



**HAL**  
open science

## **Adaptive capacity for climate change: Local initiatives and federal planning. The case of Tiksi, Sakha Republic, Russia**

Charlotte da Cunha, Inga Nikulkina, Jean-Paul Vanderlinden, Vyacheslav Shadrin, Natalia Doloisio, Dina Salakhova

### **► To cite this version:**

Charlotte da Cunha, Inga Nikulkina, Jean-Paul Vanderlinden, Vyacheslav Shadrin, Natalia Doloisio, et al.. Adaptive capacity for climate change: Local initiatives and federal planning. The case of Tiksi, Sakha Republic, Russia. *Polar Science*, 2022, 31, pp.100761. 10.1016/j.polar.2021.100761 . hal-03425267

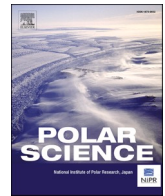
**HAL Id: hal-03425267**

**<https://hal.science/hal-03425267>**

Submitted on 15 Apr 2022

**HAL** is a multi-disciplinary open access archive for the deposit and dissemination of scientific research documents, whether they are published or not. The documents may come from teaching and research institutions in France or abroad, or from public or private research centers.

L'archive ouverte pluridisciplinaire **HAL**, est destinée au dépôt et à la diffusion de documents scientifiques de niveau recherche, publiés ou non, émanant des établissements d'enseignement et de recherche français ou étrangers, des laboratoires publics ou privés.



## Adaptive capacity for climate change: Local initiatives and federal planning. The case of Tiksi, Sakha Republic, Russia

Charlotte da Cunha<sup>a,\*</sup>, Inga Nikulkina<sup>b,c</sup>, Jean-Paul Vanderlinden<sup>a</sup>, Vyacheslav Shadrin<sup>d</sup>, Natalia Doloisio<sup>a</sup>, Dina Salakhova<sup>a</sup>

<sup>a</sup> CEARC Laboratory, University of Versailles Saint-Quentin-en-Yvelines/Université Paris Saclay, France

<sup>b</sup> Department of Taxes and Tax Administration, Faculty of Taxes, Audit and Business Analysis, Financial University Under the Government of the Russian Federation (Financial University), Russia

<sup>c</sup> Department of Economics and Finance, Financial and Economic Institute, M.K. North-Eastern Federal University (NEFU), Russia

<sup>d</sup> Institute for Humanities Research and Indigenous Studies of the North, Siberian Branch of Russian Academy of Sciences (IHRISN), Russia

### ARTICLE INFO

#### Keywords:

Climate change  
Adaptive capacities  
Sakha republic  
Uncertainties  
Federal-level dependency

### ABSTRACT

Climate change exacerbates existing threats and risks and generates new ones in the lives of the Indigenous people of the Arctic regions. The ability to cope with climate variability and extreme events is largely dependent on territorial adaptive capacities and vulnerabilities in addition to the level of regional economic development. The purpose of this article is to understand if the people living in Tiksi and its hinterland are aware of the impacts of climate change and attribute importance to them, as well as to determine if they have adaptation actions and strategies have been put in place. The future of Tiksi's population is uncertain and is highly dependent on the federal government. Issues relating to climate change are not a high priority for the local populations. Although the population of the Bulunsky district has maintained some capacity for adaptation, both uncertainty about the future and their dependence on decisions made at a higher level are undermining their ability to plan for adaptation in the long term.

### 1. Introduction

The ability to cope with climate variability and extreme events is largely determined by the level of territorial and individual adaptive capacities and vulnerabilities, and the level of regional economic development (Cardona et al., 2012; Thomas et al., 2019). These factors determine the ability of local communities to react positively or negatively to climate changes. Whether they benefit from, mitigate or suffer from these changes will vary depending on the adaptability of the populations.

One essential element of adaptation, adaptation planning, aims to reduce human vulnerability to the current and future negative impacts of climate change by designing policies, programs and plans for adaptation (da Cunha and Lioubimtseva, In press). However, it remains unclear how to address social and environmental inequity and to what extent the residents of urban and rural settlements have something to

contribute and how their opinions could influence the adaptation measures adopted (Anguelovski et al., 2016; Lioubimtseva and da Cunha, In press; Thomas et al., 2019).

Are vulnerable populations interested in climate change, have they identified its effects, and lastly, how willing are they to adapt? These issues are becoming increasingly significant in different geographical contexts and circumstances (Anguelovski et al., 2016; Baztan et al., 2020; Cameron, 2012; Huntington et al., 2019; Olazabal et al., 2019; Thomas et al., 2019). Vulnerability assessment and response strategies to natural climate variability provide a good starting point for the study of adaptation needs (Smit et al., 1999; Smit and Wandel, 2006).

Climate change exacerbates existing threats and risks and generates new ones in the lives of the Indigenous people of the Arctic regions. It exerts pressure on the environment as well as on social, economic and cultural dimensions. (AMAP, 2017; Doloisio and Vanderlinden, 2020; Huntington et al., 2019; Nuttall, 2018). Huntington et al. (2019) It has

*Abbreviations:* ARTistic project, Adaptation Research a Trans-disciplinary Transnational Community and Policy Centred Approach; NEFU, North-Eastern Federal; UVSQ, University of Versailles Saint-Quentin-en-Yvelines.

\* Corresponding author. 11 boulevard d'Alembert 78280 Guyancourt, France.

*E-mail addresses:* [charlotte.da-cunha@uvsq.fr](mailto:charlotte.da-cunha@uvsq.fr) (C. da Cunha), [inga123456@yandex.ru](mailto:inga123456@yandex.ru) (I. Nikulkina), [jean-paul.vanderlinden@uvsq.fr](mailto:jean-paul.vanderlinden@uvsq.fr) (J.-P. Vanderlinden), [odulshadrin@mail.ru](mailto:odulshadrin@mail.ru) (V. Shadrin), [n.doloisio@hotmail.com](mailto:n.doloisio@hotmail.com) (N. Doloisio), [di.salakhova@gmail.com](mailto:di.salakhova@gmail.com) (D. Salakhova).

<https://doi.org/10.1016/j.polar.2021.100761>

Received 24 May 2021; Received in revised form 17 September 2021; Accepted 28 October 2021

Available online 2 November 2021

1873-9652/© 2021 The Authors. Published by Elsevier B.V. This is an open access article under the CC BY-NC-ND license (<http://creativecommons.org/licenses/by-nc-nd/4.0/>).

been established that “many studies still retain a central focus on climate even as they consider multiple factors that affect people; they can thus overlook or minimize the principal concerns, knowledge, politics, livelihoods, experiences, and priorities of people themselves as research agendas driven by outsiders focus on climate change rather than on the people themselves”. It is important to consider climate change issues, but also the other issues it raises. It is important to identify stories of adaptability and resilience in the past and present (Cameron, 2012; Ford et al., 2015) and to highlight the adaptive capacities of the Arctic people for the future. These adaptive capacities are multi-factorial and will be influenced by political, economic or social dimensions that may be more or less deeply embedded (Ford et al., 2015).

The focus of this paper is on Tiksi (Тикси) and its interdependent hinterland, the Bulunsky District, taking into account its history and governance processes, as well as its heavy reliance on natural resources. It is located in the Sakha Republic (Yakutia) which covers an area of over 3 000 000 km<sup>2</sup>. The Arctic zone represents about 52% of the territory of the republic (Doloisio and Vanderlinden, 2020).

Starting from a predominantly autochthonous occupation of the territory, the planned economy during the Soviet period changed the socio-economic structures of the region. In 1932, the Soviet Union undertook the first northeastern passage without wintering: the Sibiryakov expedition was the first icebreaker to sail from Arkhangelsk to the Bering Strait. After the Second World War, the Northeast Passage allowed ships to navigate between the Atlantic and Pacific Oceans while remaining out of the control of the United States. Although it concerned only a few dozen boats a year, it was considered to be strategic by the USSR so it built a dozen ports, accessible only two or three months per year, in sheltered bays and Arctic Ocean estuaries: Tiksi on the Lena, Nordvik on the Gulf of Khatanga, etc. (Van Grunderbeek, 2013).

Founded in 1933, Tiksi is located in a border zone where special access rules apply. “A sea frozen for ten months of the year and its endless tundra [...] Tiksi recounts its own piece of Soviet history” (translated from (Vitkine, 2012)). This city was an important strategic military and scientific base endowed with an airport infrastructure essential for its accessibility. A wave of immigration from all over the USSR brought people attracted by work, high wages and/or a romantic vision of the Far North which allowed Tiksi to reach its peak of 11 649 inhabitants in 1989 (1989 Soviet Census).

The collapse of the USSR and the rapid transition to a market economy led to the liberalization of societies and a significant reduction in freight flows. This, along with the long winters, has resulted in the suspension of the shipping line terminus to the west and a strong shift in migration from moderate immigration to the North in the 1980s to large scale emigration in the post-Soviet period (Milanovic, 1998). Moreover, the decline of the military base and the airport produced a sharp increase in unemployment. Since 1990, many families have left the Bulunsky District and moved to larger cities in Siberia (Laruelle, 2016; Prokhorova, 2013, p. 35–36). The population of Tiksi has fallen to 5063 inhabitants (2010 Russian Census), with more than half of its population leaving the district between 1990 and 2014. The populations of both are still decreasing.

The Russian government has implemented an active state policy for the Arctic over the past few years. There is an “adjustment” (or rather “reconfiguration”) of the modern system of state regulation of the development of the Arctic zone. It aims to increase the economic development of the territories of the Arctic zone of the Russian Federation and to improve the quality of life of the population of the Russian Arctic.

In 2020, a whole set of strategic documents stating the policy of Russia in the Arctic was adopted (Table 1), including the “Fundamentals of the state policy of the Russian Federation in the Arctic for the period up to 2035 and beyond” and the “Strategy for the development of the Arctic zone of the Russian Federation and ensuring national security for the period up to 2035”. The latter defines an implementation plan for the integrated social and economic development of the Arctic territories in

**Table 1**

Key strategic planning documents and legal acts concerning the development of the Arctic Zone for the period up to 2035 (compiled by the authors according to (Portal of State Programs of the Russian Federation, 2021)).

Year	Name of the document	Purpose
2020	Fundamentals of State Policy of the Russian Federation in the Arctic for the period up to 2035 and beyond.	It defines the main objectives, main tasks, strategic priorities and mechanisms for implementing the state policy of the Russian Federation in the Arctic, as well as the system of strategic planning measures for socio-economic development of the Arctic zone of the Russian Federation.
2020	Strategy for Development of the Arctic Zone of the Russian Federation and National Security for the Period up to 2035.	Defense of national interests and achievement of the objectives of the state policy of the Russian Federation in the Arctic by completing the main tasks, considering the strategic priorities defined in the <i>Fundamentals of State Policy in the Arctic</i> and ensuring national security and sustainable socio-economic development of the Russian Arctic
2020	Socio-economic development of the Far Eastern Federal District until 2035	To accelerate regional economic development, improve population conditions, and prevent population exodus.
	Including Arctic Hectare Program (2021)	To improve the quality of life of Far East residents. Simplified procedure for the provision of land plots for free use, in accordance with Federal Law N 119- FZ - only to citizens of the Russian Federation who are registered at the place of residence on the territory of the corresponding constituent entity of the Russian Federation or the corresponding municipality
2021	State Program of the Russian Federation: “Social and Economic Development of the Arctic Zone of the Russian Federation” until 2025	To boost the economic development of territories within the Arctic Zone; To increase the contribution of the Arctic territories to the country’s economic growth To ensure the sustainable socio-economic development of the macro-region

terms of science and technology; information and telecommunication infrastructure; environmental protection; international cooperation; and defense and national border control (Kudryashova et al., 2019, Buchanan, 2020). Significant changes were also made in Russian legislation, including the introduction of various preferences and tax incentives. At the regional level, the Republic of Sakha (Yakutia) implemented a comprehensive socio-economic development program for the Arctic districts up to 2020 (Accounts Chamber of the Russian Federation, 2014; Public Chamber of the Republic of Sakha, 2016).

The aim of these development programs is to narrow the development gap between the Arctic districts and the rest of the republic, as they are currently constrained by a number of economic social, organizational and managerial problems (Borisov et al., 2015; Federation Council, 2019, 2020; Larchenko and Kolesnikov, 2017; Nikulkina, 2018; Nikulkina and Filimonova, 2019; Peshina and Zakharov, 2017; Selin, 2013; Tatarkina, 2014). At the same time, these policies seek to control access to this strategic territory. We can question, as underlined in Ford et al. (2015), the position of authorities with regard to climate change, as they tend to consider it as an opportunity to be dealt with through adaptation rather than a threat.

The purpose of this article is to understand if people living in Tiksi and its hinterland are aware of the impacts of climate change and global

warming and if they consider these to be important, but also to identify other issues they face. We also aim to identify their actions and strategies for adaptation to climate change. The paper consists of five sections, including introduction, methods and data, findings on local issues and adaptation strategies, discussion, and conclusions.

## 2. Methods and data

This article presents the data from a field trip in November 2014, piloted by the ARTistic project (Adaptation Research a Transdisciplinary Transnational Community and Policy Centred Approach) and conducted jointly with a Russian research team from North-Eastern Federal University (NEFU) with a general understanding of the Bulunsky District case study and specific disciplinary knowledge of Northern Yakutia (anthropology, biology, physics etc.) and social scientists from the University of Versailles (UVSQ). This formed the basis for an exploratory case study of the town of Tiksi and its hinterland to study its strategies for adaptation to climate change. We conducted qualitative and quantitative surveys based on conceptual and interview frameworks established by the ARTistic project while remaining open to new knowledge and hypotheses.

The purpose of the qualitative interview was to gather an understanding of environmental changes and adaptive capacities. Semi-structured interviews were designed from pre-identified themes which aimed to identify and describe adaptation initiatives to global challenges with a special focus on climate change, specifically, identification of changes in places and activities; measures/actions implemented in order to cope with these changes; adaptation processes in the past and potential ones for the future. We contacted a sample of local stakeholders, representative of social diversity of Tiksi and its hinterland. Thus, 15 interviews of representatives from six stakeholder categories (federal authorities, state authorities, municipal authorities, Indigenous people, scientists and business) and one focus group (FG) produced a lot of dense qualitative data (see [Appendix A](#)).

Analysis was done based on grounded theory, a methodology for generating theories from field data using inductive reasoning. It aims to group the data into categories and then to deduce theories and extract meaning from a situation so that the various elements can be linked ([Glaser and Strauss, 1967](#); [Paillé, 1994](#)). The semi-structured interviews were transcribed and treated using the qualitative data analysis software, Atlas.ti. In this process, text quotes were classified according to a set of codes, defined from pre-identified themes and complemented using inductive reasoning as relevant elements arose from the transcripts themselves. The quotes cited in this article are anonymous and have been translated by a native Russian speaker from Russian to English, and then English proofread ([Appendix B](#)). There may be some inaccuracies due to the difficulties inherent to any translation, the different grammar rules and the individual ways of expressing oneself in a culture. Thus, they should not be considered as exact quotations.

The quantitative survey was conducted in the Bulunsky District with 122 respondents ([Appendix C](#)). The 16 multiple-choice questions aimed to study public opinion on climate change, its impact on everyday life and the practical implementation of measures against global warming ([Appendix D](#)). The survey also asked questions about their everyday concerns, their intention/desire to move from Tiksi, the way they imagine the future, and some socio-demographic questions ([Sukneva and Nikulkina, 2017](#)).

## 3. Results

### 3.1. The changing climate, an issue among others

The future of Tiksi is of strategic importance due to its geographical location and the opening of the Northeast Passage due to climate change is regarded as an opportunity ([L'équipe, 2010](#); [Martin, 2014](#); [Thorez, 2008](#); [Van Grunderbeek, 2013](#)). In 2014, the Russian Ministry of Defense

announced that Russia would build or restore six military towns, with living and service conditions of a high standard, in their Arctic region, including Tiksi, to reinforce its role as a “maritime rescue subcenter” ([Bennett, 2014](#); [Busch, 2017](#); [Lalonde, 2017](#); [Melino et al., 2020](#)). There is also a plan to renovate the Tiksi airport infrastructure ([The Moscow Times, 2014](#)). It has been recently approved for medium-size aircrafts and air companies are now considering the establishment of regular flights to Moscow. As part of the federal Development Strategy for the Arctic Zone, the North Yakutia Support Zone will include reconstruction of the Tiksi seaport. In addition, new ships for river-sea shipping are to be built and a regional shipyard developed ([Staalesen, 2017](#)). Other projects for local power supply are emerging ([Staalesen, 2018](#)).

In fact, this comprehensive program for the socio-economic development of the Arctic was not fully financed by the federal and regional budgets. Therefore, the goals and objectives for the planned activities of the state program were not fully achieved and fulfilled. The real needs of the Arctic zone are not being fully met and the goals of sustainable socio-economic development and a reliable level of subsistence for the population are not being achieved ([Accounts Chamber of the Russian Federation, 2014](#); [Federation Council, 2019, 2020](#); [Nikulkina, 2018](#)). Furthermore, Russia appears to be significantly behind in its plans for Tiksi, or is unable to send permanent equipment as other Arctic bases are of higher priority ([Melino et al., 2020](#)).

Therefore, Tiksi is evolving in a highly uncertain context, with a mix of environmental pressures like climate change and economic, political and social uncertainties. Our surveys focus on climate change and its impacts on everyday life, but also investigate other challenges and concerns. During the quantitative survey, respondents were asked to select five answers from the options provided in response to the following question “Which everyday problems worry you most?” (see occurrences of choices in [Fig. 1](#)). We extracted the most relevant mentions from the qualitative survey to confirm or mediate the results on this question about everyday problems. All quotes are presented in [Appendix B](#).

The issues highlighted by the respondents are closely linked to circumpolar conditions and insularity and are mostly shared with other Arctic communities ([Cameron, 2012](#); [Council of Canadian Academies, 2014](#); [Forbes and Stammer, 2009](#); [Huntington et al., 2019](#)). Climate change may exacerbate other problems, particularly the central issue of Tiksi’s accessibility with other towns of the Sakha republic and its hinterland.

The most frequently highlighted problems are: High prices (14.3%); Alcoholism and heavy drinking (13.4%); Low wages and pensions (9.1%); Work by the public services (8.3%); Lack of attention by federal authorities to the problems of the northern territory (6.9%); Unemployment (6.7%). Similarly, during qualitative interviews, respondents mostly highlighted social problems: alcoholism, high prices, low salaries and unemployment (*Quotes # 1 to 4*). Participants also mention difficulties associated with climate conditions, mostly linked to living conditions, food and medicine supply and transportation. In connection with these concerns, people blame the state and federal authorities for not sufficiently taking responsibility for these issues (*Quotes # 5, 6*).

Child neglect (3.1%) and Problems of school education (2.1%) were low on the scale of worries in the quantitative survey, but are of major concern in the qualitative survey for education stakeholders who were also preoccupied with the lack of sunlight and vitamins as well as teenage suicides (*Quotes # 7, 8*). These worries should be analyzed against another interesting category from the quantitative survey: a state of anomie and deterioration of relationships between people (6%), which featured as a backdrop in many interviews.

Environmental pollution (6.7%) is also emphasized as a concern in qualitative interviews but is considered to be of secondary importance, as solving environmental problems will not improve people’s lives as much as sorting out social concerns. People highlight seawater pollution and pollution caused by forest fires as these affect fish quality and the migration paths of reindeer (*Quotes # 9, 10*).

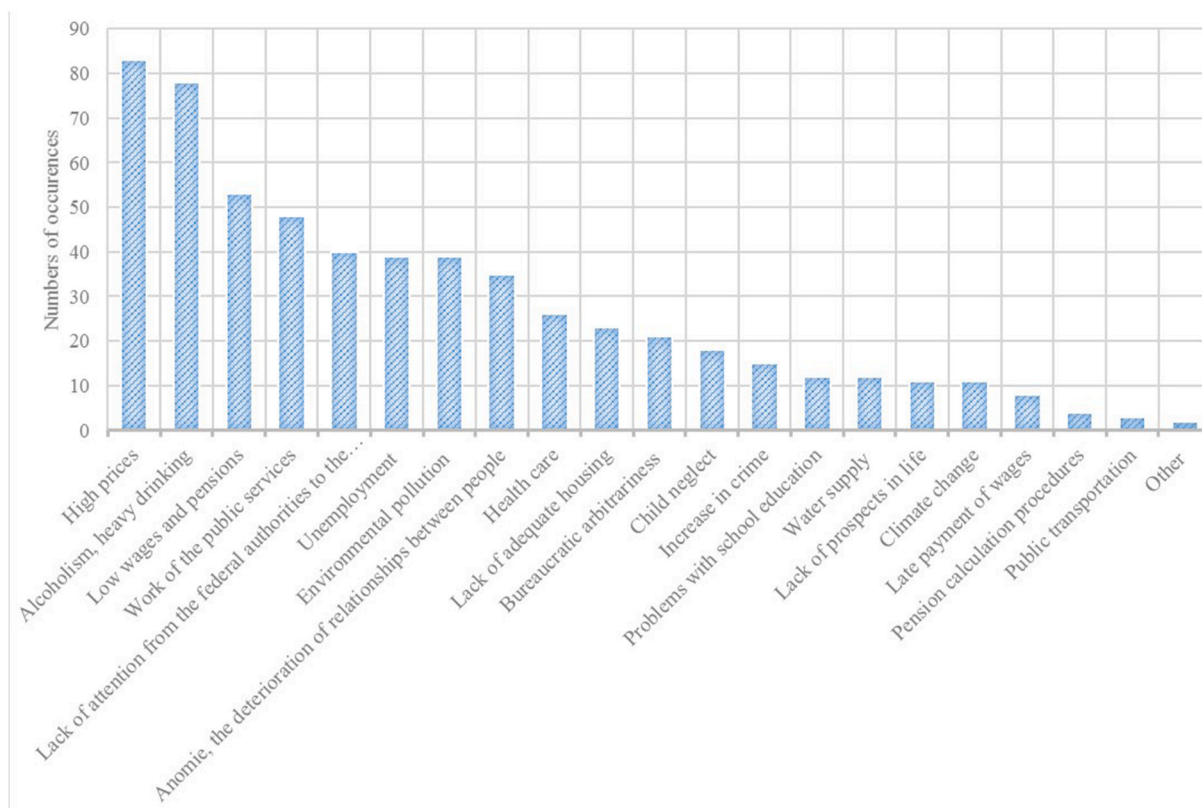


Fig. 1. Distribution of answers to the question “What are the daily problems that bother you most?” (by number of occurrence).

Respondents also highlight the need for compensation for mining pollution (Quote # 11). Climate warming in the Arctic is expected to increase the accessibility of mineral deposits, creating more favorable conditions for industrial mining. Exploitation of coal and alluvial diamond deposits and oil and gas exploration in the continental shelf of the Laptev Sea has already started in the region.

However, these activities can exert additional pressure on traditional livelihoods and the well-being of local communities (Behrends and Schareika, 2010; Yakovleva, 2014). Ford et al. (2010) points out that industry representatives are consulted in relation to the impacts of climate change on mining but community members are not. Moreover, it is very possible that Indigenous peoples will not benefit from the activities of large-scale extraction projects. These industries create jobs in the mines but these positions are rarely given to Indigenous people, mainly due to a lack of skills, training or standardized education (Quote # 12). Likewise, Nadasdy (1999, p4) notes that scientists emphasize the traditional dimensions of Indigenous knowledge and disregard the possibility that aboriginal people might have distinct cultural perspectives on modern industrial activities such as logging or mining.

Finally, another concern is pollution. Participants suggested some actions to reduce it (Quotes # 13, 14). For instance, boats should be banned from throwing fuel into the rivers and sea. Regulation and depollution actions are necessary and the waste recycling plant should be re-opened.

The problem of “Climate change” only receives 1.9% of mentions in the quantitative survey. Although 84.7% of the respondents say they feel changes in climate (question 4), these changes seem not to be judged as important. Some respondents do not detect any changes (Quote # 15). Others observe changes in terms of fauna (wild reindeer), and flora (mushroom, berries, bushes, type of flowers), in particular, an earlier maturation of berries. Not surprisingly, climate change is deemed a matter of concern for the local population when it affects their lives negatively on a daily basis. The tenability of the airport as well as the opening of roads in winter is of primary importance for Tiksi as a

reduced transport service hinders delivery of medicines, foods, fuel and other essential goods and reduces contact with the outside world (Quotes # 16).

Respondents also identify an increasing risk of flooding in Nayba (Найба), in Kyusyur (Кюсюр) (Quotes # 17), as well as rapid coastal erosion (Quote # 18), issues that raise the question of shutting down or transferring settlements. Moreover, thawing permafrost is leading to flooding and a loss of pastures (Quote # 19). Coastal erosion, due to permafrost thaw, poses a particular problem for Bykovskiy, nibbling at its old cemetery. On the other hand, coastal erosion and permafrost thaw facilitates the finding of ivory fossils collected from defrosting mammoths (Quote # 20).

Another manifestation of climate change is an increase in unpredictability. For local populations, natural phenomena have become more difficult to predict as indicators are modified by climate change. For instance, the timing of the arrival of fish is changing due to the temperature of the water. Movements of the shoals of fish also change but the inhabitants cannot understand why (Quote # 21). Another predictability issue is linked to weather phenomena (polar night, blizzard, frost, etc.). Participants explain that it is becoming more difficult to know what weather is coming and find that variability, even within a day, is higher. The reindeer breeders depend on predictability and become disoriented as a consequence of changes in climate (Quote # 22). These changes lead to an increase in the number of accidents, especially related to late freezing-over, frazil, early floods and low snow cover (Alexander et al., 2011).

Respondents are pessimistic about these issues and about the ability of funding and programs to resolve them. They complain about the lack of funding and planning, and remote decision-making. They also highlight that they have almost reached a critical population threshold and have lost economic activities (market gardening, waste treatment plant, metal processing operations) that strike at adaptive capabilities.

### 3.2. Local adaptive strategies in Tiksi and its hinterland

Environmental changes and other issues generally push Arctic people to adapt and innovate using their knowledge and resources (Huntington et al., 2019; Pearce et al., 2015). The capacity of the people to adapt to these changes is embedded in their everyday habits. For example, Evenki, Yakuts, Yamal-Nenets, Khanty, and other reindeer herders in Siberia use mobile technologies and thus have new ways of being mobile. They have added ethno-tourism, sales of traditional arts and crafts and other activities to their usual livelihoods (Stammler, 2013).

According to the Intergovernmental Panel on Climate Change, the process of adaptation can take three different forms: 1. Autonomous adaptation (adaptation in response to climate and climatic effects experienced, without explicit planning or a conscious focus on addressing climate change), 2. Incremental adaptation (adaptation actions where the central aim is to maintain the essence and integrity of a system or process at a given scale), and 3. Transformational adaptation (adaptation that changes the fundamental attributes of a system in response to climate and its effects) (IPCC, 2014). In the Arctic zone, adaptation is often associated with 1) changes in daily life and/or 2) the need for investments or funding to tackle the various impacts of climate change on northern lives and livelihoods.

Despite the pessimism, there is some local adaptive capacity and there is potential for action, more so within rural settlements than in urban Tiksi. We display below five types of adaptive strategies, also classified according to the above definitions in Table 2.

One important form of local adaptation planning is a mandatory flood prevention plan that is produced every year (Quote # 23). In Nayba, they are working on a plan for the evacuation of people in the case of flooding, relocating them to Tiksi or elsewhere on the Lena River (Quote # 24). The universal fear of losing their home and land caused people to resist moving. Due to the changing climate, environments are being fundamentally altered or disrupted and to an increasing extent, this is challenging individuals' attachment to place (Doloisio and Vanderlinden, 2020; Quinn et al., 2015).

In addition, people are developing diverse adaptation strategies to cope with coastal and bank erosion. A member of the State Natural Reserve "Ust-Lensky" (Quote # 25) and the Head of the Bulunsky region have become aware of coastline erosion and have requested scientific data on this topic to help to implement strategies to stabilize the banks. In Kyusyur, authorities plan to abandon a school that is currently affected by the erosion processes and build a new one (Quote # 26).

Transportation is a big concern for the Tiksi hinterland. Climate change influences decision-making on the opening of roads in winter, and some respondents in rural settlements have become afraid to use them because of previous accidents (Quote # 27). The official opening of winter roads is being adjusted every year (beginning later and closing earlier) and some never open (Quote # 28). Transportation of school groups on winter roads is forbidden since 2011, with consequences for school transportation and cultural events that have not yet been resolved (Quote # 29). Traditional activities have also had to adapt their methods

**Table 2**  
Classification of local adaptive strategies.

	Autonomous adaptation	Incremental adaptation	Transformational adaptation
<b>Investment or funding needs</b>	/	Flood prevention plan Strategies to combat coastal and bank erosion	/
<b>Changes in daily life</b>	Transportation practices Way of life of reindeer breeders Control of wolf population	/	/

of transportation due to climate change. Fishermen have begun using snowshoes and skis which allow them to walk on thin ice for ice fishing. Hunters have begun practicing for the trips on the rivers before they freeze up in winter so that they can arrive in their hunting areas on time.

Transportation has also deteriorated with the closure of the military base, as the military unit used to help with the delivery of synthetic vitamins to schools by helicopter. Nevertheless, this lack of access to the vitamins has led to local adaptation measures such as farming by schools in Siktyakh (Сиктыах) and Kyusyur, harvesting of berries, and mushrooms in Naiba and Siktyakh schools. The schools themselves prepare berries, mushrooms, and vegetables in summertime in order to compensate for the lack of vitamins in winter (Quote # 30). In Siktyakh, greenhouse domestic farming is in a development phase.

If we focus on the adaptive capacity of the Indigenous people, access to natural resources is closely related to the security of working conditions that their traditional knowledge offers them (Doloisio and Vanderlinden, 2020). The ongoing climate changes are transforming real life: the migration of reindeer is delayed in winter; reindeer breeders struggle with disease management when the summers are too hot (Quote # 31), and the thaw of permafrost is leading to flooding and loss of pasture area. Herds are slowly being moved from lowlands to mountainous areas (Quote # 17). Indigenous peoples are increasingly finding themselves in situations where their practices, experience and knowledge can no longer help them. As a result, the economic conditions for the production of the traditional crafts of the Indigenous peoples are deteriorating and adaptations strategies are appearing.

Reindeer breeders' ways of working and their experiences are a mix of ancestral know-how on reindeer herd management and more modern practices from recent history since the Soviet period. Nowadays, they manage to maintain their livelihood and avoid big losses by reintegrating the knowledge and experience of older herders. For instance, reindeer-herding brigades that include herders-teachers with many years of working experience produce better results. Under conditions of thick crust, they choose migration routes near the river banks on slopes where it is easier to access the lichen (Alexander et al., 2011) and they use snowmobiles ahead of the herd in order to break up the solid top crust. During hotter summers, the herds are led to mountainous areas. In addition, they seek outside help, such as asking for more accurate weather forecasts as they depend on predictability (Quote # 22) and scientific research on the wild reindeer population (Quote # 32).

In parallel, reindeer herders make economic adaptations by developing multi-activity income and there is a clear demand to increase subsidies for reindeer herders (Quote # 33). Higher subsidies would allow them to live better, in more modern living conditions, and thus attract young people. These combined factors are driving a trend toward more a more sedentary lifestyle and a loss of cultural traditions (Quote # 34).

Another concern for reindeer herders is controlling wolf predators, which represent a direct threat to reindeer. Local administrations allocate funds to organize wolf hunts but this is not enough (Quote # 35). An efficient solution needs to be found to cope with the problem of wolf attacks on reindeer herds. Respondents consider that wolf hunting, by its nature, is too difficult without external federal help, which previously took the form of hunting from helicopters (Quote # 36). Herders feel that the possibilities for action by them are limited and, in discussion they express the need to invest in controlling the population of wolves to maintain the integrity of their system. On the other hand, one respondent highlights another more local adaptive action: wolves are necessary to cull the weakest animals in the herds. Consequently, it is better to regulate the wolf packs from the inside instead of killing entire packs so that the fragile tundra ecosystem is respected (Quote # 37).

## 4. Discussions

It is essential to pay particular attention to the historical processes and the adaptive capacity of the Bulunsky district in order to cope with

climatic, political, social and economic changes. The current mode of governance is still influenced by the Soviet planning of the past, causing people to expect decision-making at the federal level. Regarding measures against global warming (question 9), 37.6% of the respondents to the quantitative survey affirm that solutions should come from the federal government, 16.9% from regional authorities and 14.6% from local authorities. Only 7.3% of the respondents expect that actions will come from inhabitants themselves. Even when there is potential for local autonomous adaptive measures, based on change in daily life, the reflex of most of the Arctic population is to turn to the federal government for funding and planning (Ford et al., 2015).

This link with the federal government is not passive however and clearly formulated requests to ensure the future of the district and its activities are submitted to it by local authorities and others administration members. Although the hinterland looks better positioned to propose local adaptation strategies, Tiksi plays the role of administrative center and is more proactive in its relationship with the federal government than other settlements in the Bulunsky District. Local authorities develop and propose changes in the current legislation, in the regulations or new incentive policies at the republic and federal levels.

Their expectations focus on public programs and policies to protect and develop the district. For example, respondents refer to federal level development policies as investment incentives which aim to attract companies and encourage local entrepreneurship. Also, the Bulunsky district makes requests to include Nayba's coastal erosion issues in federal and regional programs. Respondents highlight the role that local administrations can play in ensuring the effective implementation of these policies and programs.

Moreover, legislative changes to help Tiksi and the Bulunsky District to enhance the quality of life of their inhabitants were suggested in the qualitative survey: change of the district status to mountain-taiga zone; use of the index of climate severity as a way of financing northern regions; and a change of status for reindeer herders (transition from subsidized activities to public servants). These changes can only be made at the federal level and require an allocated budget.

This reliance on the federal level can be analyzed from two different perspectives. The first is linked to the funding of programs for local initiatives and legislative changes, as well as subsidies for economic activities. Local decision-makers estimate that funding must come from the regional and federal levels as the district does not have sufficient financial resources.

The second perspective refers to the special place of Tiksi and its hinterland in Russia. Tiksi is the only urban settlement in the Bulunsky district and has become a focal point in the life of the area. Different Indigenous groups have traditionally occupied the Russian Arctic territory leading to a current multi-ethnicity (Doloisio and Vanderlinden, 2020). In Tiksi, residents are mainly Russians and Ukrainians, while in rural settlements, Indigenous people are predominant: Evenks, Yakuts and Evens (Federal State Statistic Service, 2014).

Sovietization has brought about a deep reorganization and transformation of Indigenous economies (Takakura, 2012): reindeer herders have gone from a plurality of activities to specialization (reindeer meat for export during the emergence of the sovkhos) and a policy of immobilization led Indigenous people to move from small mobile villages to wooden houses in settlements. Nowadays, Indigenous people are returning to diversification (the community's subsistence shifted from reindeer herding to reindeer hunting), as they have more needs than before (permanent housing, television, computers, and clothing) that are difficult to meet with the low income from breeding alone.

This plurality of activities encourages Indigenous people to come to Tiksi for employment which adds to its attractiveness as the administrative center of the Bulunsky district (Statistical yearbook of Yakoutia, 2018): the rural population comes here to access banking facilities, to deal with administrative requests, and to receive health care. Tiksi acts as a Russian relay for this isolated territory, leading Tiksi and its hinterland to be interdependent. Indigenous people need Tiksi for their

everyday life endeavors, and the existence of Tiksi is partly justified by the maintenance of minimal activities in the Bulunsky district, made necessary by its strategic geographical location.

Thus, some problems need to be managed at the federal level as they require strategic federal interest and large amounts of funding. The role of Tiksi in strategic decisions linked to the northern sea route of Tiksi cannot be decided at the local level (e.g. reopening the military base, rehabilitation of the port, renovation of roads, improvement of the communication network). This situation effectively places local decision-makers in a situation of strong dependence on federal decision-making. Local authorities make requests to federal authorities but respondents in the 2014 survey doubt that the federal government is concerned about the Bulunsky district.

The abovementioned statements date from 2014. They allow us to compare the demands with recent development strategies and Federal Law. In 2008, the 'Foundations of State Policy of the Russian Federation for the Arctic up to 2020 and Beyond' was published and the region has been established as an independent object of state policy (Kudryashova et al., 2019). A system of strategic planning documents for social and economic development of the Arctic region and national security protection has been established. Budgetary regulation of the development of the Arctic territories of Russia is carried out through the implementation of state programs. Nowadays, there are more than 20 publicly declared and published federal state programs, highlighting the Arctic zone as a special development territory (Portal of State Programs of the Russian Federation, 2021).

It should be noted that strategic planning documents are not legal acts. These are documents in the sphere of development of the Arctic Zone of the Russian Federation, but there is no single legislative act regulating the activities in the Arctic Zone. As example, the Federal Law « On state support of entrepreneurial activity in the Arctic zone of the Russian Federation » create favorable conditions for entrepreneurial activity in the Arctic Zone and the Federal Law "On Amendments to Part Two of the Tax Code of the Russian Federation in connection with the adoption of the Federal Law" provide tax preferences to entrepreneurs in the Arctic to stimulate economic activities.

Predictably, specific legislation changes for district or reindeer herders status are not an issue of strategic documents. The above strategies and Federal Laws could have been a response to the respondents demand for investment incentives. Unfortunately, the continuing shortage of financial resources in the Bulunsky district can be explained by uneven distribution, with almost all investments going to regions with significant volumes of hydrocarbon production and major projects for the development of new oil and gas fields. The purpose of most of the tax incentives is also to create favorable conditions for hydrocarbon production activities (Nikulkina, 2018).

Another significant problem with state programs that hinders the development of the Arctic zone of the Russian Federation is insufficient funding of programs, despite the significant growth of the planned indicators of allocated funds. The progress report on the implementation of the program at the end of 2016 shows that 84% of the planned funds were allocated in 2014, 94% in 2015, and 93% in 2016 (Public Chamber of the Republic of Sakha, 2016). In 2019, the largest number of defaults in absolute values are in extra-budgetary funds and the federal budget, while regional budgets allocated more than 36% more funds than originally planned (Table 3). The Accounts Chamber of Russia explained the decrease in the cash execution indicators of some programs by the lack of a comprehensive approach in their formation. It is noted that the planning of specific activities for the development of the Arctic and their financial support seems inconsistent in the absence of an established system of strategic planning documents (Accounts Chamber of the Russian Federation, 2020).

Thus, the Arctic regions are not equally stimulated and suffer insufficient financial support as well as unevenness and instability in this financial support. The goals of socio-economic development of the Arctic Zone and support for the stability of life in the Arctic are not

**Table 3**

Planned versus actual financing of the Arctic in state programs in FY 2019, in thousands of rubles (compiled by the authors according to (Portal of State Programs of the Russian Federation, 2021)).

Budget level	Planned values	Actual values	Ratio of actual to planned values
Federal budget	77 892	75 213	96,56%
Regional budgets	146,71	902,06	36,43%
	19 983	27 262	
Local budgets	484,20	990,08	0,67%
	39 797,80	265,00	
Extra-budgetary funds	101 254	75 940	75,00%
	632,16	842,07	
Total	199 150	178 386	89,57%
	386,37	037,41	

achieved. This inequality in the distribution of investment support is not only a problem in itself, but it generates uneven development of the Arctic regions, which, in turn, raises doubts about the effectiveness of the development programs.

Consequently, the current development conditions of the Arctic zone of the Russian Federation require new, adequate and timely fiscal mechanisms for the implementation of state policy. At the regional level, the formation of a new financial institution, the Regional Arctic Fund, is proposed for the development of the Arctic territories of Russia to provide financial support to stimulate investment activities and to support the development of traditional economies (Nikulkina, 2018). The establishment of regional funds for the development of the Arctic territories of Russian regions will foster horizontal inter-budgetary relationships in the macro region. Also, it will permit the formation of a system of targeted ongoing financing of regional "Arctic" projects: infrastructure investment projects; projects for the development of the production sector; energy and communal infrastructural development; air travel; projects aimed at improving quality of life in the Arctic regions, including projects addressing the use of natural resources in the Arctic territories.

To return to the need for adaptation to climate change, adaptation is not specifically referred to as a target in these strategic planning documents. Environmental issues are mostly linked to reduction of pollution. Nevertheless, the multiplicity of plans indicates an awareness of the need to act and it responds to local stakeholders' requests to maintain the essence and integrity of the socio-economic system (without explicit planning for climate change). In this way, they contribute to adaptation and these development-oriented policies represent a concrete formal space where different aspects of adaptation can be introduced and addressed.

## 5. Conclusions

Even if vulnerable populations are the first to suffer from the effects of climate change, especially since they live in places extremely sensitive to change, we realize that climate issues have little importance for them. This observation is not unique to Arctic areas but is also true for developing countries and for vulnerable populations in economically strong areas (Anguelovski et al., 2016; Baztan et al., 2020; Filho et al., 2019; Smucker et al., 2015; Thomas and Twyman, 2005).

Like much of the Arctic region, Tiksi is not a traditional urban settlement as it is of strategic interest for the Russian government. It is particularly vulnerable to climate change and the socio-ecosystem is barely viable as life there is difficult. The future of Tiksi's local population depends on the will of decision-makers in the federal government and climate changes issues are not a high priority for them. People struggle with many issues and uncertainty about the future does not stimulate them to project themselves into the future. What future is possible, desirable and desired?

The interdependence between Tiksi, the regional center, and its

hinterland, coupled with important uncertainties about the future lead to a sense of inadaptability. Uncertainty about the future has not been explicitly expressed (no occurrences) but this is an underlying factor in almost all interviews. The population of Tiksi lives in a chaotic world under constant social, economic and environmental stress caused by the decline in economic activity, emigration of the youth to attend university (mainly in Yakutsk), the decline in traditional crafts which are unattractive to young people, strong dependence on the federal government for subsistence and environmental transformations due to climate change.

How can you find the strength to adapt when you depend on subsidies and federal strategic programs? How can adaptation capabilities be maintained and developed when all of the qualified young people leave? Even if the people of the Bulunsky district keep their adaptive capacities developed by their tradition of living in extreme environments, uncertainty about the future and dependence on the regional and federal authorities call into question the ability of the Bulunsky district to manage adaptation planning in the long term and to implement large-scale projects.

Climate change needs to be given priority and adaptation actions need to be integral to mainstream political policies (Casado-Asensio et al., 2016; Khailani and Perera, 2013; Smit and Wandel, 2006). How can public policies respond to the demands of the Bulunsky district and its social challenges, while implementing measures to adapt to climate change? In these conditions, how can their autonomous adaptive capacities be improved?

Adaptation is not specifically addressed within official development documents as conceived in Western countries/science, but it still represents a concrete concept where multiple key elements (directly and indirectly associated with adaptation) such as development, quality of life of northern inhabitants, conservation of traditional lifestyles, among others, are addressed. More efforts are still required to create new communication channels and spaces between different authorities and stakeholders in order to guarantee that formal policies fit the local urgent necessities. Within this context, it is possible to affirm that they can undoubtedly be useful policy tools that can promote the dialogue between the different stakeholders at federal, regional and local scales in order to find solutions to the main climate and environmental challenges that local residents from settlements like Tiksi or Bykovsky are currently facing.

Certain policies such as protection against floods or erosion are in response to societal issues and are adaptation measures, but other actions leaning towards empowerment of these populations could be better financed. Making people aware of the climate issue can only be done by considering the other challenges they face with a view to reducing their overall vulnerabilities (Huntington et al., 2019). In terms of adaptation, the socio-economic development programs should integrate the adaptation actions put in place and support and improve them. The need for higher levels of support for the local reindeer herders, hunters and fishermen is consistently highlighted in interviews and would sustain the Indigenous people who are vulnerable in the Bulunsky district and so improve the relationship between the government and the Indigenous people. It would also reinforce the role of Tiksi as a regional service center, and so help to keep the territory under control.

## Funding

This work was supported by (a) the ARTistic project (Adaptation Research a Trans-disciplinary Transnational Community and Policy Centred Approach) funded by the Belmont Forum International Opportunities Fund [Coastal 2012 call], with contributions from Agence Nationale de la Recherche, France; National Science Foundation, USA; Ministry of Earth Science, India; Russian Foundation for Basic Research, Russia; and Social Science and Humanities Research Council of Canada, Canada and (b) the Nunataryuk project funded by the European Union's Horizon 2020 Research and Innovation Programme [grant agreement



no. 773421].

## Declaration of competing interest

The authors declare that they have no known competing financial interests or personal relationships that could have appeared to influence the work reported in this paper.

## Acknowledgements

The authors wish to thank all the members of the communities where this work was conducted and particularly the team from North-Eastern Federal University (NEFU) that led the fieldwork in Tiksi.

They also wish to thank Mary Minnock for her careful revision of the language.

## Appendix A. Supplementary data

Supplementary data to this article can be found online at <https://doi.org/10.1016/j.polar.2021.100761>.

## References

- Accounts Chamber of the Russian Federation, 2014. Analysis of the Planning of Measures of the State Program of the Russian Federation "Social and Economic Development of the Arctic Zone of the Russian Federation for the Period up to 2020. Russian Federation, Moscow. <https://ach.gov.ru/en/page/expertise-of-draft-laws/>.
- Accounts Chamber of the Russian Federation, 2020. Socio-economic Development of the Arctic Zone Russian Federation. <https://ach.gov.ru/upload/iblock/439/439ec1e5ba8d9f996b06609423fdffc9.pdf>.
- Alexander, C., Bynum, N., Johnson, E., King, U., Mustonen, T., Neofotis, P., Oettlé, N., Rosenzweig, C., Sakakibara, C., Shadrin, V., Vicarelli, M., Waterhouse, J., Weeks, B., 2011. Linking indigenous and scientific knowledge of climate change. *Bioscience* 61, 477–484.
- AMAP, 2017. Adaptation actions for a changing arctic: perspectives from the barents area. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. <https://www.amap.no/documents/download/2981/inline>.
- Angelovski, I., Shi, L., Chu, E., Gallagher, D., Goh, K., Lamb, Z., Reeve, K., Teicher, H., 2016. Equity impacts of urban land use planning for climate adaptation: critical perspectives from the global North and south. *J. Plann. Educ. Res.* 36, 333–348.
- Baztan, J., Vanderlinden, J.-P., Jaffrès, L., Jørgensen, B., Zhu, Z., 2020. Facing climate injustices: community trust-building for climate services through arts and sciences narrative co-production. *Climate Risk Management* 30, 100253.
- Behrends, A., Schareika, N., 2010. Significations of oil in Africa: what (more) can anthropologists contribute to the study of oil? *Suomen Antropologi* 35, 83–86.
- Bennett, M., 2014. Rhetorical or real, Russian expansionism threatens the Arctic. *CRYOPOLITICS*. [www.cryopolitics.com/2014/10/24/rhetorical-or-real-russian-expansionism-threatens-the-arctic/](http://www.cryopolitics.com/2014/10/24/rhetorical-or-real-russian-expansionism-threatens-the-arctic/). Accessed 03/02 2020.
- Borison, V.N., Didenko, N.I., Komkov, N.I., Porfiriev, B.N., Skripnyuk, D.F., 2015. Theory and Practice of the Integrated Development of the Arctic Zone of the Russian Federation: Monograph. Publishing house - Tomsk Polytechnic University, Tomsk, Tomsk Oblast (Russian Federation).
- Buchanan, E., 2020. The overhaul of Russian strategic planning for the Arctic Zone to 2035. NATO Defense College - Research Division, Rome, Italy. <https://www.ndc.nato.int/research/research.php?icode=641>.
- Busch, G.K., 2017. Russia's New Arctic Military Bases. *Lima Charlie News*. Online, [ppp. https://limacharlienews.com/russia/russia-arctic-military-bases/](https://limacharlienews.com/russia/russia-arctic-military-bases/).
- Cameron, E.S., 2012. Securing Indigenous politics: a critique of the vulnerability and adaptation approach to the human dimensions of climate change in the Canadian Arctic. *Global Environ. Change* 22, 103–114.
- Cardona, O.D., van Aalst, M.K., Birkmann, J., Fordham, M., McGregor, G., Perez, R., Pulwarty, R.S., Schipper, E.L.F., Sinh, B.T., 2012. Determinants of risk: exposure and vulnerability. In: Field, C.B., Barros, V., Stocker, T.F., Qin, D., Dokken, D.J., Ebi, K.L., Mastrandrea, M.D., Mach, K.J., Plattner, G.-K., Allen, S.K., Tignor, M., Midgley, P.M. (Eds.), *Managing the Risks of Extreme Events and Disasters to Advance Climate Change Adaptation*. Special Report of Working Groups I and II of the Intergovernmental Panel on Climate Change (IPCC). Cambridge University Press, Cambridge, UK, and New York, NY, USA, pp. 65–108.
- Casado-Asensio, J., Drutshinin, A., Corfee-Morlot, J., Campillo, G., 2016. *Mainstreaming Adaptation in National Development Planning*, vol. 29. OECD Development Co-operation Working Papers.
- Council of Canadian Academies, 2014. *Aboriginal Food Security in Northern Canada: an Assessment of the State of Knowledge*. Canada, Ottawa, ON. <https://cca-reports.ca/reports/aboriginal-food-security-in-northern-canada-an-assessment-of-the-state-of-knowledge/>.
- da Cunha, C., Lioubimtseva, E., In press. Local Climate Change Adaptation Plans: Comparison and Lessons Learned, in: Carrillo, F.J., Garner, C. (Eds.), *City Preparedness for the Climate Crisis*. Edward Elgar Publishing, Northampton, MA, USA, pp. (xx-xx).
- Doloiiso, N., Vanderlinden, J.-P., 2020. The perception of permafrost thaw in the Sakha Republic (Russia): narratives, culture and risk in the face of climate change. *Polar Science* 26, 100589.
- Federal State Statistic Service, 2014. *The Demographic Yearbook of the Republic of Sakha (Yakutia)*. Yakutsk, Yakutia, Russian Federation. <https://eng.gks.ru/Publications/document/13972>.
- Annual Report of the Council on the Arctic and Antarctic to the Federation Council (2018 Federation Council, 2019. On the State and Problems of Legislative Support for the Implementation of the Development Strategy of the Arctic Zone of the Russian Federation and Ensuring National Security for the Period until 2020. Russian Federation, Moscow. Federal Assembly of the Russian Federation. <http://council.gov.ru/structure/docs/54443/>.
- Annual Report of the Council on the Arctic and Antarctic to the Federation Council (2019 Federation Council, 2020. On the State and Problems of Legislative Support for the Implementation of the Foundations of State Policy of the Russian Federation in the Arctic for the Period up to 2035. Russian Federation, Moscow. Federal Assembly of the Russian Federation. <http://council.gov.ru/structure/docs/54443/>.
- Filho, W.L., Balogun, A.-L., Olayide, O.E., Azeiteiro, U.M., Ayal, D.Y., Muñoz, P.D.C., Nagy, G.J., Bynoe, P., Ogue, O., Yannick Toamukum, N., Saroar, M., Li, C., 2019. Assessing the impacts of climate change in cities and their adaptive capacity: towards transformative approaches to climate change adaptation and poverty reduction in urban areas in a set of developing countries. *Sci. Total Environ.* 692, 1175–1190.
- Forbes, B.C., Stammler, F., 2009. Arctic climate change discourse: the contrasting politics of research agendas in the West and Russia. *Polar Res.* 28, 28–42.
- Ford, J.D., McDowell, G., Pearce, T., 2015. The adaptation challenge in the Arctic. *Nat. Clim. Change* 5, 1046–1053.
- Ford, J.D., Pearce, T., Prno, J., Duerden, F., Berrang Ford, L., Beaumier, M., Smith, T., 2010. Perceptions of climate change risks in primary resource use industries: a survey of the Canadian mining sector. *Reg. Environ. Change* 10, 65–81.
- Glaser, B., Strauss, A., 1967. *The Discovery of Grounded Theory: Strategies for Qualitative Research*, 2006. AldineTransaction, New Brunswick. U.S.A.) and London (U.K.).
- Huntington, H.P., Carey, M., Apok, C., Forbes, B.C., Fox, S., Holm, L.K., Ivanova, A., Jaypoody, J., Noongwook, G., Stammler, F., 2019. Climate change in context: putting people first in the Arctic. *Reg. Environ. Change* 19, 1217–1223.
- IPCC, 2014. *AR5 Climate Change 2014: Impacts, Adaptation, and Vulnerability - Glossary*. Contribution of Working Groups II to the Fifth Assessment Report of the Intergovernmental Panel on Climate Change IPCC (Geneva, Switzerland).
- Khailani, D.K., Perera, R., 2013. Mainstreaming disaster resilience attributes in local development plans for the adaptation to climate change induced flooding: a study based on the local plan of Shah Alam City, Malaysia. *Land Use Pol.* 30, 615–627.
- Kudryashova, E.V., Lipina, S.A., Zaikov, K.S., Bocharova, L.K., Lipina, A.V., Yu, Kuprikov, M., Kuprikov, N.M., 2019. Arctic zone of the Russian Federation: development problems and new management philosophy. *The Polar Journal* 9, 445–458.
- L'équipe, 2010. Les pôles : nouveaux eldorado pour le trafic maritime ? *Nouvelle Europe*. Online, [ppp. http://www.nouvelle-europe.eu/node/769](http://www.nouvelle-europe.eu/node/769).
- Lalonde, S., 2017. The northwest and northern sea route: sovereignty and responsibilities. In: Conde, E., Sánchez, S.I. (Eds.), *Global Challenges in the Arctic Region*. Sovereignty, Environment and Geopolitical Balance. Routledge, Abingdon, Oxon, UK, p. 464.
- Larchenko, L.V., Kolesnikov, R.V., 2017. Differentiation of Socio-Economic Development of the Arctic Regions of Russia, pp. 69–75. *Innovation*.
- Laruelle, M., 2016. *Assessing Social Sustainability: Immigration to Russia's Arctic Cities, Sustaining Russia's Arctic Cities: Resource Politics, Migration, and Climate Change*. Berghahn Books, Oxford, UK, pp. 88–111.
- Lioubimtseva, E., da Cunha, C., In press. Community Engagement and Equity in Climate Adaptation Planning: Experience of Small and Mid-size Cities in the United States and in France, in: Petersen, B., Ducros, H. B. (Ed.), *Justice and Climate Action Planning*. Springer, pp. (xx-xx).
- Martin, B., 2014. L'Arctique ne sera pas de sitôt une grande route maritime. *Reporterre*. Online [ppp. https://reporterre.net/L-Arctique-ne-sera-pas-de-sitot-une-grande-route-maritime](https://reporterre.net/L-Arctique-ne-sera-pas-de-sitot-une-grande-route-maritime).
- Melino, M., Conley, H.A., Bermudez, J.S., 2020. Ice Curtain: Tiksi Airbase. Many Russian Announcements, Little Equipment. Center for Strategic and International Studies (CSIS), Washington, DC, USA. <https://www.csis.org/analysis/ice-curtain-tiksi-airbase%E2%80%94many-russian-announcements-little-equipment>.
- Milanovic, B., 1998. *Income, Inequality, and Poverty during the Transition from Planned to Market Economy*. World Bank, Washington, DC, USA.
- Nadasdy, P., 1999. The politics of Tek: power and the "integration" of knowledge. *Arctic Anthropol.* 36, 1–18.
- Nikulkina, I.V., 2018. *Methodology for the Development of Fiscal and Customs Mechanisms for the Implementation of State Financial Policy in the Arctic Zone of the Russian Federation*. Financial University under the Government of the Russian Federation, Moscow, Russian Federation, p. 398.
- Nikulkina, I.V., Filimonova, L.M., 2019. Tax regulation as a tool for the development of the Arctic zone of Russia. *Journal of Economy and Entrepreneurship* 153–160.
- Nuttall, M., 2018. Arctic environments and peoples. In: Callan, H., Coleman, S. (Eds.), *The International Encyclopedia of Anthropology*. Wiley Online Library, pp. 1–7.
- Olazabal, M., Galarraga, I., Ford, J., Sainz De Murieta, E., Lesnikowski, A., 2019. Are Local Climate Adaptation Policies Credible? A Conceptual and Operational Assessment Framework. *International Journal of Urban Sustainable Development*, pp. 1–20.
- Paillet, P., 1994. *L'analyse Par Théorisation Ancrée*. Cahiers de recherche sociologique, pp. 147–181.

- Pearce, T., Ford, J., Willox, A.C., Smit, B., 2015. Inuit traditional Ecological knowledge (TEK), subsistence hunting and adaptation to climate change in the Canadian arctic. *Arctic* 68, 233–245.
- Peshina, E.V., Zakharov, A.S., 2017. Spatial integration of budgetary resources in the Arctic zone of Russia. *Regional economy: Theor. Pract.* 15, 814–831.
- Portal of State Programs of the Russian Federation, 2021. Programs Summary. <https://programs.gov.ru>. (Accessed 19 January 2021). Accessed.
- Prokhorova, I., 2013. *Russians Remember a Turning Point*. MacLehose Press, London, UK, 1990.
- Public Chamber of the Republic of Sakha, 2016. Report on the Implementation of the Comprehensive Program "Social and Economic Development of the Northern and Arctic Regions of the Republic of Sakha (Yakutia) for 2014-2017 and for the Period until 2020" for 2015 and 9 Months of 2016. Yakutsk, Yakutia, Russian Federation. <https://oprs.sakha.gov.ru/docs/doklady/doklad-o-xode-realizacii-kompleksnoj-programmy-socialno-ekonomicheskoe-razvitiye-severnnyx-i-arkticheskix-rajonov>.
- Quinn, T., Lorenzoni, L., Adger, W.N., 2015. Place attachment, identity, and adaptation. In: Selboe, E., O'Brien, K. (Eds.), *The Adaptive Challenge of Climate Change*. Cambridge University Press, Cambridge, UK, pp. 160–170.
- Selin, V.S., 2013. The third paradigm of the development of the Russian Arctic. *Regional economy: Theor. Pract.* 21, 17–25.
- Smit, B., Burton, I., Klein, R.J.T., Street, R., 1999. The science of adaptation: a framework for assessment. *Mitig. Adapt. Strategies Glob. Change* 4, 199–213.
- Smit, B., Wandel, J., 2006. Adaptation, adaptive capacity and vulnerability. *Global Environ. Change* 16, 282–292.
- Smucker, T.A., Wisner, B., Mascarenhas, A., Munishi, P., Wangui, E.E., Sinha, G., Weiner, D., Bwenge, C., Lovell, E., 2015. Differentiated livelihoods, local institutions, and the adaptation imperative: assessing climate change adaptation policy in Tanzania. *Geoforum* 59, 39–50.
- Staalesen, A., 2017. 5 Billion for Development of Tiksi Infrastructure. The Barents Observer. The Independent Barents Observer AS, Kirkenes, Norway, ppp. <https://thebarentsobserver.com/en/industry-and-energy/2017/01/5-billion-development-tiksi-infrastructure>.
- Staalesen, A., 2018. Japanese Investors Sign Deal on Wind Farm in Tiksi. The Barents Observer. The Independent Barents Observer AS, Kirkenes, Norway, ppp. <https://thebarentsobserver.com/en/industry-and-energy/2018/03/japanese-investors-sign-deal-wind-farm-tiksi>.
- Stammler, F., 2013. Narratives of adaptation and innovation: ways of being mobile and mobile technologies among reindeer nomads in the Russian Arctic. In: Miggelbrink, J., Habeck, J., Mazzullo, N., Koch, P. (Eds.), *Nomadic and Indigenous Spaces: Productions and Cognitions*. Ashgate, Farnham, UK, pp. 221–245.
- Statistical yearbook of Yakoutia, 2018. Sakha Republic (Yakutia): Statistical Compilation/territorial Body of the Federal State Statistics Service of the Sakha Republic. Federal State Statistics Service, Yakutsk, Yakutia (Russian Federation).
- Sukneva, S.A., Nikulkina, I.V., 2017. Tax mechanisms of economic development and the improvement of migration situation in the Russian arctic. *Int. J. Econ. Financ. Issues* 7, 144–153.
- Takakura, H., 2012. The shift from herding to hunting among the siberian Evenki: indigenous knowledge and subsistence change in northwestern Yakutia. *Asian Ethnology* 71, 31–47.
- Tatarkina, A.I., 2014. *Russian Arctic: Modern Development Paradigm*. Russian Federation, Moscow. *Нестор-История (Nestor-History)*.
- The Moscow Times, 2014. Russian Defense Ministry to Establish Military Zone in the Arctic. Russian Federation. The Moscow Times, Moscow. ppp. <https://themoscowtimes.com/news/russian-defense-ministry-to-establish-military-zone-in-the-arctic-37702>.
- Thomas, D.S.G., Twyman, C., 2005. Equity and justice in climate change adaptation amongst natural-resource-dependent societies. *Global Environ. Change* 15, 115–124.
- Thomas, K., Hardy, R.D., Lazrus, H., Mendez, M., Orlove, B., Rivera-Collazo, L., Roberts, J.T., Rockman, M., Warner, B.P., Winthrop, R., 2019. Explaining Differential Vulnerability to Climate Change: A Social Science Review. *Wiley interdisciplinary reviews*, p. e565. *Climate change* 10.
- Thorez, P., 2008. La Route maritime du Nord. Les promesses d'une seconde vie. *Courr. Pays Est* 1066, 48–59.
- Van Grunderbeek, P., 2013. Le passage du Nord-Est : un espace stratégique dans l'Arctique. *Mondialisation.ca*. Centre de recherche sur la mondialisation (CRM). Montreal, Quebec, Canada, ppp. <https://www.mondialisation.ca/le-passage-du-nord-est-un-espace-strategique-dans-larctique/5325348>.
- Vitkine, B., 2012. Siderante Sibérie. *M le magazine du Monde*. Online, ppp. [https://www.lemonde.fr/m-styles/article/2012/03/23/siderante-siberie\\_1673830\\_4497319.html](https://www.lemonde.fr/m-styles/article/2012/03/23/siderante-siberie_1673830_4497319.html).
- Yakovleva, N., 2014. Land, oil and indigenous people in the Russian North: a case of oil pipeline and Evenki in Aldan. In: Gilberthorpe, E., Hilson, G. (Eds.), *Natural Resources Extraction and Indigenous Livelihoods: Development Challenges in an Era of Globalization*. Ashgate, Aldershot, UK, pp. 147–178.