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Tetsuya Hiyama
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Global Warming and Human-Nature Dimension in Northern Eurasia

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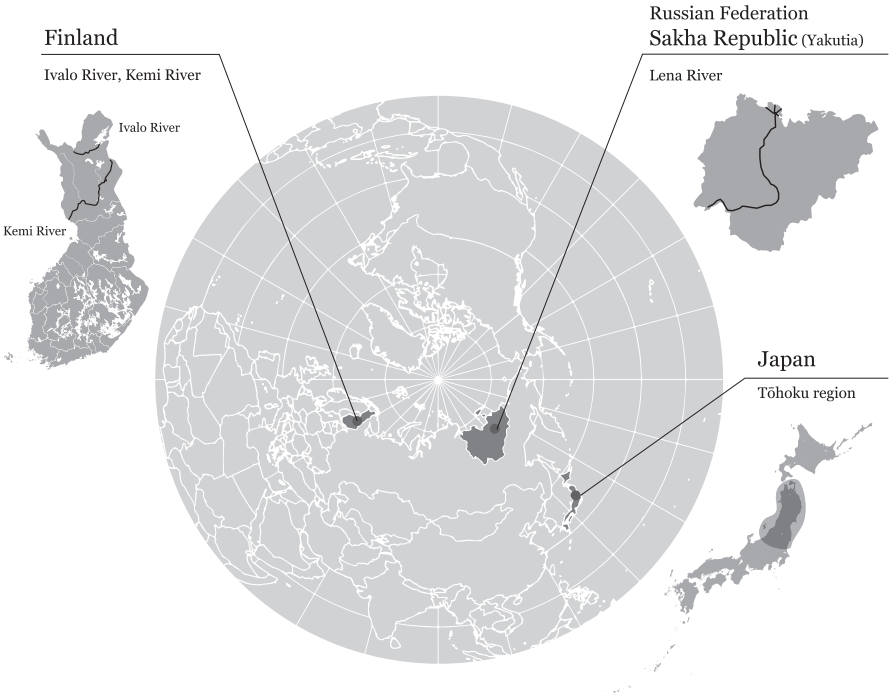
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Tetsuya Hiyama • Hiroki Takakura
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Global Warming and Human - Nature Dimension in Northern Eurasia

Springer

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Preface

This book is part of the series *Global Environmental Studies*, from Springer, supported by the Research Institute for Humanity and Nature (RIHN), a leading institute promoting interdisciplinary and transdisciplinary global socio-ecological research in Japan.

This book aims to describe the current status of environmental change caused by global warming in Northern Eurasia, with a special focus on Eastern Siberia. It concentrates on spring river flooding, ice-jam movement, and the monitoring of both conditions using field observations and remote sensing. The issues facing reindeer herders in Siberia and conspicuous environmental changes such as waterlogging, rising temperatures, and vegetation change are also discussed. In addition, adaptation strategies implemented by the government at various levels are also discussed.

The primary topics of this book are (i) an introduction to global warming and the human–nature dynamic in Siberia, with special emphasis on humidification of the region in the mid-2000s; (ii) a description of social adaptation to changes in the terrestrial ecosystem, with an emphasis on water environments; and (iii) a discussion of adaptation strategies based on an assessment of vulnerability to environmental change in Northern Eurasia. The latter topic is presented as a local phenomenon, influenced by climate science politics among states and intergovernmental organizations such as the Intergovernmental Panel on Climate Change (IPCC). The book covers scientific findings of studies in hydrology, ecology, anthropology, politics, and civil engineering and provides a multifaceted approach including information about ongoing processes as well as insightful theoretical considerations. We believe that the scientific analysis in this book will be of interest not only to environmental researchers and policy makers but also to local people who are affected either as right-holders or as stakeholders.

A discussion on the background of this book follows. The main contents (Chaps. 1, 2, 3, 4 and 9, 10, 11) are based on the first international conference on "Global Warming and the Human–Nature Dimension in Siberia: Social Adaptation to the Changes of the Terrestrial Ecosystem, with an Emphasis on Water Environments," which was held in Kyoto, Japan, on March 7–9, 2012. It examined human–nature

interactions affected by environmental changes in Siberia. The foci of the conference included (i) contemporary and future variations in the water and carbon cycles, (ii) the results of long-term field observations of the effects of carbon and hydrologic variability and the key driving forces behind these effects, and (iii) the distinct social economies of multiethnic Siberian societies and their potential for adaptation to predicted changes in climate and terrestrial ecosystems. These arguments are laid out in the aforementioned chapters.

Chapters 8, 12, and 13 are based on the RIHN's eighth international symposium, entitled "Risk Societies, Edge Environments: Ecosystems and Livelihoods in the Balance," which was held in Kyoto, Japan, on October 23–25, 2013. This symposium examined social and ecological risk in several "edge" environments, i.e., boundary zones that typically exhibit high rates of biodiversity and many ecological niches, but that are also particularly susceptible to disturbance. The editors of this book organized the session entitled "Global Warming Risk in the Far North" at this symposium. It addressed the social and ecological risks presented by global warming in the circumpolar North, including Russia.

Over millennia, Northern indigenous peoples have adapted to a cold climate, but their cultural traditions and techniques are being disrupted by natural disasters related to climate change. Modern global warming has apparently increased the magnitude and frequency of flooding and land erosion. Thus, new adaptation strategies are needed in relation to these risks and should be explored. The case studies in this book show how indigenous peoples, local governments, and civil organizations evaluate contemporary environmental change and mitigate its risks.

It should be noted that a research project with the same title as the first symposium "Global Warming and the Human–Nature Dimension in Siberia: Social Adaptation to the Changes of the Terrestrial Ecosystem, with an Emphasis on Water Environments" took place between 2009 and 2014 at RIHN. One of the editors, Tetsuya Hiyama, led this project. Most of the members of the project had not previously experienced a multidisciplinary approach including natural and social sciences. We remember clearly the misunderstandings and anxieties among the team members during the first 1–2 years. After many discussions at research meetings and/or the shared experience of fieldwork, the tensions were eventually mitigated, and we came to a mutual understanding. On a personal note, most members of the project experienced the Great East Japan Earthquake on March 11, 2011, together. We had a research meeting at Tohoku University, Sendai, near one of epicenters of the quake on that day. The shared experience of the disaster and evacuation contributed to the sense of solidarity and commitment among the project members.

This book successfully uses a crosscutting approach to the issue of Northern Eurasian climate change, based on its background as a collaborative project between scholars in the natural sciences and human social sciences. The international collaboration included Russian, Finnish, American, and Japanese contributors from both natural and social sciences who tried to explore shared concerns. The editors believe that we have accomplished a well-balanced integration of multiple disciplines for exploring human–environment interactions affected by climate change.

The in-depth description of socio-ecological processes will be satisfying to readers interested in climate change science, Arctic studies, and Russian studies.

Nagoya, Japan — Tetsuya Hiyama
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Contents

Global Environmental Studies

The Global Environmental Studies series introduces the research undertaken at, or in association with, the Research Institute for Humanity and Nature (RIHN). Located in Kyoto, Japan, RIHN is a national institute conducting fixed-term, multi-disciplinary, international research projects on pressing areas of environmental concern.

RIHN seeks to transcend the common divisions between the humanities and the social and natural sciences, and to develop synthetic and transformative descriptions of humanity in the midst of a dynamic, changeable nature. The works published in the series will reflect the full breadth of RIHN scholarship in this transdisciplinary field of global environmental studies.

Editorial Structure

Chapter 1
Water, Water Everywhere: Perceptions of Chaotic Water Regimes in Northeastern Siberia, Russia

Susan A. Crate

Abstract This paper explores applied anthropological research examining perceptions, understandings and responses to increasing water on the land, one of the major effects of global climate change for native Viliui Sakha agropastoralist communities of northeastern Siberia, Russia. The paper draws on fieldwork investigating perceptions, understandings and responses to the local effects of global climate change for native Viliui Sakha agropastoralist communities of northeastern Siberia, Russia. For Viliui Sakha, global climate change translates locally into a highly altered climate system and water regime. 2008 fieldwork shows Inhabitants observing warmer winters, increased snowfall, excessive precipitation, changed seasonality, and the transformation of their ancestral landscape due to increased water on the land and degrading permafrost. One urgent change is how the increased water on the land is turning hayfields into lakes, inundating households and ruining transportation networks. The increasing water on the land interferes with subsistence and threatens to undermine settlement. Beyond these physical changes, what does the increased water on the land mean to Viliui Sakha? Inhabitants expressed not only concern about their future but also common fear that they would 'go under water.' Water has visceral meaning to Sakha, based on their historically-based belief system, their adaptation to their environment, and knowledge system. In response, 2009 field research looked in more depth at communities' perceptions of water, and worked to bring those perceptions and beliefs into our 2010 knowledge exchange exercise. This paper will present our initial findings and make suggestions on how these findings can be understood more broadly for other peoples unprecedentedly affected by water crises in the face of global climate change.

Keywords Climate change • Anthropology • Local perceptions • Water • Viliui Sakha • Siberia • Russia

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1.1 Introduction

> The climate is definitely different from before … For people who live with a short summer when there needs to be the right weather to accomplish all for the winter, and there are cool rainy times so that the hay does not dry and has to sit and sit and the quality is bad because of that … it is the right time for haying but the conditions are all wrong. – Sakha elder

At the end of a 2003–2005 research project[1] focusing on understanding local definitions of sustainability in Viliui Sakha villages of northeastern Siberia, Russia (Crate 2006a), our research team administered a survey to gauge the extent that what inhabitants expressed concern about in focus groups and semi-structured interviews was shared by the overall population. The final question asked if the respondent had any other concerns that the survey did not cover. Ninety percent of the responses to that question had something to do with changes in local weather, climate and seasonal timing. In response, our team used the final 2 weeks of the summer's field research to interview elders, those having the longest life experience observing change, about their observations. In the context of those interviews, remarks like the one above by a Sakha elder were common. In addition to providing lifetime observations of these changes, the elders also sparked our team's curiosity about how a people are affected culturally by climate change, in ways beyond the physical realm. Ten of the 33 elders interviewed explained that these unprecedented changes were a result of the Bull of Winter no long arriving (Crate 2008).

The Bull of Winter is a mythological being who Sakha believe arrives when the deep Siberian winter, characterized by conditions too cold and dry for snow and relatively windless, in late December. Those ten elders stated that the Bull of Winter was not arriving in the last 10 years, with overall temperatures softening. This led me, from my training as an anthropologist and therefore keen to pursue issues of culture and change, to want to understand the cultural implications of climate change for Viliui Sakha. At the time, I had been working with these people since 1991 on various issues of change and adaptation (Crate 2006b). I wanted to know how they would continue to inhabit their homelands if climate change altered their environment to the extent that they could no longer breed horses and cows, their age-old subsistence strategy. Perhaps more significant in my mind was pondering the meaning and power of place for Viliui Sakha and the implications of that place changing to the extent that it no longer supported familiar ecosystem conditions and cosmological meanings. While pondering these issues, I confronted sentiments like

[1] I first thank all Viliui region inhabitants, project collaborators, research assistants, and in-country specialists involved in the research on which this article is founded. I also acknowledge the National Science Foundation (NSF) and program officers Anna Kertulla de Echave, Office of Polar Programs, Arctic Social Sciences Division, and Neil Swanberg, Office of Polar Programs, Arctic Sciences Division, for funding support. This article is mainly based on research from the NSF Office of Polar Programs, Arctic Social Science Program Grant 0710935 "Assessing Knowledge, Resilience & Adaptation and Policy Needs in Northern Russian Villages Experiencing Unprecedented Climate Change," and NSF Office of Polar Programs, Arctic Science Program Grant 0902146 "Understanding Climate-Driven Phenological Change: Observations, Adaptations and Cultural Implications in Northeastern Siberia and Labrador/Nunatsiavut (PHENARC)."

the following that made my curiosity that much stronger: "The Eveny people are highly adaptive. Sometimes they joke and say, this is our home. If the climate gets too hot, we'll just stay and herd camels" (anonymous). There is no doubt that Viliui Sakha, like their neighbors the Eveny, are resilient, adaptive cultures, but the question remained as to how much environmental change they could adapt to.

Anthropologists have long argued for the importance to local peoples of the subtler and non-physical characteristics of local ecosystems. For example, Keith Basso argues that social life is everywhere accomplished through an exchange of symbolic forms, that human existence is irrevocably situated in time and space, and that wisdom "sits in places" (Basso 1996: 53). In agreement with Basso's contention, it follows that climate change can displace not only a people's wisdom but also the very human-environment interactions that are a culture's core (Steward 1955; Netting 1968, 1993).

1.2 Investigating Change

To pursue this investigation in-depth, I submitted a specific project investigating perceptions, understandings and responses to the local effects of global climate change, and the National Science Foundation (NSF) funded it (Fig. 1.1).

Our research team first organized focus groups to gain a solid understanding of what changes local inhabitants were observing, how they were understanding those changes, and how those changes were affecting their lives. We worked in four Viliui Sakha villages in the Suntar region, namely Elgeeii, Kutana, Khoro and Tolon. In each, we hired a village assistant to identify six women and six men, with an even breakdown of youth, middle age, and elderly participants, for each focus group. In these group interviews, we first asked participants to complete a form that asked them to record their observations of change, what they thought the source of that change was, how it was affecting them, and what they thought the future would be if the change continued. Through analysis of focus group results, we discerned that the majority of participants were in agreement about the following nine main changes: (1) winters are warm; (2) the land is waterlogged; (3) too much rain; (4) summers are cold; (5) more floods; (6) seasons arrive late; (7) too much snow; (8) temperatures change more suddenly; and, (9) fewer birds and animals. Although inhabitants were quick to identify that warmer winters are a welcome change because it means less wood is required to heat their homes, and animals could be outside more and go to water instead of having to haul it for them, the graver implications of these changes tended to dominate our discussions. In the end, we determined that each of these changes has largely negative effects on Viliui Sakha's horse and cattle subsistence, in addition to creating problems with transportation, housing and supplemental subsistence like gardening, hunting, and fishing.

Most of the changes listed represent the effects of a highly altered climate system and water regime. Like all humans in the context of their local environment, Sakha's ancestors adapted to an annual water regime that had an overall sufficient supply to

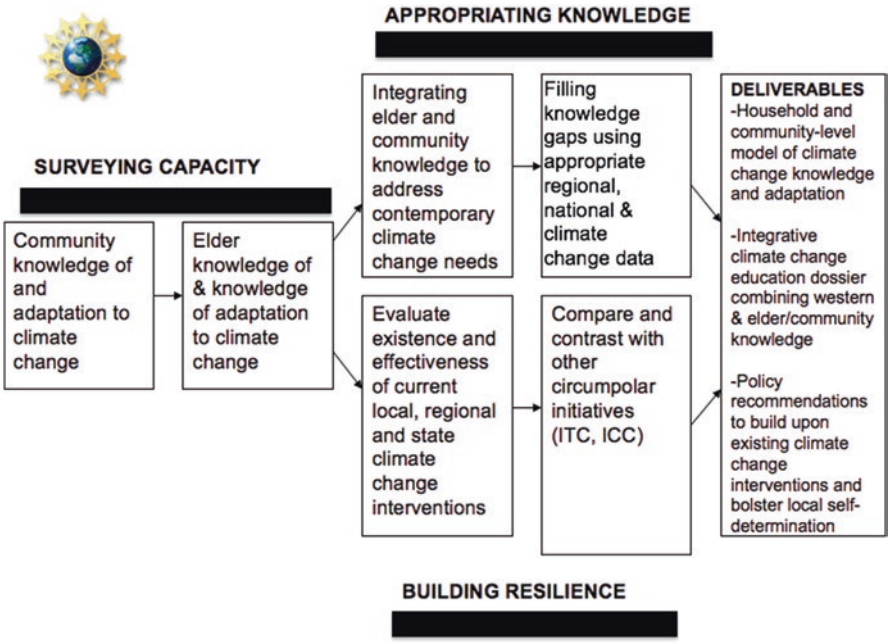

Fig. 1.1 Assessing knowledge, resilience & adaptation and policy needs in Viliui Sakha villages experiencing unprecedented climate change

support ecosystem functioning but that also fluctuated from year to year in a relatively predictable range of wet and dry. However, with the advent of contemporary climate change, this range is increasingly disrupted, due to a combination of changing seasonal patterns, altered precipitation regimes and an overall "softening" of the extreme annual temperature range (Crate 2011a, b; Roshydromet 2008; Fedorov and Konstantinov 2008, 2009). By increasing labor and paying higher costs, inhabitants are adapting to these changes. However, the number of households continuing to keep cows has dropped precipitously in the last 5 years, suggesting that fewer are meeting the increasing challenge.

As I worked with inhabitants in subsequent years, they talked frequently about warmer winters, increased snowfall, excessive precipitation, changed seasonality, and the transformation of their ancestral landscape due to increasing water on the land and degrading permafrost. One urgent change is how the increased water on the land is turning hayfields into lakes, inundating households, and ruining transportation networks. The increasing water interferes with subsistence and threatens to undermine settlements (Fig. 1.2).

Interviews in 2012 confirmed previously reported seasonal changes including: spring either arriving late or on time but remaining cold or not gradually warming up as in the past; less rain in the spring than before; a cool summer with too much rain during hay season and cold nights; an elongated autumn characterized by a freeze – thaw pattern; an unusual winter season, with more snow than previously

Fig. 1.2 "Like this, 10 years of water I do not remember – before we hayed all the fields – now we have to go here and there to hay since all our hay lands are under water." (middle-aged Viliui Sakha resident)

and *chiskhaan* or freezing winds. These seasonal changes challenge Viliui Sakha in their cow-keeping and other subsistence practices. Because of a lack of space here to go into detail about all the effects, for the sake of illustration, I next highlight a few for each season.

Inhabitants emphasized that the elongated autumn is better because cows can go to pasture later which prolongs winter hay stores. However, it also requires more hay stores since pasture is often not available into winter and the warm temperatures delay the timing of the annual slaughter, performed after temperatures have fallen sufficiently to remain below freezing. Horses are negatively affected because the freeze – thaw pattern keeps them from accessing their fodder, which typically remains semi-green beneath a thick, insulating blanket of snow. Instead, they encounter a hard sheet of ice and, unable to find fodder, many starve if not given supplemental food. The winter is unusual due to snowfall and freezing wind in an ecosystem in which the historical pattern is no snowfall during that 3-month season and no wind, the period Sakha characterize as when the Bull of Winter has arrived. This new regime requires much more human labor, since cattle stay in barns for more of the winter due to uncertain conditions of their paths to water. Spring is late or arrives on time but remains cold instead of a gradual warming as before, and there is less rain. These extreme spring conditions affect early fundamental hay growth because of the cold and lack of rain. Recent summers have been unseasonably cool and rainy and the nights are especially cold, slowing plant growth, meaning

that harvest time now comes before crops have reached full maturity. Last, summer used to be a relatively dry season, but now there is too much rain, which impedes hay cutting and ruins its quality.

Beyond these physical changes, what does the increased water on the land mean to Viliui Sakha? Inhabitants expressed not only concern about their future but also a common fear that they would "go under water". One middle-aged Viliui Sakha inhabitant said, "I am very scared that we are going under water—looking down from a plane you can see that the land has patches of water across it—water is coming up from below—it looks like the land is sinking down." Water has visceral meaning to the Sakha, based on their historically-based belief system, their adaptation to the environment, and knowledge system. Scholars specializing in the meaning of water to various peoples are outspoken about how important it is to understand those meanings to grasp perceptions. A people's interactions with water, and how experiences, images and metaphors arise from those interactions and flow into their interpretations of themselves and others (Strang 2004).

In response to both Viliui Sakha's expressions of fear and the experts' call to investigate the meanings of water, our team continued field research, taking a more in-depth look at communities' perceptions of water. Based on Sakha's ancient belief system, water, like all of the natural world, is sentient or spirit-filled. For example, when interacting with water, for example, when crossing a river or fishing in a lake, according to their ancient belief, they are to speak specific words and offer gifts to appease the spirit of the water. As an anthropologist, I knew that it was important to grasp the "emic" or local understanding, similar to Arlene Rosen's argument in her 2007 book, *Civilizing Climate*:

> If rainfall is a divine gift, then solving the problems related to drought must involve dealings with the supernatural in the form of pleasing the deity responsible. Failure to adjust to environmental stress is as much a social and cosmological problem as an environmental one (Rosen 2007).

In addition, it was clear that inhabitants were attributing such changes to many other sources besides climate change. Granted, although none of the changes were occurring *solely* due to climate change, it was certainly a driving force for most. When asked what they thought was causing the changes, their main explanations, in order of preference, were: (1) the Viliui hydroelectric station reservoir; (2) nature itself, i.e., wet years/ dry year cycles; (3) too much *technika* (explained later); and, (4) global climate change. Regarding the first explanation, inhabitants explained how the huge water surface of the reservoir generates steam that forms clouds that enter their area, keeping their climate artificially cool in summer and warm in winter, and increasing rain and snow year round. A more recent opening of GES's third generator, which further expanded reservoir volume and surface area, was responsible for an increase in these effects over recent years. However, hydrological and meteorological research shows how the reservoir affects only a microclimate area directly adjacent to it (Shadrin 1984; Nogovitzin 1985).

The second explanation purports that the observed changes were because of a pre-existing wet and dry year "natural cycle," a normal condition of the ecosystem

to which Viliui Sakha ancestors adapted. They did so by practicing a form of water management called *nulustur,* which entailed either draining or flooding productive areas to maintain proper growing conditions within the natural wet and dry cycles (Ermolaev 1991). Those who subscribed to this explanation held that there was nothing humans could do or, for that matter, should do. Some even said that the government's draining of the lakes is wrong because when the dry cycle returns, the lands will be rendered much too dry and will never recover. Several were concerned about angering the spirit of the water by excessive draining. When asked what to do to adapt to the excessive water, most said to rely on Sakha adaptations. Specifically they mentioned *muus oto* or cutting hay after lake and pond ice freezes, *wolba* or cutting hay in the water, feeding herds with other fodder including ground-up shrubs and trees, and moving households temporarily to the higher lands of headwaters to cut hay and pasture their herds.

The third explanation, "too much *technika*," refers to the increasing use of mechanization both locally and globally, as witnessed on television and in the news and in the activity of the night sky. Most residents who attributed contemporary change to this explanation were elders who had certainly seen great change in their lifetimes, beginning with a world powered by human and animal labor to the current cyber-reality. Finally, only a handful of the participants explained the changes as a result of contemporary climate change. These tended to be either teachers or elders who read extensively.

To see the extent to which our findings in the focus groups and interviews were shared in the greater communities, we administered a survey in summer 2009. The most relevant results for this chapter's purpose are that a majority agreed with the nine main changes and with the four explanations of causes of change. These explanations, with climate change being the least mentioned one, showed the extent to which perceptions are historically constructed, in Viliui Sakha's case, very much based on Soviet-period industrial development that severely altered Viliui Sakha's natural environment (Crate 2002). My further investigation into these explanations revealed how these people clarify the political ecology with "water in mind" (Crate 2011a). More pertinent to the immediate situation, I collaborated with Alexander Fedorov of the Melnikov Permafrost Institute of Yakutsk, whose extensive research data from the central Sakha Republic showed that permafrost degradation and many of the other changes Viliui Sakha were observing were partially or completely attributable to global climate change. Because my research had shown how inhabitants had very locale- and culture-specific knowledge of these changes, Alexander Fedorov and I decided that the next step was to explore the extent to which these two knowledge bases could complement each other and enhance understanding for both local residents and regional scientists. We envisioned a two-part process: (1) To develop models and frameworks to understand a people's mythological, cosmological, historical, geopolitical, and contemporary perceptions of and responses to climate change; (2) to provide sources of information that complement local understanding and facilitate adaptive resilience, using a research approach that is community-based, collaborative, and locale- and culture-specific.

Fig. 1.3 2010 Knowledge exchange team preparing to leave Yakutsk to conduct knowledge exchanges in eight Viliui Sakha settlements: Viliuisk, Verkhny-viliuisk, Nerba, Suntar, Elgeeii, Kutana, Khoro and Tolon

Therefore, we decided to conduct what we called "knowledge exchanges" in summer 2010 (Crate and Fedorov 2013a). We spent winter and spring 2010 preparing, and then departed in late June of that year to do knowledge exchanges in eight Viliui Sakha settlements (Fig. 1.3). We structured these exchanges to provide a maximum opportunity for the audience to share their local observations, first inviting audience members to do so. For illustrative purposes, I provide two excerpts of these testimonies here. The first is the testimony of a life-long resident of Khoro Village known for her vegetable gardening:

> As a gardener, I know that animals and birds changing; some are more and some are less. There are some new birds, the *druzhdi* (thrush) and *grach* (rook), and they make nests and have lived here for the last 5 or 6 years. They are moving in here and move from one village to the next each year. There were two nests outside my house and this year, it seems like 100 appeared. They eat the insects but also the tomatoes—the very ripest ones—and suck the juice out. If you keep the tomatoes in the greenhouse they cannot reach them but on the open ground they can. Never before have birds eaten our vegetables!

The second illustrative testimony is from a horse-watcher who traveled 20 km by horse to attend the knowledge exchange:

> I am a cowboy and hunter. The land has changed—there are now ravines and gullies where there never were before. The land has caved in—around the streams where the flat hay lands are, the same thing is happening; the ravines have formed and all the water goes away very quickly down them, and lands are now dry that were never dry before. The ducks come very late. I am speaking mostly about changes in the land's form; there are now hills or mounds

> where there never were before, and small holes or hollows where there never were before. The wetlands are now dry and the ravines are more and more—land that never had water now does. Erosion of our lands is occurring very quickly, over just the last few years. Horses have a very hard time in the warm winter; we thought that this would be good for them but now understand that it is bad. Overall, we have come to a time when we cannot forecast the weather; before, things came at the right times, but now it is not so.

In all eight settlements, these stories varied, but all are very illustrative of the diversity of peoples' perceptions and experiences and the different ways the local environment is being affected by this global phenomenon.

Following the audience testimonies, we presented our findings in collaboration with local communities to define the major changes, their effects and causes. When we shared these results, audience members were quite moved to understand how similar our research respondents' experiences were to theirs. This tended to prompt more audience sharing and discussion. Then, Alexander Fedorov presented his regional research on permafrost degradation, first explaining how global climate change is affecting the earth system overall, the specific ways in which Russia is affected, and the particulars within the Sakha Republic. He shared pictures of how the land was falling and rising in places because of the changing permafrost layer. He also showed ways to protect the permafrost by building new houses and retrofitting older ones. His presentation stimulated even more discussion and we entertained many questions.

1.3 Conclusion

In follow-up evaluations with knowledge exchange participants, we discovered an overwhelming interest in bringing the knowledge exchange process to all inhabitants of the Viliui regions. In response, we completed a handbook designed to lead readers through a very similar process as the knowledge exchanges, and incorporates local knowledge, our research findings, and Fedorov's explanations of global climate change and permafrost degradation (Crate and Fedorov 2013b). With our research funding we were able to publish 3000 copies and, with coordination by the Sakha Monistry of Ecology, distribute the handbooks throughout the Viliui regions. We hope that we can share this knowledge exchange model with other communities facing the same issues, toward increasing understanding on the local level and bolstering adaptive responses.

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Chapter 2
Sakha Republic (Yakutia): Local Projections of Climate Changes and Adaptation Problems of Indigenous Peoples

Vanda Ignat'eva

The climate is crawling like a snail, barely noticeable, and destroying civilizations – A. Nikonov

Abstract The most dramatic collisions, directly or indirectly related to changes in the global climate, have occurred in Yakutia (Sakha Republic, Russian Federation) through a noticeable growth in natural disasters (such as floods, fires, and drought). The range and scope of these collisions increases the costs of mitigation and continual deterioration of the environment. As sociological studies show, the issues of ecology and environmental change are always present in the list of the stressful subjects, causing serious concerns for the indigenous peoples, together with such vital issues as unemployment and rising commodity prices.

In this regard, it is interesting to consider the local aspects of climate variability in the light of observations, opinions and assessments of the indigenous people themselves, most of whom live in rural areas. This chapter presents the results of a field study conducted by the author in the village of Betenkes, Verkhoyansk Ulus (District). The results indicate that for inhabitants of that transpolar village, climate change is not a distant prospect but a directly experienced reality to which they are currently trying to adapt.

Keywords Climate change • Flood • Indigenous peoples • Security risks to life • Adaptation problems

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2.1 Introduction

It is generally recognized that the greatest threat to the population and economy of Yakutia are emergencies caused by water during spring and summer floods on the rivers. Indeed, despite preventive measures by the government of the Republic of Sakha, there has been an interannual increase not only in the number of those affected by such natural disasters but in economic damage they have caused. That damage involves the evacuation of people, flooding of settlements, meadows and pastures, restoration of roads, and residential and industrial buildings. (Boyakova et al. 2010a, b).

Such negative effects are attributable to a large part of the natural environment of Yakutia having a high probability of flooding. The current settlement system increases the risk of flooding villages, which are mostly within the basins of large and small rivers. According to experts, the worsening of floods along the rivers of Yakutia is inevitable, and is contemporaneous with the increasing effects of global climate change (Arzhakova 2006a, b; Spektor 2006). In this context, research interest lies in the prevention and protection of rural settlements from the negative effects of flood waters.

In the present study, I used field data including the results of a survey of local residents, interviews with key informants (long-term residents, regional ethnographers, folk meteorologists, administration staff), district newspaper publications, and illustrative data. With these data, I outline local projections of climate change, identify existing and potential security risks to livelihoods of the rural population of Yakutia.

2.2 Betenkes: Brief Description of the Study Area

The village of Betenkes (135°34′15″E, 67°38′57″N) is a typical Yakut village, the center of Adychinsky Nasleg, situated on the left bank of the river Adycha, a tributary of the Yana (872 km). The Yana is one of the largest northern navigable rivers of Yakutia. The Yana upstream is one of the poles of cold in the Northern Hemisphere, where the absolute temperature minimum in the world was recorded at −71.2 °C (Fig. 2.1).

The Adycha flows into the Yana 648 km from its mouth. The Adycha's length is 715 km and it has a basin area of 89,800 sq. km. It originates from the western slopes of the Chersky Range and flows within a wide valley. Its water supply is from both snow and rain. The average flow rate is 485 m^3/s. The river freezes in October and thaws in late May. The winter freeze is complete, reaching the bottom for 1 to 4.5 months, forming huge ice mounds. The main tributaries on the right are the Delakag, Charky and Tuostakh, and the Derbeke, Nelgese and Borulakh on the left. The nature of the water regime according to the classification of B.D. Zaykov makes the river a Far Eastern type. The characteristic feature of such rivers is an excess of maximum levels and water flow rates during rain-induced flood peaks in spring. Therefore, the formation of floods is mainly due to prolonged rains (Yakutia 2007a).