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

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

7 **ABSTRACT**

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

21 **1. INTRODUCTION**

22 Sakha Republic, also known as Yakutia, covers an area of over 3,000,000 km<sup>2</sup>, more than 40%  
23 of which is located within the Arctic Circle. The particularity of this region lies not only on its  
24 size, but also on its historical processes and its cultural diversity. Different indigenous groups  
25 – mainly of Turkic origin – have traditionally occupied the Russian Arctic territory (Reisser,  
26 2016). Several waves of settlement have also taken place in this area, involving the spatial  
27 allocation of new populations (Heleniak et al, 2013). After the collapse of the Soviet Union,  
28 this region underwent demographic reorganization characterized by immigration and  
29 emigration processes throughout the territory accompanied by profound economic  
30 restructuring.

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

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

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

52 The most visible impacts of these phenomena have been observed in infrastructure,  
53 especially in gas and oil pipelines and the associated infrastructures and roads (Hjort et al.  
54 2018, Shiklomanov et al. 2017, Streleski et al. 2019). Accordingly, most adaptation-oriented  
55 research focuses on the material dimensions of climate change. Several natural-science  
56 projects are currently being implemented in the Russian Arctic in order to obtain a deeper  
57 understanding of the biological and physical processes that climate change entails in this  
58 area including potential methane emissions from permafrost thaw, carbon feedbacks to  
59 climate change, extensive vegetation changes, etc. Estimations of the potential costs of  
60 adapting or maintaining infrastructures have also been calculated (Larsen et al. 2008; Melvin  
61 et al. 2017; Hjort et al. 2018).

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

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

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

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

95

## 96 **2. METHODS AND DATA**

97 INSERT FIGURE 1 ABOUT HERE

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

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

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

110 Each framework consisted of questions accompanied by complimentary prompts.

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

113 2006) while giving them the sufficient scope to tell us about anything they considered  
114 relevant or important. The challenges associated with this methodology are the difficulty in  
115 expressing the results quantitatively and the need for a detailed and repeated interpretation  
116 of them. Linguistic limitations due to live translations could also lead to a loss of  
117 terminological precision.

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

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

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

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

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

### 145 **3. RESULTS AND DISCUSSIONS**

#### 146 **3.1 Initial thematic coding results**

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



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

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

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

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

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

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

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

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

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

195 **f) An additional category, entitled “Opportunity”,** was included. Throughout the interviews,  
196 people expressed concern about the negative character of perceived changes while only one  
197 opportunity was identified, referring to the commercial opportunities that an increase in the  
198 number of mammoth tusk finds – sold at impressively high prices in the Asian markets –  
199 represent for local inhabitants. However, this is not entirely positive, as it was identified to  
200 be an activity that goes against the traditional beliefs of indigenous peoples. With this in  
201 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

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

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

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

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

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

249 **3.3 Furthering the analysis of the “requires” operator - looking for risk-mitigation options**  
250 **through collective action**

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

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

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

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

### 277 **3.4 Furthering the analysis of the “is part of” operator: when material impacts threaten** 278 **culture.**

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

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

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

#### 294 **4. CONCLUSION**

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

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

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

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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

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

389

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

<p>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.”</p>	<p>Kolimskoie</p>	
<p>“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.”</p>	<p>Representative of the Institute for Humanitarian Research and Indigenous Issues</p>	<p>2</p>
<p>“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</p>	<p>Student #2 from Tiksi</p>	<p>3</p>

<p>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.</p>		
<p>“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.”</p>	<p>Student #3 from Tiksi</p>	<p>4</p>
<p><b>(2) Samples associating changes solely with permafrost thaw</b></p>	<p><b>Interviewee</b></p>	<p><b>Quote #</b></p>
<p>“...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</p>	<p>Seamstress from Saskylakh</p>	<p>5</p>

<p>they need to move their houses in order to survive. And even technology cannot move that.”</p>		
<p>“...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.”</p>	<p>Representative of the Institute for Humanitarian Research and Indigenous Issues</p>	<p>6</p>
<p>“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.”</p>	<p>Biologist from Kazachie</p>	<p>7</p>
<p><b>(3) Samples identifying a weak relevance of permafrost</b></p>	<p><b>Interviewee</b></p>	<p><b>Quote #</b></p>
<p>“...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</p>	<p>Law student from Yakutsk</p>	<p>8</p>

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
<b>(4) Samples identifying a strong relevance of permafrost</b>	<b>Interviewee</b>	<b>Quote #</b>
“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
<b>(5) Samples asserting that traditional knowledge and occupations are being threatened by changes in their environment</b>	<b>Interviewee</b>	<b>Quote #</b>
“...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

<p>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.</p> <p>You can say the same about each of our traditional occupations, fishing, hunting too. Not only infrastructure.”</p> <p>“...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.”</p>	<p>Research and Indigenous Issues</p>	
<p>“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.”</p>	<p>Biologist from Kazachie</p>	<p>16</p>
<p>“...all our life is regulated by the official laws, orders and others decrees, for example, period of the year when we can</p>	<p>Former representative</p>	<p>17</p>

<p>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"</p>	<p>of the Indigenous People in the Parliament</p>	
<p><b>(6) Samples identifying a need for further action</b></p>	<p><b>Interviewee</b></p>	<p><b>Quote #</b></p>
<p>"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, Alezeyya, there are floods. This is the result of changing permafrost. Not long ago, the members of the local</p>	<p>Former representative of the Indigenous People in the Parliament</p>	<p>18</p>

<p>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."</p>		
<p>"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</p>	<p>Student from Tiksi #3</p>	<p>19</p>

<p>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.”</p>		
<p>“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.”</p>	<p>Guide from the Mammoth Museum</p>	<p>20</p>
<p><b>(7) Samples identifying key potential stakeholders associated with the implementation of responses related to permafrost thaw and climate change impacts</b></p>	<p><b>Interviewee</b></p>	<p><b>Quote #</b></p>
<p>“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..”</p>	<p>Minister of Nature Protection</p>	<p>21</p>
<p>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</p>	<p>Former representative of the</p>	<p>22</p>

<p>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!"</p>	<p>Indigenous People in the Parliament</p>	
<p>"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"</p>	<p>Law student from Yakutsk</p>	<p>23</p>

<p>“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).”</p>	<p>Representative of the Institute for Humanitarian Research and Indigenous Issues</p>	<p>24</p>
<p>“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.”</p>	<p>Seamstress</p>	<p>25</p>
<p>“Most people don’t want to know about the conditions of permafrost. This is a topic for scientists.”</p>	<p>Student from Tiksi #1</p>	<p>26</p>

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

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





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.