seems like most associations from Russia to other nations are based on scientific collaboration.

Typical organisations:

- Scientific Research Centre of the Arctic (Salekhard)
- Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences
- State Scientific Centre of "Arctic and Antarctic Research Institute" (St. Petersburg)

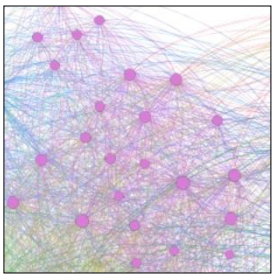

Figure 6. Cluster 2.

Cluster 2:
The second cluster may be interpreted as an indigenous and reindeer organisational group mainly situated in Finland. It consists of local/international associations with a focus on reindeer herding and meat production, Sami and other indigenous people, as well as scientific institutions specialized on indigenous people and reindeer herding (Finland, Russia, Norway). Nation-wise, this cluster is dominated by Finland, where the most common connections relevant for CLINF seem to be based on institutions dedicated to the Sami culture, reindeer herding and governmental health and food safety authorities.

Typical organisation:

- Sami Education Institute Inari, Finland
- Food Safety Authority, Finland (EVIRA)
- Sámi Cultural Centre Sajos

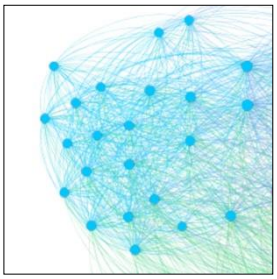

Figure 7. Cluster 3.

Cluster 3:
Like the second cluster encountered, this group can again best be described as related to Sami and reindeer interests, this time however with a strong Norwegian focus. It includes country related interest organisations and govermental authoritites dealing with reindeer herding, Sami issues, environmental issues, food safety, and agriculture. The focus lays upon interest organisations relating to land

use-, agriculture- and meat production like the Norwegian Farmers Union and Norwegian Agricultural Cooperatives. Further, the Norwegian and Swedish Interest organisations for hunting and fishing are also included. With regard to commercial activities by the Norwegian Sami, a clear hierarchical structure becomes visible: Beginning bottom-up with the local reindeer slaughter houses, it extends through the Norwegian reindeer pasture districts, the Reindeer Herders' Association of Norway (NRL), and all the way up to the Sami Parliament of Norway (SPR). Within the third cluster, Norway clearly dominates as a nation. It appears like its CLINF relevant connections primarily consist of Sami and reindeer herder interest institutions followed by the official health and agricultural agencies.

Typical organisations:

- Reindeer Herders' Association of Norway (NRL)
- Sami Parliament of Norway (SPR)
- Norwegian Food Safety Authority

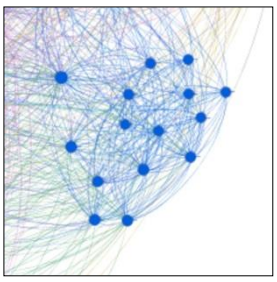

Figure 8. Cluster 4.

Cluster 4:
Much like a Swedish oriented combination of clusters 1 and 2, cluster 4 consists of reindeer meat production and processing industry, veterinary medicine, food safety authorities and Sami organisations. All nodes within this cluster are of Swedish origin. The country is hence represented foremost by Sami herder interest institutions and official authorities related to food, agriculture, and veterinary medicine. Analogous to the Norwegian dominated cluster 3, a clear hierarchical bottom-up structure seems to range from local reindeer slaughterhouses, through the Swedish Sami villages, the governmental institutions dealing with environmental protection and veterinary medicine, all the way up to the Sami Parliament of Sweden.

Typical organisations:

- National Association of Swedish Sami (SSR)
- Sami Parliament of Sweden
- Swedish Sami villages

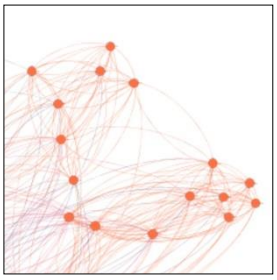

Figure 9. Cluster 5.

Cluster 5:
This cluster consists of tourism companies and one governmental co-operative body which is responsible for regional development. All depicted institutions within this cluster are Swedish. The branch of Tourism, which is potentially vulnerable to the CSI threat, has a higher relative distance from all of the other clusters. This may be interpreted as this group of organisations possesses few bilateral ties with other societal sectors.

Typical organisations:

- Swedish Lapland
- Region Västerbotten
- Kiruna Lappland

4.2 CLINF stakeholder analysis with STATISTICA

The "Plot of Eigenvalues" in Figure 10 visualizes the clustering of organisations into relatively independent functional groups that share organisational characteristics. When the plot levels off into a horizontal "scree", no unique information remains. It may, therefore, be concluded that the five functional groups found with Gephi makes sense, but also that an eight-factor solution, reflecting the existence of eight relatively independent functional groups, seems possible. The exact solutions depend on how the plot is interpreted.

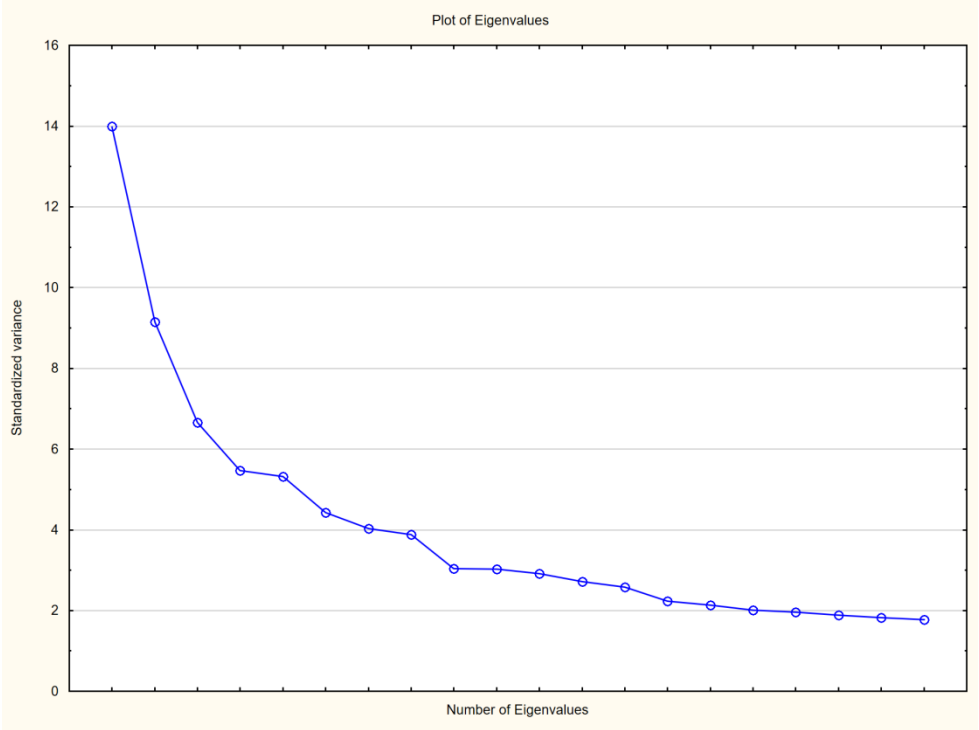

Figure 10. Plot of Eigenvalues from the CLINF stakeholder correlation matrix.

When the information received with the binomial Gephi approach, where five functional groups of organisations were identified, is added to the results of the PCA analysis, it may be concluded that a five-dimensional solution seems feasible. Hence, the original stakeholder matrix containing 146 organisations may be expressed in terms of five hierarchical organisational groups without too much loss of information. The so-called "ground-truthing[18]" of these groups reveals that the most important cluster, carrying approximately 14 % of the total information contained in the original matrix, mainly consists of research institutions with a focus on medical sciences, diseases prevention, veterinary medicine, and Arctic sciences. Russia seems to be the dominating country within this cluster. The second clus-

18. Ground-truthing: a method used to examine the extent to which various structural definitions of network communities correlate with real functional groups (Yang *et al*., 2012).

ter which is dominated by Norwegian organisations represents approximately 9 % of the total information contained in the original matrix. The third cluster represents mostly Finnish organisations connected to Sami culture, reindeer herding and governmental health and food safety authorities. This cluster represents approximately 7 % of the all the information of the original matrix. Cluster 4 is dominated by tourism organisations and cluster 5 refers to foremost Greenlandic organisations, both clusters carry about 5 % of the total information contained in the original matrix.

Another analysis performed with STATISTICA is a tree clustering analysis where a dendrogram was computed that displays correlated groups by single linkage clustering[19] based on the 1-Pearson r correlation. This analysis provides a hierarchical clustering technique, which enables the investigator to obtain the most important clustering partitions from the entirety of all variables (of all sample organisations).

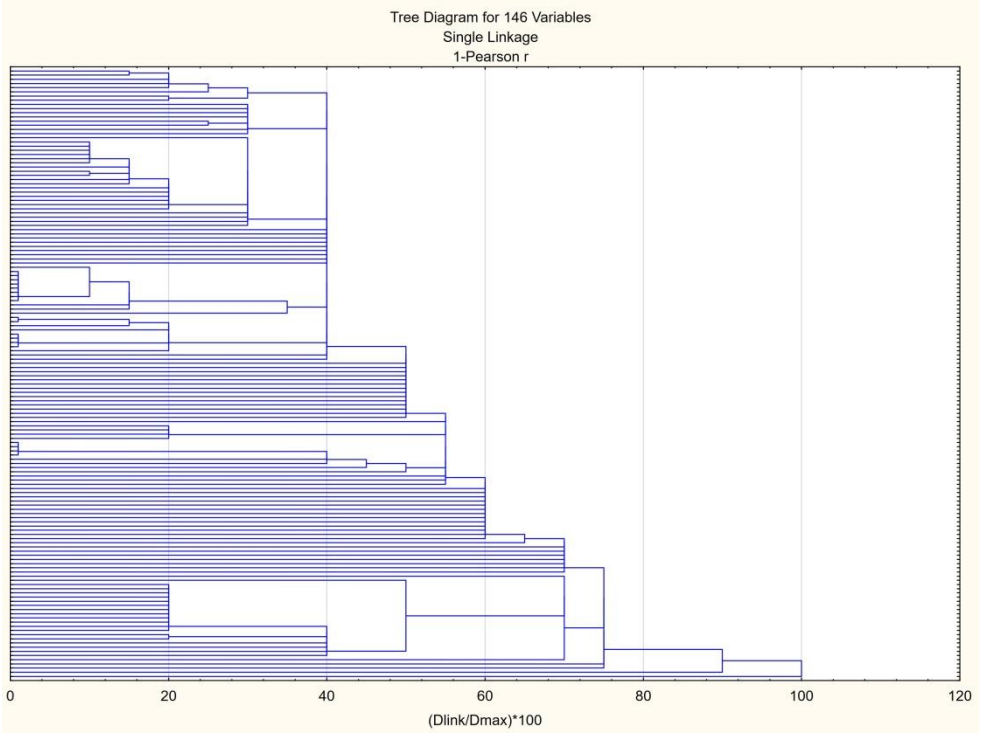

Figure 11. Dendrogram of the 146 Variables based on single linkage clustering with 1-Pearson r.

The 1-Pearson r tree diagram in Figure 11 shows that there are approximately five to six more or less distinguishable clusters found in the original matrix of stakeholders. These results introduce additional verification value to the results discussed above. The dendrogram displays the different correlation levels in a gradu-

19. Single linkage clustering: clustering technique based on the smallest of all pairwise dissimilarities between two clusters (Everitt *et al*., 2001).

al manner, the first level to the left shows all stakeholder organisations that are most correlated with each other. At the level Pearson's r = 0.8, the tree diagram presents five individual clusters, whereas six clusters appear when r = 0.7. An analysis of the six-factor solution reveals that there is little difference in the group characteristics, the five-factor solution shows a more distinguishable outline of each individual cluster and is therefore assumed to describe the network with both the least amount of interference and yet the most necessary attributes. Although it may be stated that striving for the correct number of groups is not a straightforward procedure, often times an examination of the different fusion levels in the referred tree diagram can be utilized to realize appropriate partition (Everitt *et al*., 2001).

Cluster composition with STATISTICA

Table 5. Selection of typical Stakeholder organisations assigned to the five clusters by a factor-analysis with STATISTICA.

Cluster	Typical organisations
1	Scientific Research Center of the Arctic (Salekhard); State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg); Research Institute of Medical Problems of the North; Ministry of Healthcare of the Russian Federation
2	County Governor of Nordland; Norwegian Food Safety Authority; Norwegian Agricultural Authority; Norwegian reindeer pasture districts
3	Sami Education Institute Inari, Finland; Finnish Reindeer Herders' Association; Sámi Cultural Center Sajos, Food Safety Authority, Finland (EVIRA); International Centre for Reindeer Husbandry (ICR)/ Association of World Reindeer Herders
4	Swedish Lapland; Heart of Lapland; Pajala tourism and events (Pajala Turism och Evenemang); HaparandaTornio tourist office
5	Greenland Center for Health Research (GCHR); Board of Agency for Health and Prevention (Greenland); Queen Ingrid's Hospital, Nuuk; Danish Medical Association

Table 5 shows a selection of stakeholder organisations which were assigned to each of the five clusters by a factor analysis with STATISTICA software. The order of the stakeholders within each cluster is determined according to the factor loadings[20] values.

Results comparison: Gephi and STATISTICA

The characteristics of the first principal component identified with PCA, which is representing 14 % of the total information content of the original stakeholder matrix, can be described as being very similar to the results of the analysis of binomial associations conducted with Gephi. The stakeholders associated with this first cluster seem similar irrespective of the method of analysis. The second and third cluster computed with STATISTICA corresponds to the third and second clusters

20. Factor loadings: refers to the degree of association between factors and variables (Fox, 2010).

in Gephi. And cluster 4 from the STATISTICA statistics refers to cluster 5 in the Gephi analysis. However, the composition of these clusters seems also, in this case, similar irrespective of the applied method. The remaining cluster 4 (Gephi) and 5 (STATISTICA) was associated with different stakeholders depending on the method. Results based on STATISTICA suggest a cluster associated with mainly Greenlandic organisations, whereas an analysis with Gephi recommends a composition predominated by Swedish organisations.

The factor analysis (principal components in combination with Varimax rotation) performed in STATISTICA adds the possibility of ranking clusters to the results found with Gephi algorithms. This is an important addition to the overall results, where it may be claimed that the STATISTICA Cluster 1 dominates by terms of information content, STATISTICA Cluster 2 comes second, and so on. "Information content" is measured as the proportion of information as compared with the total information content kept in the original matrix of all 146 sample organisations.

An analysis and comparison of both a five and six-factor solution with Gephi and STATISTICA was conducted. See Appendix A for more details about the CLINF stakeholder cluster allocation. The high value for Pearson's r for five clusters in the dendrogram, the consequential high coefficient of determination (R^2) and the results of the "Plot of Eigenvalues", computed with STATISTICA, suggest a five-cluster solution for the stakeholder network. These findings also verify the five clusters that were identified with Gephi, even though the result for the modularity value calculated with Gephi indicates a marginal case of significance. In addition, as pointed out above, with help of the factor analysis performed with STATISTICA, the Gephi clusters may now be ranked with respect to their information content.

5 Discussion

Justification of the five-cluster solution

The analyses conducted in both Gephi and STATISTICA may be interpreted as suggesting a five-cluster solution for the generic CLINF stakeholder network. This means that the five-cluster solution balances between describing the stakeholder network with an acceptable amount of distortion while providing an acceptable level of detail. The "Plot of Eigenvalues" indicates a transition between a five- and six-cluster solution, which was followed up with a six-factor computation in Gephi as well as in STATISTICA. This allowed a comparison between solutions where differences in cluster composition were examined. In the case of the Gephi based analysis, an additional cluster would largely lead to the separation of Finnish institutions from cluster 2. However, the characteristics of this additional sixth Finnish dominated cluster appear to be rather redundant as compared with other clusters. A six-factor solution computed with STATISTICA would lead to the formation of a cluster that is foremost associated with Swedish organisations. In terms of composition would this cluster correspond to the Swedish dominated cluster 4 in the five-cluster version of the Gephi analysis. This fact is useful to consider when arguing for the establishment of a possible pan-northern CSI organisation, but is not likely to justify a sixth cluster by itself. The higher value for Pearson's r, the coefficient of determination, and the results of the "Plot of Eigenvalues" conducted with STATISTICA, indicate that five clusters describe the distribution of the CLINF stakeholder organisations into functional groups more precisely than six or any other number of clusters.

Characteristics of inter-stakeholder connections

The analysis of the CLINF stakeholder network seems to indicate that the CLINF project-relevant connections between all individual countries are distributed among different societal sectors. This means that some countries' associations with other countries are based foremost on e.g. science, whereas other countries connect via e.g. governmental authorities or other sectors. This could be interpreted as if there is a potential for improved collaboration among the different CLINF-relevant sectors through which the countries may be connected.

Cluster interpretation and vision - CLINF stakeholder network

The results from STATISTICA seem to indicate a better fit for the allocation of the clusters than the approach conducted with Gephi. Hence, larger emphasis may be placed upon the STATISTICA-based apportionment of potential CLINF stakeholder organisations for each of the five clusters. Further, both five-cluster versions differ only in the way that STATISTICA-based computations suggest a cluster with mostly Greenlandic organisations where Gephis' approach instead identifies a Swedish dominated cluster. In other words, the apportionments of stakeholder organisations to the five clusters correspond mostly with each other regardless of the method applied.

The cluster analysis suggests that there already exists international collaboration in the fields of governmental health authorities and certain research institutions with a focus on medical sciences, disease prevention, veterinary medicine, and Arctic Sciences. Furthermore, organisations associated with local/international reindeer herding and meat production, Sami and other indigenous people, and scientific institutions specialized on indigenous people and reindeer herding, seem to be considerably well connected across country boarders. In contrast with this, organisations engaged with land use-, agriculture- and meat production, as well as superordinate health-surveillance authorities and Sami associations appear to be highly country dependent, not the least in the cases of Norway and Sweden. In these sectors, international networking between different country-specific stakeholder organisations seem to exhibit potential for improvement. In addition, Greenlandic institutions and organisations associated with tourism seem to be rather isolated from other CLINF stakeholder organisations.

An improvement of communication across all organisations that are potentially threatened by emerging CSIs' could be realized by establishing a northern overarching organisation built in accordance with the cluster patterns identified in the current study. If and when such an organisation is designed, member organisations from each of the identified clusters should be invited to participate where each cluster should be represented by the respective organisations that have maximum associative depth[21].

Such an organisation could serve the purpose of designing supra-national CSI mitigation management plans and, additionally, implement early warning systems across the North. Besides an overarching management plan for all CSI stakeholder organisations, differentiating management plans in accordance with the thematic characteristics of individual clusters could also prove meaningful. Other multi-stakeholder networks, like the project for global public-policy (GPP)

21. Associative depth refers to the number of connections to other organisations.

(http://www.gppi.net/home/) promoted by the United Nations, have proven to provide powerful tools for collaborative actions in several complex cases (Streck, 2002; Reinicke *et al*., 2000). Another option could be to apply the approach of the Global Systems Science (http://global-systems-science.eu/) to a supra-national CSI organisation, where cross-scale issues are tackled with a trans-disciplinary approach (Helbing, 2013). Analogous to the principles of the GPP and Global Systems Science, a pan-northern CSI organisation could very well integrate stakeholders from different societal sectors and sciences in combination with the research findings of the CLINF NCoE, in order to face CSI threats and their complexity with multi-sector and cross-border collaboration.

Evengård *et al*. (2015) stresses that the Arctic is best served by transnational programs for monitoring, data collection, and surveys due to its size and partial inaccessibility. Especially in the field of human health are already well-structured networks in place in the Arctic and high North (Evengård *et al*., 2015). However, at present there is still no pan-northern organisation in place to meet the emerging CSI-threats. Such an organisation may represent a unique voice of aggregated interests and connect to policy makers all across the North.

6 Limitations of the study

Missing values and zeros in the correlation/association matrix
The methodical and statistical correct way of handling differences between lacking information regarding the eventual collaboration between two stakeholders (missing values = N/A) and an approved absence of this collaboration (no collaboration = zero association) would be to use different codes for either one of them. For reasons of practicability, both cases have been combined to remain zero in the corresponding matrix cell. As a consequence, some associations are accounted for as being logically zero, although, in fact, the respondents were just unsure or had not enough information for a sufficient evaluation. The resulting error is considered to be marginal.

Different association estimates
In the cases where different respondents provided different estimates of associative correlations across pairwise CLINF stakeholder organisations, the estimates were arithmetically averaged prior to statistical processing.

Possible data bias
One important factor in the interpretation of the results achieved in the current study is to evaluate the sources of possible biases in the processes of measurement, analysis, and design. One such first-kind bias may emanate from different behaviours of the interviewed expert subjects. With the judgmental sampling design, the organisational associations were subjectively estimated which means that the depth of knowledge regarding the issues asked for vary from one respondent to another, and that there really doesn't exist any method of controlling the resulting bias. This bias introduces the possibility for some stakeholder organisations to be overrepresented. As an example, some Russian and Finnish stakeholder organisations received high associative ranks as a result of possible overrepresentation. This adds to the error that surrounds all empirical science results that are statistically inferred, and that needs to be considered when the results are interpreted.

Another potential source of error concerns analytical bias related to arbitrariness in defining boundaries between clusters. The input network data was examined for clustering with three complementary statistical approaches in order to evaluate the convergence or results. While the tree-clustering dendrogram coincided very well with the results derived in Gephi, the factor analysis produces many options of interpretation whereof the five-factor solution is one. This leaves some uncertainty regarding the actual information content of individual clusters (of individual principal components) that need to be considered through the evaluation of results.

7 Conclusions

- The inferred sample of 146 CSI stakeholder organisations from Nuuk to Yakutsk can be best described by 5 relatively independent organisational clusters, each carrying unique characteristics. It is suggested that the generic population of CSI stakeholder organisations possess similar clustering characteristics.

- In parts, the observed network of CSI stakeholder organisations appears to be country-dependent by multiple criteria. Even though clusters also indicate strong international associations, it seems like many CSI organisations exhibit a potential for strengthened international associations.

- The results of the performed analysis enable an identification of the CSI stakeholder organisations that are best suited to represent the identified clusters if and when a pan-northern organisation is constituted to meet the climate-induced CSI threats. Each cluster should be represented by the respective organisations that have maximum intra-cluster associative depth.

- The strength of international administrative relations is inhomogenously distributed across the studied stakeholder organisations, and seems to depend on cluster characteristics. There is, therefore, potential for international homogenisation across CLINF stakeholder organisations, perhaps by means of improved collaboration and communication.

8 Acknowledgements

I want to thank my supervisor Tomas Thierfelder from the Swedish University of Agriculture Sciences for his support throughout this thesis. Thank you for introducing me with projects, international conferences and contacts into the scientific community, which broadened my horizons and also helped to adapt my thesis to the special needs of the CLINF scientific project. Your enthusiasm, guidance with statistical questions and help with the everyday challenges of my thesis have been invaluable for the development of this work.

I also wish to thank Birgitta Evengård from the Umeå University, Anna Omazic and Ann Albhin from the Swedish National Veterinary Institute for their numerous thematic contributions and development ideas for my thesis. Thank you for your help, also regarding the selection of experts and organisations that were needed to cover the purpose of this project.

Furthermore, would we, I and CLINF like to express our gratitude to all experts that enthusiastically engaged in answering very difficult questions regarding the selection of stakeholders and their associations across all CLINF stakeholder organisations.

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Appendix A – CLINF stakeholder clustering allocation

The tables in Appendix A contain information about the CLINF stakeholder allocation for the 5 and 6 cluster version that were computed both with Gephi and STATISTICA software. The listed values represent the ten stakeholder organisations with the highest scoring values (STATISTICA: factor loadings; Gephi: degree value) for each cluster. For each of the clusters the organisations are arranged in descending order according to their importance expressed by the factor loadings- or respective degree value. This arrangement of CLINF stakeholder organisations is meant to provide information about which ten stakeholders have maximum associative depth for each particular cluster and cluster version.

Factor loadings (Varimax raw) for CLINF stakeholder matrix (STATISTICA)

The ten stakeholders with the highest scoring factor loadings value for each of the five clusters allocated with STATISTICA software are presented in Table 1.

Table 1. *Factor loadings (Varimax raw) for CLINF stakeholder matrix. Presentation of the ten stakeholders with the highest scoring factor loadings value per cluster, five cluster version.*

Stakeholder	Cluster	Factor Loadings
Scientific Research Center of the Arctic (Salekhard)	1	1,098346
State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg)	1	1,067746
Research Institute of Medical Problems of the North	1	1,059266
Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences	1	1,042032
Institute of Humanitarian Research and Indigenous Peoples of the North of SB RAS	1	0,966639
Northern (Arctic) Federal University named after MV Lomonosov	1	0,946917
Yakut Scientific Center of Complex Medical Problems	1	0,857068
Tyumen Research Institute of Regional Infectious Pathology	1	0,791880
Russian Association of Indigenous Peoples of the North, Siberia and Far East (RAIPON)	1	0,701492
Ministry of Healthcare of the Russian Federation	1	0,687953

Stakeholder	Cluster	Factor Loadings
County Governor of Nordland	2	-1,02324
Norwegian Food Safety Authority	2	-0,89037
Norwegian Agricultural Authority	2	-0,83410
Norwegian reindeer pasture districts	2	-0,83362
Norwegian Ministry of Agriculture and Food	2	-0,73115
Association of Norwegian Sheep and Goat Farmers	2	-0,72769
Norwegian Nature Inspectorate (SNO)	2	-0,70014
Norwegian Environment Agency	2	-0,67597
Municipality of Saltdal	2	-0,66114
Norwegian Farmers and Smallholders Union	2	-0,65776
Sami Education institute Inari, Finland	3	0,920532
Municipality of Inari	3	0,745201
Municipality of Utsjoki	3	0,698361
Municipality of Enontckiö	3	0,690534
Finnish Reindeer Herders' Association	3	0,624226
Sámi Cultural Center Sajos	3	0,616480
Utsjoen reindeer slaughterhouse	3	0,601086
Finnish reindeer herding communities	3	0,592909
Siida – The National Museum of the Finnish Sámi	3	0,578358
Sallan reindeer slaughterhouse	3	0,550257

Stakeholder	Cluster	Factor Loadings
Swedish Lapland	4	1,182519
Heart of Lapland	4	0,723751
Pajala tourism and events (Pajala Turism och Evenemang)	4	0,694160
Överkalix development (Överkalix Utveckling AB)	4	0,671317
HaparandaTornio tourist office	4	0,659216
Visit Gellivare Lapland	4	0,591670
Destination Jokkmokk	4	0,519311
Arvidsjaur in Swedish Lapland	4	0,517791
Kiruna Lappland	4	0,507076
Visit Luleå	4	0,469561
Greenland Center for Health Research (GCHR)	5	-1,04279
Board of Agency for Health and Prevention (Greenland)	5	-0,91946
Queen Ingrids Hospital, Nuuk	5	-0,87057
Chief Medical Officer, Greenland	5	-0,84619
Greenland's Medical Research Council	5	-0,62112
Greenland's Nutrition Council	5	-0,59968
Greenland Institute of Natural Resources (GINR)	5	-0,46226
Danish Medical Association	5	-0,42777
Circumpolar Health Research Network (CHRN)	5	-0,42160
Greenland's Research Council	5	-0,41405

The ten stakeholders with the highest scoring factor loadings value for each of the six clusters allocated with STATISTICA software are presented in Table 2.

Table 2. *Factor loadings (Varimax raw) for CLINF stakeholder matrix. Presentation of the ten stakeholders with the highest scoring factor loadings value per cluster, six cluster version.*

Stakeholder	Cluster	Factor Loadings
Scientific Research Center of the Arctic (Salekhard)	1	1,097166
State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg)	1	1,064730
Research Institute of Medical Problems of the North	1	1,059852
Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences	1	1,040360
Institute of Humanitarian Research and Indigenous Peoples of the North of SB RAS	1	0,966045
Northern (Arctic) Federal University named after MV Lomonosov	1	0,945952
Yakut Scientific Center of Complex Medical Problems	1	0,858479
Tyumen Research Institute of Regional Infectious Pathology	1	0,793013
Russian Association of Indigenous Peoples of the North, Siberia and Far East (RAIPON)	1	0,699905
Ministry of Education and Science of the Russian Federation	1	0,687916
County Governor of Nordland	2	-1,02327
Norwegian Food Safety Authority	2	-0,89031
Norwegian Agricultural Authority	2	-0,83407
Norwegian reindeer pasture districts	2	-0,83391
Norwegian Ministry of Agriculture and Food	2	-0,73115
Association of Norwegian Sheep and Goat Farmers	2	-0,72760
Norwegian Nature Inspectorate (SNO)	2	-0,70008
Norwegian Environment Agency	2	-0,67597
Municipality of Saltdal	2	-0,66120
Norwegian Farmers and Smallholders Union	2	-0,65767

Stakeholder	Cluster	Factor Loadings
Sami Education institute Inari, Finland	3	0,949162
Municipality of Inari	3	0,768266
Municipality of Utsjoki	3	0,718433
Municipality of Enontckiö	3	0,711261
Sámi Cultural Center Sajos	3	0,656918
Finnish Reindeer Herders' Association	3	0,621033
Siida – The National Museum of the Finnish Sámi	3	0,616552
Finnish reindeer herding communities	3	0,580469
Utsjoen reindeer slaughterhouse	3	0,573261
Sallan reindeer slaughterhouse	3	0,522446
Swedish Lapland	4	1,183219
Heart of Lapland	4	0,725712
Pajala tourism and events (Pajala Turism och Evenemang)	4	0,695465
Överkalix development (Överkalix Utveckling AB)	4	0,672715
HaparandaTornio tourist office	4	0,661422
Visit Gellivare Lapland	4	0,592294
Destination Jokkmokk	4	0,520387
Arvidsjaur in Swedish Lapland	4	0,518112
Kiruna Lappland	4	0,506572
Visit Luleå	4	0,470620

Stakeholder	Cluster	Factor Loadings
Greenland Center for Health Research (GCHR)	5	-1,05183
Board of Agency for Health and Prevention (Greenland)	5	-0,92550
Queen Ingrids Hospital, Nuuk	5	-0,87982
Chief Medical Officer, Greenland	5	-0,85037
Greenland's Medical Research Council	5	-0,62479
Greenland's Nutrition Council	5	-0,60236
Greenland Institute of Natural Resources (GINR)	5	-0,46391
Danish Medical Association	5	-0,43056
Circumpolar Health Research Network (CHRN)	5	-0,42582
Greenland's Research Council	5	-0,41719
Swedish National Veterinary Institute	6	0,996616
Swedish University of Agricultural Sciences	6	0,724731
National Food Agency, Sweden	6	0,701041
Swedish Farm and Animal Health Service	6	0,668741
Swedish Board of Agriculture	6	0,648128
Food Safety Authority, Finland (EVIRA)	6	0,504131
Natural Resources Institute Finland (Luke)	6	0,366611
Grundnäs reindeer slaughterhouse (Grundnäs Kött AB)	6	0,336539
Arvidsjaurs reindeer slaughterhouse	6	0,331388
Idre Sami village (Idre nya sameby)	6	0,313011

Clustering allocation for CLINF stakeholder matrix (Gephi)

The ten stakeholders with the highest degree values for each of the five clusters computed with Gephi software are presented in Table 3. The allocation of the five clusters was based on modularity statistics.

Table 3. *Clustering allocation for CLINF stakeholder matrix computed with Gephi software. Presentation of the ten stakeholders with the highest degree values for each cluster, five cluster version.*

Stakeholder	Cluster	Degree value
Scientific Research Center of the Arctic (Salekhard)	1	248
Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences	1	242
Institute of Humanitarian Research and Indigenous Peoples of the North of SB RAS	1	200
Northern (Arctic) Federal University named after MV Lomonosov	1	196
State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg)	1	194
Research Institute of Medical Problems of the North	1	175
Yakut Scientific Center of Complex Medical Problems	1	116
Tyumen Research Institute of Regional Infectious Pathology	1	112
Arctic Council	1	66
Chief Medical Officer, Greenland	1	57

Stakeholder	Cluster	Degree value
Sami Education institute Inari, Finland	2	154
Food Safety Authority, Finland (EVIRA)	2	154
Ministry of Healthcare of the Russian Federation	2	142
Siida - The National Museum of the Finnish Sámi	2	126
Sámi Cultural Center Sajos	2	123
National Institute for Health and Welfare , Finland	2	122
Municipality of Inari	2	118
Natural Resources Institute Finland (Luke)	2	118
Municipality of Utsjoki	2	112
Municipality of Enontekiö	2	112
Norwegian reindeer pasture districts	3	122
Reindeer Herders' Association of Norway (NRL)	3	114
Sami Parliament of Norway (SPR)	3	96
Municipality of Saltdal	3	75
NORD University	3	73
Norwegian Food Safety Authority	3	71
Norwegian Environment Agency	3	71
County Governor of Nordland	3	70
Nordland County Municipality	3	69
Norwegian Ministry of Agriculture and Food	3	69

Stakeholder	Cluster	Degree value
Swedish Sami villages	4	96
National Association of Swedish Sami (SSR)	4	87
Sami Parliament of Sweden	4	82
National Food Agency, Sweden	4	55
Swedish Board of Agriculture	4	49
Swedish National Veterinary Institute	4	49
Swedish University of Agricultural Sciences	4	49
Grundnäs reindeer slaughterhouse (Grundnäs Kött AB)	4	41
Swedish Farm and Animal Health Service	4	41
Swedish Environmental Protection Agency	4	41
Swedish Lapland	5	66
Region Västerbotten	5	43
Kiruna Lappland	5	38
Heart of Lapland	5	38
HaparandaTornio tourist office	5	37
Destination Jokkmokk	5	31
Gold of Lapland	5	31
County Administrative Board of Västerbotten	5	30
Arvidsjaur in Swedish Lapland	5	28
Överkalix development (Överkalix Utveckling AB)	5	26

The ten stakeholders with the highest degree values for each of the six clusters computed with Gephi software are presented in Table 4. The allocation of the 6 clusters was based on modularity statistics.

Table 4. *Clustering allocation for CLINF stakeholder matrix computed with Gephi software. Presentation of the ten stakeholders with the highest degree values for each cluster, six cluster version.*

Stakeholder	Cluster	Degree value
Institute of Ecological Problems of the North, Ural Branch of the Russian Academy of Sciences	1	242
Institute of Humanitarian Research and Indigenous Peoples of the North of SB RAS	1	200
Northern (Arctic) Federal University named after MV Lomonosov	1	196
State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg)	1	194
Research Institute of Medical Problems of the North	1	175
Yakut Scientific Center of Complex Medical Problems	1	116
Tyumen Research Institute of Regional Infectious Pathology	1	112
Arctic Council	1	66
Chief Medical Officer, Greenland	1	57
Greenland Center for Health Research (GCHR)	1	56
Sami Education institute Inari, Finland	2	154
Food Safety Authority, Finland (EVIRA)	2	154
Ministry of Healthcare of the Russian Federation	2	142
Siida - The National Museum of the Finnish Sámi	2	126
Sámi Cultural Center Sajos	2	123
Russian Association of Indigenous Peoples of the North, Siberia and Far East (RAIPON)	2	111
Ministry of Education and Science of the Russian Federation	2	110
Yakutsk State Agricultural Academy	2	103
Norwegian Sami Association (NSR)	2	76
Northern Research Institute Narvik	2	60

Stakeholder	Cluster	Degree value
National Institute for Health and Welfare , Finland	3	122
Municipality of Inari	3	118
Natural Resources Institute Finland (Luke)	3	118
Municipality of Utsjoki	3	112
Municipality of Enontekiö	3	112
International Centre for Reindeer Husbandry (ICR)/ Association of World Reindeer Herders	3	110
Saami Council	3	80
Finnish reindeer herding communities	3	64
Finnish Reindeer Herders' Association	3	60
Kittilän reindeer slaughterhouse	3	60
Norwegian reindeer pasture districts	4	122
Reindeer Herders' Association of Norway (NRL)	4	114
Sami Parliament of Norway (SPR)	4	96
Municipality of Saltdal	4	75
NORD University	4	73
Norwegian Food Safety Authority	4	71
Norwegian Environment Agency	4	71
County Governor of Nordland	4	70
Nordland County Municipality	4	69
Norwegian Ministry of Agriculture and Food	4	69

Stakeholder	Cluster	Degree value
Scientific Research Center of the Arctic (Salekhard)	5	248
Swedish Sami villages	5	96
National Association of Swedish Sami (SSR)	5	87
Sami Parliament of Sweden	5	82
National Food Agency, Sweden	5	55
Swedish University of Agricultural Sciences	5	49
Swedish National Veterinary Institute	5	49
Swedish Board of Agriculture	5	49
Grundnäs reindeer slaughterhouse (Grundnäs Kött AB)	5	41
Swedish Farm and Animal Health Service	5	41
Swedish Lapland	6	66
Region Västerbotten	6	43
Heart of Lapland	6	38
Kiruna Lappland	6	38
Haparanda Tornio tourist office	6	37
Destination Jokkmokk	6	31
Gold of Lapland	6	31
County Administrative Board of Västerbotten	6	30
Arvidsjaur in Swedish Lapland	6	28
Överkalix development (Överkalix Utveckling AB)	6	26

Appendix B

List of all examined CLINF stakeholder organisations

with all due reservations for incorrect naming and/or spelling

Indigenous reindeer herder organisations:

Sami Education Institute, Inari, Finland
International Centre for Reindeer Husbandry (ICR)/ Association of World-Reindeer Herders
Swedish Reindeer Herding Communities
Norwegian reindeer pasture districts
Finnish reindeer herding communities
Sami Parliament of Finland
National Association of Swedish Sami
Sami Parliament of Norway (SPR)
Reindeer Herders' Association of Norway (NRL)
Saami Council
Norwegian Sami Association (NSR)
Sami Parliament of Sweden
Finnish Reindeer Herders' Association
Union of Indigenous Peoples communities of the Republic of Sakha-(Yakutia)
Soyuz nomadic communities of Yakutia
Reindeer Herders' Union of Republic of Sakha (Yakutia)
Yasavey Association
Union of (Nenet) Reindeer Herders of NAO
Association of "Yamal Descendants"
Department of Indigenous Peoples YaNAO
Herders' union YaNAO

Municipal organisations:

Municipality of Saltdal
Municipality of Utsjoki
Municipality of Inari
Municipality of Enontekiö
Queen Ingrids Hospital, Nuuk
County Administrative Board of Västerbotten
County Administrative Board of Norrbotten
Kiruna Municipality

Region Västerbotten
Nordland County Municipality
Troms County Municipality
Finnmarks County Municipality
Administration hatyrykskogo nasleg municipality “Namsky region”-
of the Republic of Sakha (Yakutia)

General advocacy groups:

Norwegian Association of Hunters and Anglers
Swedish Association for Hunting and Wildlife Management
Arctic Council
Yasavey Association

Cultural advocacy groups:

Sámi Cultural Center Sajos
Siida – The National Museum of the Finnish Sámi
Russian Association of Indigenous Peoples of the North, Siberia and Far-East (RAIPON)
Gáldu Resource Centre for the Rights of Indigenous Peoples
Árran Lulesami Center

Economic advocacy groups:

Association of Norwegian Sheep and Goat Farmers
Norwegian Farmers Union
Local Grazing Associations – Norway
Nortura
Finnmark Estate agency (FeFo)
Norwegian Farmers and Smallholders Union
Norwegian Agricultural Cooperatives (NAC)
Kittilän reindeer slaughterhouse
Utsjoen reindeer slaughterhouse
Kuusamon reindeer slaughterhouse
Sallan reindeer slaughterhouse
Narsaq slaughterhouse Neqi A/S
Swedish Lapland
Kiruna Lappland
Pajala tourism and events (Pajala Turism och Evenemang)
Haparanda Tornio tourist office
Heart of Lapland
Överkalix development (Överkalix Utveckling AB)
Visit Luleå

Boden tourism
Visit Gellivare Lapland
Destination Jokkmokk
Arvidsjaur in Swedish Lapland
Region Västerbotten tourism
Visit Umeå
Gold of Lapland
Visit Skellefteå
South Lapland
Visit Hemavan Tärnaby
River Country
Nord Norwegian tourism (Nord Norsk Reiseliv AS)
Kautokeino reindeer slaughterhouse
Røros reindeer slaughterhouse
Mo i Rana reindeer slaughterhouse
Vesterålen reindeer slaughterhouse
Grundnäs reindeer slaughterhouse (Grundnäs Kött AB)
Swedish Wild Meat, Hammerdal
Svantes Game & Berry (Svantes Vilt & Bär AB)
Idre Sami village (Idre nya sameby)
Mittådalens Sami village
W. Eliasson's Wholesale Business
Arvidsjaurs reindeer slaughterhouse
Laestadius Meat and Game (Laestadius Kött och Vilt AB)
Icelandic Tourist Board
Icelandic Farmers Association

Environmental advocacy group:

Norwegian Wild Reindeer Centre

Health advocacy groups:

Swedish Farm and Animal Health Service
Icelandic Veterinary Association

Governmental organisations:

County Governor of Nordland
Norwegian Food Safety Authority
Norwegian Nature Inspectorate (SNO)
Norwegian Agricultural Authority
Norwegian Ministry of Agriculture and Food
Statskog SF – the Norwegian state-owned land and forest enterprise

Norwegian Ministry of Health and Care Services
Norwegian Environment Agency
National Institute for Health and Welfare, Finland
Food Safety Authority, Finland (EVIRA)
Ministry of Education and Science of the Russian Federation
Ministry of Healthcare of the Russian Federation
Chief Medical Officer, Greenland
Board of Agency for Health and Prevention (Greenland)
Swedish Board of Agriculture
Public Health Agency Sweden
Swedish Ministry of Health and Social Affairs
National Food Agency, Sweden
Swedish Environmental Protection Agency
Ministry of the Environment and Energy – Sweden
Nordic Council of Ministers
Expert Commission ethnological expertise of the Republic of Sakha-(Yakutia)
Eveno-Bytanayskiy department of agriculture Ministry of Agriculture of-the Republic of Sakha (Yakutia)
Public Health Institute of Iceland
Ministry of Health and Social Security in Iceland
Icelandic Food and Veterinary Authority (MAST)

Scientific institutions:

Natural Resources Institute Finland (Luke)
Yakutsk State Agricultural Academy
State Scientific Center of "Arctic and Antarctic Research Institute" (St. Petersburg)
Northern (Arctic) Federal University named after MV Lomonosov
Institute of Ecological Problems of the North, Ural Branch of the Russian-Academy of Sciences
Research Institute of Medical Problems of the North
Scientific Research Center of the Arctic (Salekhard)
Tyumen Research Institute of Regional Infectious Pathology
Yakut Scientific Center of Complex Medical Problems
Institute of Humanitarian Research and Indigenous Peoples of the North of-SB RAS
Greenland Institute of Natural Resources (GINR)
Greenland's Medical Research Council
Greenland's Nutrition Council
Greenland Center for Health Research (GCHR)
Danish Medical Association
Greenland's Research Council
Inuit Circumpolar Council (ICC)
Circumpolar Health Research Network (CHRN)

Thule Institute, Oulu University, Finland
Swedish National Veterinary Institute
Norwegian Institute of Public Health
Swedish University of Agricultural Sciences
Umeå University
Northern Research Institute Narvik
NORD University
UiT The Arctic University of Norway
Sámi University of Applied Sciences
Institute For Experimental Pathology, University of Iceland, KELDUR
National University Hospital of Iceland

Sveriges Lantbruksuniversitet
Institutionen för energi och teknik
Box 7032
750 07 UPPSALA
http://www.slu.se/institutioner/energi-teknik/

Swedish University of Agricultural Sciences
Department of Energy and Technology
P. O. Box 7032
SE-750 07 UPPSALA
SWEDEN
www.slu.se/en/departments/energy-technology/