Permafrost thaw: scoping the cultural and material dimensions at risk in Sakha Republic (Russia)

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Key words: permafrost, climate change, Sakha Republic, narrative, risk

ABSTRACT

Changes with regard to climate and permafrost are giving rise to new, inter-related processes and stressors, which in turn are creating new risk patterns for Arctic communities. Obtaining an increased knowledge of these new risks could be a starting point for understanding the opportunities for, and implications of, possible solutions. This article focuses on the social representations of permafrost thaw among people who were born or live in different regions of Sakha Republic (Russia). In this sense, our research aims to obtain a better understanding of the new risk patterns through the collection and subsequent analysis of narratives of personal experiences in order to identify the main concerns, how these are defined and framed and which coping strategies are considered by local inhabitants. We conducted fieldwork in Yakutsk (the capital city of Sakha Republic) in order to meet and interview a wide range of stakeholders including, among others, governmental authorities, people working in or representing research institutions, indigenous people, students and reindeer herders.

1. INTRODUCTION

Sakha Republic, also known as Yakutia, covers an area of over 3,000,000 km², more than 40% of which is located within the Arctic Circle. The particularity of this region lies not only on its size, but also on its historical processes and its cultural diversity. Different indigenous groups – mainly of Turkic origin – have traditionally occupied the Russian Arctic territory (Reisser, 2016). Several waves of settlement have also taken place in this area, involving the spatial allocation of new populations (Heleniak et al, 2013). After the collapse of the Soviet Union, this region underwent demographic reorganization characterized by immigration and emigration processes throughout the territory accompanied by profound economic restructuring.

Furthermore, climate and permafrost shape every aspect of life in the Russian Arctic, and trying to understand their particularities involves exploring numerous complex systems simultaneously. The effects of these factors across several spheres make this socio-environmental system difficult to understand, maintain and predict (Graybill, 2016). More specifically, local responses to change will be highly conditioned by the institutional context, demographic dynamics, characteristics of local economies, ethnic diversity and their involvement in the decision-making processes. These responses will also be shaped by the diversity and flexibility of resource-use systems, traditional and local knowledge and the capacity of self-organization processes (Ford et al, 2015).

The effects of climate change in this region of the world are currently being studied and debated by the scientific community. In line with the projections of previous reports, the IPCC (2018) estimated that “human-induced warming reached approximately 1°C (±0.2°C likely range) above pre-industrial levels in 2017, increasing at 0.2°C (±0.1°C) per decade (high confidence)” (p.51) This trend is likely to be amplified in Arctic regions, as melting sea ice

and diminishing snow cover increase the absorption of solar radiation in the seas and landmasses (ACIA, 2004). In accordance with these estimations, and as a response to a warmer climate in the region, two main phenomena have already been observed: permafrost temperature increases of between 0.5°C and 2°C at the depth of zero annual amplitude (Romanosvky et al, 2010) and an increase in the active layer thickness (ALT) in the majority of the regions, especially in the Russian European North (Shiklomanov, Streletskiy and Nelson, 2012; Romanovsky et al, 2015).

The most visible impacts of these phenomena have been observed in infrastructure, especially in gas and oil pipelines and the associated infrastructures and roads (Hjort et al. 2018, Shiklomanov et al. 2017, Streleski et al. 2019). Accordingly, most adaptation-oriented research focuses on the material dimensions of climate change. Several natural-science projects are currently being implemented in the Russian Arctic in order to obtain a deeper understanding of the biological and physical processes that climate change entails in this area including potential methane emissions from permafrost thaw, carbon feedbacks to climate change, extensive vegetation changes, etc. Estimations of the potential costs of adapting or maintaining infrastructures have also been calculated (Larsen et al. 2008; Melvin et al. 2017; Hjort et al. 2018).

However, it is equally important to include the cultural dimension of climate change while promoting research aimed at understanding communities' perceptions of how these processes threaten their lives and livelihoods is absolutely essential. More specifically, the non-material processes and resources enabling people to lead meaningful and dignified lives, but which are nevertheless at risk, require special attention (Adger et al. 2013).

Climate change exerts further pressure on cultural dimensions such as beliefs, ritual practices, art forms, identity, community cohesion and the sense of place (Adger et al, 2013; Quinn & Adger, 2015; Crate et al, 2017). Simultaneously, culture conditions how societies perceive and respond to the new risk patterns associated with climate change. By assuming that risk perception is a cultural construct (Garcia Acosta 2005, Vanderlinden et al 2017), we recognize that the notion of risk is neither objective nor pre-determined, but is instead an intellectual construct between the members of a society (Douglas and Wildavsky, 1982). Culture thus needs to be at the core of research aimed at understanding the social impacts of climate change. This is particularly relevant in the Russian Arctic, as communities have developed a particular understanding and sense of place which is closely related to living in the presence of permafrost and extreme climatic conditions. Furthermore, people's perceptions, definitions and assessment of risks will determine whether or not they consider adaptive measures necessary. Finally, taking cultural dimensions into consideration will contribute to understanding the diverse range of possible responses to similar environmental changes.

With this in mind, the purpose of this paper is to explore the complexity of permafrost thaw and climate change in Sakha Republic by collecting and analyzing narratives from a number of different local stakeholders. As illustrated by McComas & Shanahan (1999), it is only through narratives that humans succeed in weaving together fragmented observations in order to construct meanings and realities. Through narratives, people assign specific meaning and valuation to social and environmental issues. A detailed analysis of their answers will provide us with useful information in terms of how communities perceive changes, while also enabling us to identify the possible differences existing between norms, definitions and expectations among the scientific community and local stakeholders

regarding permafrost thaw and climate change. Assessing these differences at an early stage of permafrost thaw science will avoid the difficulties linked to miscommunication between those impacted and the research community, leading to a more fluent conversation (Kane et al, 2014).

2. METHODS AND DATA

INSERT FIGURE 1 ABOUT HERE

We conducted the scoping fieldwork in Yakutsk, the capital city of the Sakha republic. The goal of this scoping was to meet regional authorities and research institutes ideally placed to provide us with a better understanding of the Russian administrative system relating to permafrost thaw. This also helped us define the framework regarding the Arctic region in Sakha Republic. In addition to this more institutional scoping, we also conducted face-to-face semi-direct interviews with local stakeholders directly or indirectly concerned by permafrost thaw in Sakha Republic.

Three interview frameworks were created in order to address different local stakeholders (see appended table A.1):

- governmental authorities or people working in/representing research institutions
- inhabitants from non-coastal areas of Sakha Republic
- people living in Tiksi

Each framework consisted of questions accompanied by complimentary prompts.

Semi-direct interviews were designed to ensure a better understanding of the interviewees' experiences, concerns, values, knowledge and ways of thinking, seeing and acting (Schostak,

2006) while giving them the sufficient scope to tell us about anything they considered relevant or important. The challenges associated with this methodology are the difficulty in expressing the results quantitatively and the need for a detailed and repeated interpretation of them. Linguistic limitations due to live translations could also lead to a loss of terminological precision.

An initial sample of key respondents, mainly from institutions and governmental authorities (See appended Table A.1), was contacted as advised by our local informants. We subsequently relied on the suggestions of the interviewees to contact new potential respondents. This snowball sampling procedure does not represent the population in statistical terms, but this was not intended aim. Instead, we wanted to capture the diversity of experiences related to permafrost thawing in the Sakha Republic - as seen from its capital city.

On average, the interviews lasted 50 minutes with a minimum of 18 minutes and a maximum of 70 minutes. In order to facilitate the interviewing process, interviews were conducted by the authors accompanied by an interpreter. All interviews were recorded. A minority of interviewees expressed their willingness to answer in English. Four participants who were not in Yakutsk at that time agreed to answer the questions in Russian by email. These were translated to English.

The whole body of translated interviews was transcribed and subjected to qualitative analysis using Atlas.ti 8 (Friese, 2014). The first stage of this process involved creating codes in order to organize the information obtained thematically. These codes were used to design a mental map in the form of a network in which the different relationships between the mentioned topics can be identified. This mental map is the outcome of the analysis of the

interviews and we endeavored to respect the order and words used by the interviewees. For the final stage, we created broader categories to pool the aforementioned codes according to 6 different levels of action or concerns that we identified:

1. Impacts on natural resources
2. Impacts on infrastructure
3. Impacts on health and mental well-being
4. Governance needed
5. Knowledge related issues
6. Opportunities

3. RESULTS AND DISCUSSIONS

3.1 Initial thematic coding results

Throughout the fieldwork, it was noticeable that all the respondents were keen to tell us about their life experiences related to permafrost and their environment. All the interviewees were familiar with the terms “permafrost”, “permafrost thaw” and “climate change”, which were mentioned in our questions and prompts. Some differences were observed in terms of the type and level of concerns manifested by people, according to their places of origin (big cities, villages or small settlements, coastal or non-coastal areas, urban or rural areas, etc.). Their narratives did not contradict each other, but rather extended the state of knowledge about local stakeholders’ perceptions regarding the complex network of non-linear and rapid changes in their environment, lives and livelihoods. All the interviewees seem to be aware of the complex chain of modifications and new risk patterns created by changes to permafrost and the climate in Sakha Republic (see appended table A.2 which presents representative quotes while organizing them thematically into 5 categories).

An in-depth, cross-cutting analysis of the narratives demonstrates that interviewees not only have a similar understanding of the multidimensional changes their environment and societies are currently experiencing, but also that they are able to link these changes with two main elements: permafrost and climate. Interviewees claim to observe modifications which take a number of different forms, for example, an increase in the number of mammoth remains found, an increase in the number and intensity of floods, the detrimental damage to and collapse of infrastructure (buildings, routes, pipelines), landscape modifications as well as changes in the composition and distribution of flora and fauna in the region. All these modifications represent different facets of the same unpredictable and changing reality they are living in.

Through this further cross cutting analysis, we identified six overarching ("a" to "f" below), integrative categories (plus an extra one) bringing together the different concerns expressed during the interviews (see codes of the mental map). These were organized into thematic groups. A first general theme refers to "impacts" ("a" to "c" below). The stakeholders interviewed clearly identified several negative impacts of permafrost thaw on the physical elements of their environment, including:

a) Impacts on natural resources: rivers, soils, mammoth tusks, flora, fauna, etc. They consider these to be closely related to the maintenance of their traditional occupations such as herding, fishing and hunting - e.g., sample quotes #1, 3, 4, 7, 11, 12 in table A.2.

b) Impacts on infrastructure (roads, buildings and pipelines) which reduce the possibility for different settlements/villages/towns in Sakha Republic to transport people, goods and supplies between them- e.g., sample quotes #2, 5, 7 in table A.2.

Interviewees also identified other impacts linked to non-material dimensions that dignify their lives and livelihoods in the region including health, mental well-being, identity and a sense of belonging:

c) Impacts on health and mental well-being – e.g., sample quotes #2, 5, 6, 10, 11, 12, 13, 14 in table A.2.

A second theme concerns issues relating to collective action and refers to:

d) Knowledge-related issues: these refer, on the one hand, to how the new risk patterns affect their traditional knowledge systems and on the other hand to the need for scientific participation and research in terms of permafrost thaw and climate change processes – e.g., sample quotes 1, 4, 8, 11, 12, 14, 15, 16 in table A.2.

e) Governance needed: multidimensional and multi-scale changes to the environment have created governance gaps that interviewees deemed necessary to be identified, treated and filled by authorities. More specifically, they emphasized the need for new, better adapted norms/regulations – e.g., sample quote 17 in table A.2.

f) An additional category, entitled "**Opportunity**", was included. Throughout the interviews, people expressed concern about the negative character of perceived changes while only one opportunity was identified, referring to the commercial opportunities that an increase in the number of mammoth tusk finds – sold at impressively high prices in the Asian markets – represent for local inhabitants. However, this is not entirely positive, as it was identified to be an activity that goes against the traditional beliefs of indigenous peoples. With this in mind, one representative of the people of the North said:

202 “In the minds of traditional Northern Peoples, the mammoth is the God of the
203 underworld. And it was a taboo to pick and collect bones. We believe that if, for
204 example, we take this bone or tusk, it opens the door to the underworld. And it will
205 bring us many troubles. It is one of the strongest taboos in our culture. Sometimes,
206 however, some people try to sell them (…) and now we see that collecting mammoth
207 bones is one of the biggest businesses in the North and many people get involved in
208 this business. I see big changes in our traditional life or traditional worldview,
209 because it destroys our traditional beliefs and the connections between older and
210 younger generations. I can say that we are losing our traditional ecological worldview
211 because if you can pick the land ground, you collect these bones, it means that you
212 have stopped believing in our traditions. “

213 **3.2 On causality, values at risk and uncertainty**

214 We further analyzed the causal statements that were associated with these
215 multidimensional impacts, sticking closely to the respondents’ stories of permafrost thaw. In
216 doing so, we identified five categories of operators linking permafrost thaw to its perceived
217 origin and impacts: “threatens,” “is the cause of”, “is associated with,” “requires,” and “is
218 part of.” “Threatens”, “is part of” and “is the cause of” are unidirectional operators.
219 “Associated with” and “requires” are bidirectional - which is quite unusual for the latter.
220 These relationships, as observed in our interviews, are mapped in Figure 2 below.

221 INSERT FIGURE 2 ABOUT HERE

222 Impacts are identified along causal chains which jointly find their origin in permafrost thaw.
223 A fine distinction is made in our corpus: the “is the cause of” and “threaten” distinction.
224 Actual observations are required for the respondent’s explicit causal statements (that we

associate with the “is the cause of” operator) to be expressed - these observations are expressed as verbs describing (unwanted) impacts. A series of permafrost thaw risks have already been identified and their causal origin is, in the respondents’ eyes, quite clear. These impacts and associated causal statements are erosion, floods and forced displacement; mammoth tusk poaching, cultural erosion; damage to pipelines and buildings; and changes in the migration routes of wild and domestic animals.

The “threaten” operator refers to causal statement loaded with uncertainty that are associated with objects / values at risk, either directly or indirectly, including cemeteries, health, water quality, underground storage, infrastructures, hunting, reindeer herding, fishing, flora and fauna, roads (see figure 2 above).

The “associated with,” and “requires” bidirectional operators show that the respondents believe that the impacts of permafrost thaw are part of complex interrelated phenomena. Some of these could be expected, such as associating a threat to flora and fauna with a threat to reindeer herding. Some indicate a grasp of climate change and its specific place in the changes observed. For instance, climate change is jointly associated with permafrost thaw and the future. It also allows a threat to be linked to cultural heritage (cemeteries) and health through potential diseases. The “requires” operator reflects the identification of a call to action within the respondents’ narratives. Most of these solutions refer to some sort of collective action be it through state institutions, science, regulation or administrative responsibility.

Finally, the “is part of” operator captures causal statements where an initial impact on part of a greater ensemble has an impact on this greater ensemble. This operator is particularly

important here as it captures multiple impacts, in the form of threats to hunting, fishing and migratory routes that lead to a general threat to the greater ensemble of local culture.

3.3 Furthering the analysis of the "requires" operator - looking for risk-mitigation options through collective action

In order to cope with the new non-linear changes and impacts, respondents explicitly mentioned the need for further action (see sample quotes #18, 19 and 20) and identified the government and the scientific community as being responsible for developing adaptive measures related to permafrost and climate change (see sample quotes #22, 23, 24, 25 and 26). They also mentioned the need to update the norms and laws, as in some cases they are no longer adapted to the current changing environment people are living in (see sample quote #17). Finally, they also highlighted the importance of defining the administrative responsibility for some new resources resulting from changes to permafrost such as mammoth tusks, as they are being found more frequently. In this respect, a representative of the Melnikov Permafrost Institute said:

> "In Yakutia now, there have been long discussions with Moscow and the central part of Russia concerning the status of the mammoth tusks. Is it a national resource or not? The issued is raised because all national resources are subject to a special law. They all belong to the central federation, not to the local governments. The Yakutsk Academy for Sciences has a Department of mammoth fauna that is partly working on these issues (…) It is very chaotic and unknown, but very important for making a point on the permafrost economy in coastal areas and climate impacts."

From the analysis of this operator, we can infer that collective action is essentially conceived as something that can only be achieved through the intervention of "upper external" actors.

In this respect, the notion of agency could – a priori – be related to a vertical and hierarchical social structure. A better understanding of the historical processes and the socio-political configuration of the region is essential in clarifying the way in which potential adaptive measures can be developed and successfully implemented. This confirms some of the findings in Kennedy et al. (2018), including a case study from Sakha Republic. Our research shows that understanding current and past colonial processes is one of the keys to accessing current abilities and the representation of and for adaptation to climate change.

3.4 Furthering the analysis of the "is part of" operator: when material impacts threaten culture.

The unidirectional "is part of" operator reflects how changes might lead to physical and material impacts but also represent a threat to cultural dimensions, including the three main traditional activities practiced in Sakha Republic: hunting, fishing and reindeer herding. These are not only economic activities but are also strongly linked to the identity and the worldviews of indigenous people (see quote sample #15). The increasingly unpredictable environmental and climatic conditions put these traditional occupations at risk of disappearance, and with it, the potential loss or degradation of their traditional knowledge and culture.

A deeper analysis of the elements mentioned by respondents appearing in the mental map also reveals an interconnection between the physical and the cultural dimensions (see sample quotes #15 and 18). More specifically, physical changes represent a threat to their culture. This is the case of forced displacements, the destruction of underground caves traditionally used by reindeer herders and hunters during migrations, the erosion of places

of cultural value such as cemeteries, and the shorter periods of winter roads on which several communities depend to obtain goods and supplies.

4. CONCLUSION

Using a series of interviews and coding them thematically, we explored how, when relating their experiences, the inhabitants of Sakha Republic express their understanding of permafrost thaw. During this process, we uncovered key elements such as a high level of awareness regarding permafrost thaw and its impacts - permafrost thaw is a salient issue in Yakutia; an explicit understanding of the complex causal webs that permafrost thaw entails; and the expressed need for potential mitigation strategies that seems to reflect an agency deficit and an associated reliance on external authorities.

In this paper, we also clarify how, through the intermeshing of ordinary life experiences, material and cultural impacts are connected and need to be taken into account simultaneously in order to understand precisely how permafrost thaw is taking shape within Sakha Republic. Ordinary life and everyday concerns, both practical and symbolic, ranging from personal to local, regional and national levels, are interconnected and, according to our respondents, should remain so. The material and cultural dimensions of permafrost thaw are two sides of a single coin. Maintaining a focus on both while conducting research may be quite a formidable challenge. This is even more important as our results show that science is understood, by our interviewees, to be one of the central sources of solutions with regard to permafrost thaw. Science-based solutions seem legitimate to our respondents. In this conclusion, we argue that maintaining this close association of material and cultural dimensions while conducting research may help to support this legitimacy.

Our results successfully map out permafrost thaw and its impacts, using local interests as an entry point. Furthering this analysis, outside of the capital city, would facilitate a much-needed finer analysis that goes beyond the scope of this paper. Finally, the translation of these results in terms public policies in the face of climate change would appear to us, and we hope to our readership, to be something of a necessity.

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6. REFERENCES

ACIA, Impacts of a Warming Arctic: Arctic Climate Impact Assessment (2004). Cambridge University, Press.

Adger., Barnett., Brown., Marshall & O'brien. (2013). Cultural dimensions of climate change impacts and adaptation. Nature Climate Change, 3(2), 112.

Crate et al (2017). Permafrost livelihoods: A transdisciplinary review and analysis of thermokarst-based systems of indigenous land use. *Anthropocene*, *18*, 89-104.

Douglas and Wildavsky. (1982). Risk and culture: An essay on the selection of technological and environmental dangers.

Friese. (2014). Qualitative Data Analysis with ATLAS.ti (2nd ed.). Thousand Oaks: SAGE.

IPCC. (2018). Global Warming of 1.5° C: An IPCC Special Report on the Impacts of Global Warming of 1.5° C Above Pre-Industrial Levels and Related Global Greenhouse Gas Emission Pathways, in the Context of Strengthening the Global Response to the Threat of Climate Change, Sustainable Development, and Efforts to Eradicate Poverty. Intergovernmental Panel on Climate Change.

Ford., McDowell and Pearce. (2015). The adaptation challenge in the Arctic. Nature Climate Change, 5(12), 1046.

García Acosta. (2005). El riesgo como construcción social y la construcción social de riesgos. Desacatos, (19), 11-24.

Graybill. (2016). Urban Vulnerability to Climate Change in the Russian Arctic. *Sustaining Russia's Arctic Cities: Resource Politics, Migration, and Climate Change*, *2*, 221.

Heleniak., Laruelle and Orttung. (2013). Boom and bust: Population change in Russia's Arctic cities. Climate change/environmental issues, 429.

Hjort et al. (2018). Degrading permafrost puts Arctic infrastructure at risk by mid-century. Nature communications, 9(1), 5147.

Kane., Vanderlinden., Baztan., Touili., and Claus. (2014). Communicating risk through a DSS: A coastal risk centred empirical analysis. Coastal Engineering, 87, 240-248.

Kennedy et al.(2018). Environmental History and the Concept of Agency: Improving Understanding of Local Conditions and Adaptations to Climate Change in Seven Coastal Communities. Global Environment, 11(2), 405-433.

Larsen et al. (2008). Estimating future costs for Alaska public infrastructure at risk from climate change. Global Environmental Change, 18(3), 442-457.

McComas and Shanahan. (1999). Telling stories about global climate change: Measuring the impact of narratives on issue cycles. Communication Research, 26(1), 30-57.

Melvin et al. (2017). Climate change damages to Alaska public infrastructure and the economics of proactive adaptation. Proceedings of the National Academy of Sciences, 114(2), E122-E131.

Quinn., Lorenzoni and Adger. (2015). Place attachment, identity, and adaptation. *The adaptive challenge of climate change*, 160e170.

Romanovsky et al. (2015). Terrestrial Permafrost (in 'State of the Climate in 2014'), Bulletin of the American Meterological Society 96(7):S139-S141.

Romanovsky., Smithand Christiansen. (2010). Permafrost thermal state in the polar Northern Hemisphere during the international polar year 2007–2009: a synthesis. Permafrost and Periglacial processes, 21(2), 106-116.

Shiklomanov., Streletskiy and Nelson. (2012). Northern hemisphere component of the global circumpolar active layer monitoring (CALM) program. In Proc. 10th Int. Conf. on Permafrost (Vol. 1, pp. 377-382).

Shiklomanov., Streletskiy., Swales and Kokorev. (2017). Climate change and stability of urban infrastructure in Russian permafrost regions: prognostic assessment based on GCM climate projections. Geographical review, 107(1), 125-142.

Schostak. (2006). Interviewing and representation in qualitative fieldwork. Open University Press, New York.

379 Streletskiy., Suter., Shiklomanov., Porfiriev and Eliseev. (2019). Assessment of climate
380 change impacts on buildings, structures and infrastructure in the Russian regions on
381 permafrost. Environmental Research Letters, 14(2), 025003.
382 Swidler. (1986). Culture in action: Symbols and strategies. American sociological review, 273-
383 286.
384 Vanderlinden et al. (2017). Coastal Flooding, Uncertainty and Climate Change: Science as a
385 Solution to (mis)Perceptions? - A qualitative enquiry in three European coastal settings.
386 Journal of Coastal Research, SI77, 127-133.
387
388 **7. APPENDICES**

Category	Interviewee
Representative of ethnic minorities	Office of the Northern Arctic People's Culture Institute for Humanitarian Research and Indigenous Issues Ex-representative of the Indigenous People in Parliament
Educational authorities	Upper Authorities from the North Eastern Federal University of Yakutsk
Governmental authorities	Minister of Nature Protection
Cultural institutions	Mammoth Museum
Research institutions	The Melnikov Permafrost Institute Office of the Arctic

	4 researchers in the medical field
Students	Journalism student from Tomponsky District Law student from Yakutsk History student from Tiksi Financial economics student from Anabarsky District 2 students from Tiksi Financial economics student from Vilyuysky District
Traditional occupations	Reindeer herder Seamstress
Other occupations	Entrepreneur from Momsky District Biologist from Kazachie (Ustiansky District) Power supply worker from Siktyakh (Bulunsky District)
TOTAL INTERVIEWEES	24

389 Table A.1: List of interviewees from the scoping fieldwork in Yakutsk

390

(1) Samples associating changes with both permafrost thaw and climate change	**Interviewee**	**Quote #**
"It (permafrost) affects reindeer herders because before we were moving along the coastline. Now the climate has	Reindeer herder from	1

changed, big bushes have appeared and it has become really hard to herd the deer. (…) Because the soil has changed, the lakes are disappearing, there are landslides, insects have appeared, polar bears have started to move around, everything has changed. The birds, the water, the nature, the soil and the weather of course. It appears that the weather affects many things, the routes taken by of birds and animals have changed and there are also migrations, animal diseases."	Kolimskoie	
"Another challenge for our people is the catastrophic flooding observed in recent years. Why does this happen? Many reasons. More meltwater. More rain. Another reason: maybe because the deltas of these rivers now are not dug and that's why water can't flow. But hydrologists say that one of the main reasons for the new floods in the northern rivers is the amount of water which gets accumulated in the surface (more than 30%) due to melting permafrost. Then, it comes to the rivers and this is another challenge of permafrost melt."	Representative of the Institute for Humanitarian Research and Indigenous Issues	2
"Actually, there was an article maybe a month ago. They found a huge glacier that broke away from the shore and the main reason I read in the article was because of permafrost, the weather is getting hotter and today is close to 19°C – a	Student #2 from Tiksi	3

week ago it was -2°C. When I was studying there (Tiksi), the weather was not like that. Maybe we got a few days which were very hot in the middle of July and afterwards it was always very foggy and under 2 degrees. I was really surprised by the news.		
"People living in Tiksi are concerned about climate change and permafrost thaw. (…) For example, I know that students of the Arctic Gymnasium (High School) conduct their own research to identify changes in climatic conditions. (…) Changes in permafrost affected the flora and fauna most severely. New plants are appearing in the tundra, which are more common in the western and southern regions of Yakutia. The animal world has changed habitat. (…) Local hunters also agree with the fishermen and believe that animals traditionally being hunted (deer, arctic foxes) have changed their habitat and moved further away from old places."	Student #3 from Tiksi	4
(2) Samples associating changes solely with permafrost thaw	**Interviewee**	**Quote #**
"…in the houses built on permafrost, the permafrost will soon melt and the building will be destroyed so we need another place to build the houses. Such cases are in villages (…) The special areas for fishermen are being eroded and	Seamstress from Saskylakh	5

they need to move their houses in order to survive. And even technology cannot move that."		
"…earlier, 2 or maybe 3 centuries ago, we had epidemics such as the black death. The people and the cattle were buried in some places but we don't know exactly where. Now the permafrost is melting and they (dead bodies) are appearing during the autumn or they come to the water, rivers, lakes. However, we don't have any diseases or epidemics in Yakutia yet, but the example of Yamal shows us that this is one of the big problems for us and the future."	Representative of the Institute for Humanitarian Research and Indigenous Issues	6
"I think yes (people are concerned about permafrost) because permafrost thaw begins the erosion process. People start losing their houses which are destroyed. And in the tundra, it creates holes."	Biologist from Kazachie	7
(3) Samples identifying a weak relevance of permafrost	**Interviewee**	**Quote #**
"…people in our city and in our Republic don't usually think about permafrost. We don't care. We only care about winter and I guess people from villages must care about the weather in winter because sometimes they get food for themselves by fishing or hunting and they need to understand when they can go outside and how to get dressed. So, nobody cares about permafrost, we don't think	Law student from Yakutsk	8

about this."		
"…most people don't want to know about the conditions of permafrost (…) People are interested in knowing about the conditions of the land under Tiksi because there are seismic movements."	Student #1 from Tiksi	9
"I can't say whether it (permafrost) is important or not, because permafrost is part of our lives. The entire territory of Yakutia is covered by permafrost and our traditional lifestyle is connected with this, it depends on it."	Representative of the Institute for Humanitarian Research and Indigenous Issues	10
(4) Samples identifying a strong relevance of permafrost	**Interviewee**	**Quote #**
"Our culture, or circumpolar civilizations, is based on these territories where there is permafrost or a cold climate. And that is why each change to permafrost or our climate has an impact on our culture. We started to feel these changes a very long time ago (…) when reindeer herders or fishermen come to a place, they have like a storage place. They put their meat and fish one or two meters deep, but now this is disappearing because the permafrost is melting. All these places are destroyed. However, we still try to make them,	Former representative of the Indigenous People in the Parliament	11

but they will be destroyed every time.“		
“I cannot speak on behalf of the whole population of Sakha Republic, but for our district it is definitely very important because our entire life is related to it (…) I think that all our life depends on the permafrost so we wouldn’t exist without it. We get food from the reindeer, so if there are no reindeer we cannot survive, and we also obtain fish.”	Seamstress from Saskylakh	12
“First of all, it (permafrost) is a visiting card, an image of Yakutia. Secondly, permafrost is really cold and people who live in the cold have a long life expectancy. And thirdly, it’s our culture.”	Young entrepreneur from Momsky District	13
“That (permafrost) is our outstanding special point and that is why we are in a unique place in the world. In earlier times, people just got used to living in such conditions and dislike the heat.”	Financial Economics student from Anabarsky District	14
(5) Samples asserting that traditional knowledge and occupations are being threatened by changes in their environment	**Interviewee**	**Quote #**
“…because the ground is moving, changing, that’s why we have to change our migration routes. Sometimes we don’t know what the best route is because everything has become unpredictable. Normally we could predict the weather for	Representative of the Institute for Humanitarian	15

one month, for seasons, years! Using these predictions, we could choose routes for more comfort. Now we can't do it because we don't know what is happening. All of our traditional knowledge about the weather is being destroyed. You can say the same about each of our traditional occupations, fishing, hunting too. Not only infrastructure." "…the young generation is not interested in our traditional occupations like reindeer herding, hunting, fishing, because they understand that they are not comfortable: "they don't give us enough profit for our life", but this is the base of our traditional lifestyle and knowledge! If these young people find one tusk, the price of this tusk is more than the money from one-year's work as a reindeer herder or hunter. This is why we can now say that our traditional occupations – reindeer herding, fishing and hunting – are in crisis because people involved in these are very old. They are over 50. If we sustain this situation for a long time, it means we might lose these traditions."	Research and Indigenous Issues	
"After school, children come to Yakutsk and do not come back. They stay in Yakutsk. That's negative. Traditional reindeer herders and fishermen are disappearing."	Biologist from Kazachie	16
"…all our life is regulated by the official laws, orders and others decrees, for example, period of the year when we can	Former representative	17

catch fish. But these laws were for the past, now everything has changed and people are losing their harvest (…) And the procedure for changing this regulation is very hard, very bureaucratic. The fish spawning time has changed and all the laws and directives regulated this but now everything has changed and people can't do anything. And if they go to fish during the real spawning time, this might be considered illegal (…) Three years ago, people raised the question of traps for wolves because wolf traps are banned, but now wolves are becoming an epidemic for us. This is a big challenge because every year they take 5-10 thousand reindeer from us"	of the Indigenous People in the Parliament	
(6) Samples identifying a need for further action	**Interviewee**	**Quote #**
"We started to feel these (climatic) changes a very long time ago. In 1995, at the meeting of reindeer herders in the Itum Kalinsky region, we spoke about it. And we spoke about the need to change the migration routes of the reindeer herders because some changes have been observed. This is why the melting of permafrost has a major impact on our traditional lifestyle. Today it is a reality and every year, on the northern river, Alezeya, there are floods. This is the result of changing permafrost. Not long ago, the members of the local	Former representative of the Indigenous People in the Parliament	18

parliament were interested in this question, and at the beginning of June they organized parliamentary discussions about the impact of climate change on the traditional lifestyles and traditional occupations of indigenous peoples in the North. Now, scientific expert groups and authorities examine the system to make research on this process in order to face this challenge and think about the changes we need. (…) Many changes…We have never paid too much attention to this but now it is urgent. (…) (People) always try to adapt to these changes just as they happen. And they try to raise these questions with their officials to fight against wolves and bears, to help them in flood situations, etc. When we speak about this during parliamentary discussions, I say we don't have a normal program or plan on how to mitigate this, we only act with the results, not to mitigate or to prevent, only after something happens (…) We must do something to prevent it. We must adapt. We must understand where we are going. All these global questions are for all mankind, we must all work on them."		
"People living on the coast feel climate change. For example, the winters are very short and almost windless. Strong winds no longer reach the maximum level, as they did 10 years ago. The summers have become mild, the temperature has	Student from Tiksi #3	19

increased. The reservoirs of ice have changed in the autumn. (…) we can say that the permafrost is really melting and this can only worry the inhabitants of Tiksi. Something has to be done."		
"Yes, there are several conflicts. It is commonly known that where there it is legal to obtain (mammoth tusks) there is also illegal trade. And the point is that the tusks are going to China. It is the imperfection of the laws that regulate how to obtain these tusks. I hope for your next visit, everything will be clearer."	Guide from the Mammoth Museum	20
(7) Samples identifying key potential stakeholders associated with the implementation of responses related to permafrost thaw and climate change impacts	**Interviewee**	**Quote #**
"The influence of climate on the population is not an issue for the Ministry for Nature Protection. It thinks you should look at the research done by the Institute of Health. You should get in contact with the Ministry of International Relations of our region because it is in charge of the research related to health, ecology, life etc.."	Minister of Nature Protection	21
Now it is the Federal Authorities (responsible for fixing quotas and dates). It's very hard to change because they are for the whole Russian territory. They don't think that maybe	Former representative of the	22

each territory is different. And the procedure for changing this regulation is very hard, very bureaucratic. The spawning time for fish has changed and all the laws and directives regulated this, but now everything has changed and people can't do anything. And if they go to fish during the real spawning time, they might be considered illegal. We need to think about regional conditions. For example, three years ago, people raised the question of traps for wolves because you know wolf traps are banned, but now wolves have started to become an epidemic for us. This is a big challenge because every year they take 5 or 10 thousand reindeer from us. This question was only raised when we brought experts from the European Union to this Arctic area four years ago, and they prepared a special document to start treating this problem. However, you see that it is not only a federal responsibility but also an international responsibility!"	Indigenous People in the Parliament	
"Roads cannot be of very good quality because in spring or summer you can take very good roads but then, in winter they can be broken because winters are too cold. We need new methods but it is very expensive. And for me, honestly, the government doesn't pay attention to roads in Yakutia. As you know, our city is very small so I think that the government can try to create some new methods in our city"	Law student from Yakutsk	23

“I think the main actor must be the government: federal, local, regional government. They must implement special programs on how to mitigate the effects of this climate change or melting permafrost. But we must understand that all that I say is measured by the results. We must think how to prevent and how to support (people from Yakutia).”	Representative of the Institute for Humanitarian Research and Indigenous Issues	24
“I think that the industrialists will cope with the problems (of permafrost thaw) because they do all their business on the permafrost. In permafrost there is oil, natural resources, precious resources, the entire periodic table is there, and of course there are so many people interested in the Arctic in terms of business.”	Seamstress	25
“Most people don’t want to know about the conditions of permafrost. This is a topic for scientists.”	Student from Tiksi #1	26

391 Table A.2: sample quotes representative of the 7 central initial results that were identified:
392 awareness of permafrost thaw (1) linking it to climate change and (2) not linking it to climate
393 change; judgment on the (3) weak and (4) strong relevance of permafrost thaw; (5)
394 expression of the threat to traditional activities represented by permafrost thaw; (6) need
395 for further action; and (7) key stakeholders for implementing adaptive measures related to
396 climate and permafrost

397

Figure 1: Map locating Tiksi and Yakutsk within Sakha Republic and other Republics of the Russian Arctic

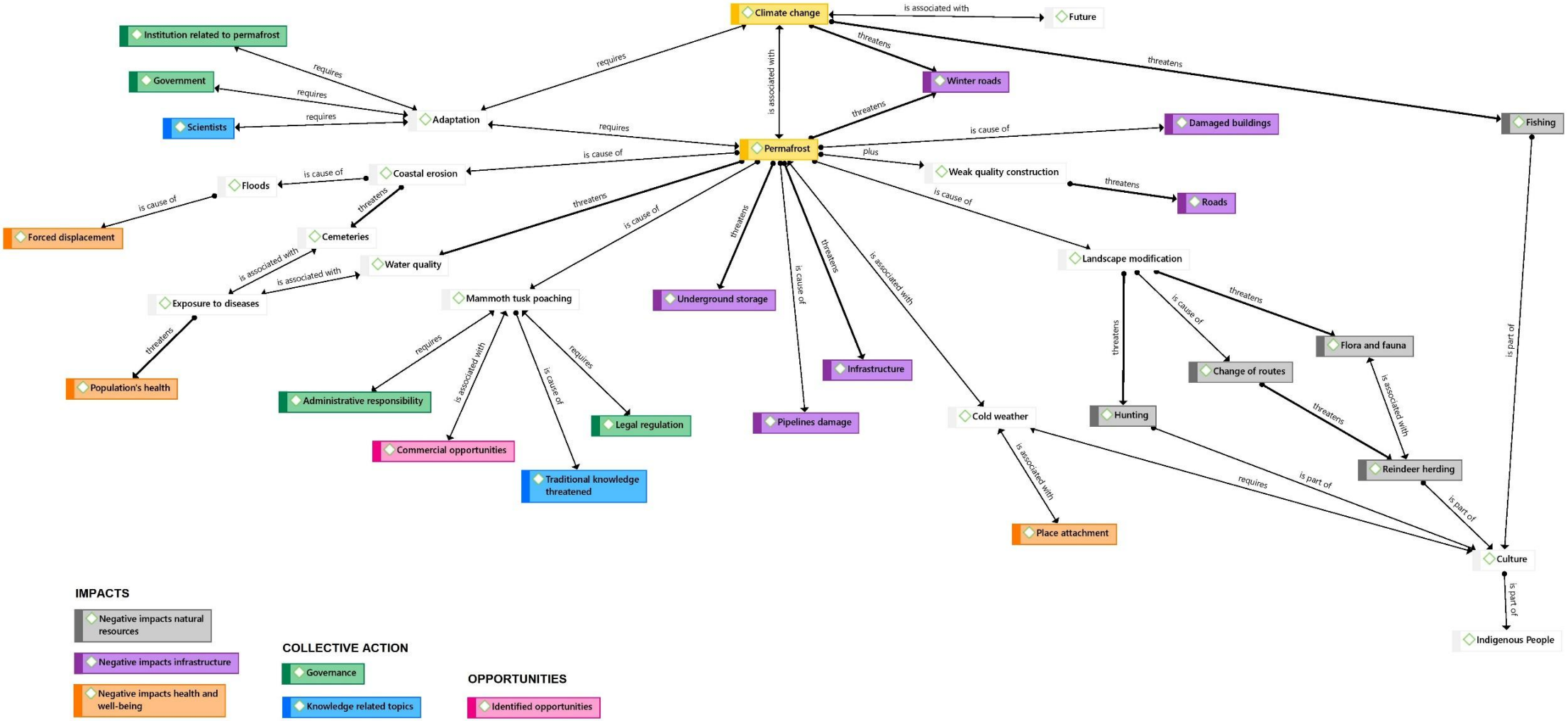
Climate change
is associated with
Future
Institution related to permafrost
requires
Government
requires
Scientists
requires
Adaptation
requires
requires
is associated with
threatens
Winter roads
threatens
Fishing
Permafrost
is cause of
Damaged buildings
plus
Weak quality construction
threatens
Roads
is cause of
Landscape modification
is cause of
Coastal erosion
is cause of
Floods
is cause of
Forced displacement
threatens
Cemeteries
threatens
Water quality
is associated with
is associated with
Exposure to diseases
threatens
Population's health
is cause of
Mammoth tusk poaching
threatens
Underground storage
is cause of
Infrastructure
threatens
Pipelines damage
is associated with
Cold weather
requires
Administrative responsibility
is associated with
Commercial opportunities
is cause of
Traditional knowledge threatened
requires
Legal regulation
threatens
Hunting
is cause of
Change of routes
threatens
Flora and fauna
is associated with
Reindeer herding
is associated with
Place attachment
requires
is part of
is part of
Culture
is part of
Indigenous People
IMPACTS
Negative impacts natural resources
Negative impacts infrastructure
Negative impacts health and well-being
COLLECTIVE ACTION
Governance
Knowledge related topics
OPPORTUNITIES
Identified opportunities

Figure 2: Mental map showing the relationship between the issues associated to permafrost thaw, organized along the 6 broad categories that are describes in the text and using the operators that are also described in the text.