Chapter 4
Climate Change, Vulnerability and Adaptation Among Nenets Reindeer Herders

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Abstract The case study presented here concerns two geographical areas: the Yamalo-Nenets Autonomous Okrug (Tyumen Oblast) and Nenets Autonomous Okrug (Archangelsk Oblast). The question that prompted this study was how the Nenets reindeer herders perceived the effect of climate change on reindeer husbandry. This chapter presents local understanding of reindeer husbandry related exposure-sensitivities, climatic influences on reindeer herding and local reactions to recent climate change. Herders consider that not only climate warming, but also weather instability and abruptness, resulting in the formation of ice crusts inhibiting reindeer forage access and phenological shifts and in turn contributing to both pasture overgrazing and the loss of new-born calves, are the most frequent and severe hazards occurring in recent years. The traditional reindeer herding economy has proved flexible and adaptive to the changeable environment; however the combination of current stresses may prove too severe a test. Nenets reindeer herders, despite developing means to adapt to climate change, are on the whole pessimistic about the future of a reindeer herding economy.

Keywords Reindeer husbandry and health · Reindeer pasture · Adaptive strategies · Weather instability · Emic approach · Conversations about weather

4.1 Introduction

The Nenets, indigenous people in Russia (population 41,302), inhabit areas between the Kanin and Taymyr peninsulas, around the Ob and Yenisey rivers and most of them live in the Yamalo-Nenets Autonomous Okrug (Tyumen

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Oblast) and Nenets Autonomous Okrug (Archangelsk Oblast). The case studies presented in this paper relate to both regions and are based on field material consisting of interviews concerning indigenous local knowledge about the influence of climate change on reindeer herding from an emic perspective.[1] The goal of the paper, in line with the emic approach, is to discuss and understand the climate change related vulnerability, perspectives and adaptation strategies of Nenets reindeer herders, from the viewpoint of those who are involved in the processes under study.

The research strategy largely consisted of interviewing the Nenets reindeer herders (two elders and two young herders) and their professional housewives, (*choomrabotnitsa*)[2] (four all together) from the Nenets Autonomous Area and the Yamal-Nenets Autonomous Area (2008). These interviews combined constitute two case studies, each chosen from different regions. One presents the information collected in the village of Krasnoye and the town of Naryan-Mar in Nenets Autonomous Okrug (three reindeer herders and four herders' housewives). The information about reindeer herding in Yamalo-Nenets Autonomous Okrug was received from a reindeer herder, who permanently lives and grazes his herds in Priuralskij district, but travels to Saint Petersburg for short stays. Besides the interviews, this chapter is based on a survey of local media publications concerning this topic.

The influence of climate warming on reindeer husbandry is little discussed in official circles, and scientific discussions in Russia almost entirely neglect climate change. The subject is rarely touched upon in official public statements, or discussions in meetings, congresses, and the mass media. This situation is in stark contrast to the wide spread discussions concerning damage to the pastures caused by the oil producing companies and other industrial activities. 'When in the congresses, Nenets people argue about the deficiency of winter pastures', the reindeer herder Denis says, 'they affirm that it is caused by building the roads in the territory of pastures and by extracting oil there. They also say that the oil-production enterprises receive good benefits from their industry, but they pay too little to them, to the native people who live here.' 'Why our native people do not usually say anything in such meetings about climate change, about what is happening in nature itself?' wonders Denis. 'Maybe some of them do not realize how much it harms the reindeer husbandry. Maybe they do not pay enough attention to it, do not feel it in the right way, do not observe it well, I do not know!'

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[1] Emic and etic are terms used in cultural anthropology, to refer to kinds of fieldwork done and viewpoints obtained. An 'emic' approach supposes a description of ideas in terms meaningful to the actor. In this case an emic account comes from a person within the culture. It presents the herders' and their wives' understanding of the issues discussed here. Emic approach is opposite to 'etic' account that is a description of ideas of an observer.

[2] Chumrabotnitsa is reindeer herder's assistant who is a house (choom) keeper. Her duties are to meet reindeer herders, feed them, dry and mend their dress, and so on. In Soviet time it became a official profession.

Conversations about weather with Nenets at an official level also present certain distinctive characteristics. The natives discuss related topics cautiously, which from their viewpoint implies an incorrect attribution of blame to weather and climate. In some cases they prefer to hide some apparent information or manipulate it, thus avoiding the climate topic. This peculiarity of indigenous peoples' attitude to the conversations about climate change was also noticed by other scholars. Marino and Schweitzer noticed that 'not talking about climate change proved the best method for understanding local concepts of change' (Marino and Schweitzer 2009, 210). Referring to Wisniewski, they also noted that 'when hunters or other local experts are asked to speak about the environment, it can require breaking strict hunting taboos of talking about the future or being irresponsibly presumptive about a changing and sentient natural world' (Marino and Schweitzer 2009, 215). This cautious attitude in talking about weather is explained by the belief that there are spirits which influence weather and thus any complaint about weather actually constitutes a protest against the spirits. That is why Nenets reindeer herders usually prefer give any reason to explain the challenges caused by climate change rather than explanations connected with the environment itself. If asked about the harshest weather conditions the Nenets reindeer herders would always say that the weather was as good as it should be, because it was God who gave them such weather and that is why they have no reasons to criticize weather and complain about it. 'If this is the case, so it is necessary!' said the reindeer herder Denis. 'The only thing is that we ourselves should be able to get out of any difficulty. We must cope with any problems, even if unfortunately not everybody can be equal to the task.' 'If a reindeer died because of weather conditions', Denis continues, 'a herder would never say that his animal perished on account of weather; he would say that it was his own fault. The herders never complain; even last year, when lots of reindeer died because of snowfall, they only blamed themselves.' The informant told me about a recent tragedy, where due to heavy spring tides (a recent and frequent phenomena) and sudden spring warming, a big snow avalanche slipped from the flank of a hill in Priuralskij district in Yamal. The avalanche flow washed away an entire *choom* with all its dwellers resulting in the death of the herder's wife and all his children. Only the herder himself survived. But neither the herder, nor anyone else accused nature and climate for the tragedy. The people explained to the others that it happened because the victim obeyed the Protestant missionaries who advised him to burn his sacral sledge, where the herder kept his idols. My informant also inclined to that interpretation. He said: 'It was the missionaries who actually caused that tragedy,' said Denis. 'We lodged a complaint to our administration that people, who come from England and from France, forced us to change our life.'

Despite the fact that native people avoid talking about global warming and its negative influence on reindeer husbandry, they are fully aware of it. Conversations on this topic are just limited, not completely forbidden; thus I had opportunity to collect the information I needed. Circumstantial and indirect inquiries helped me to establish some facts, which revealed Nenets reindeer

herders' real attitude to climate change, exposure-sensitivities and their understanding of how to adapt to it.

The material presented in this chapter is divided into five sections. The first four concern the seasons and employ an identical structure. They first describe findings about current exposure-sensitivities of Nenets reindeer husbandry, and conclude by explicating current adaptive strategies in use by Nenets reindeer herders. The fifth section concerns the displacement of the annual biological cycle as a result of climatic change. The future exposure-sensitivities and the future adaptive strategies are discussed in the conclusion.

4.2 Current Seasonal Exposure-Sensitivities and Adaptive Strategies

4.2.1 Winter

4.2.1.1 Winter Exposure-Sensitivities

The beginning of the winter season in the Nenets Autonomous Okrug is considered to be in mid-November, when the rivers and lakes are frozen to such an extent that they become accessible for reindeer transportation. Recently however, freezing has occurred much later than usual. In mid-November 2007 the local newspaper of the Nenets Autonomous Okrug wrote: 'The residents of the Nenets Autonomous Area hardly are able to remember another year, when it was still possible to boat down the Pechora River,' (Kiselev 2007b, 4). In the end of November 2007 the same newspaper wrote: 'It is really dangerous to walk out to the Pechora River ice. From the beginning of its freezing-over already two people have drowned in the river,' (Tonkiy liod 2007). People drowned because they underestimated the degree of warming and did not believe that in November river-ice, at such high latitude, could still be very thin. In the same publication the Department of the State Inspectorate of small-size ships warned people: 'The thickness of the river ice is minimal now. Because of temperature drop and current warmth, the ice freezes on the river very unevenly, and is not strong enough.' The newspaper gave an advice to its readers not to go out onto the river ice until mid-December (Tonkiy liod 2007).

By mid-November, the Nenets Autonomous Okrug is normally covered by a thick blanket of snow. In the recent years there has been not only far less snow, but also thaws and winter rains. In late December 2007, the regional newspaper reported that 'the polar village Khorej-Ver has been already readied to meet Santa-Claus and Snow Maiden. The villagers had set up two New Year's trees; they have rehearsed the merry round dances and learned the New-Year songs. Everything has been made ready, except frosts. Only frosts have not yet come' (Budet prazdnik 2007).

Instability of weather is another feature of recent years. Due to a sudden frost, following a thaw, a crust of ice develops over the snow blocking reindeer

access to lichens and mosses, an essential forage source. Sometimes such ice becomes further covered with snow and reindeer have to dig snow out. Thick ice-crusts, have been witnessed, which covered wide territories in Yamal in the beginning of winter 2006–2007. This severely decreased reindeer access to forage and constituted a life threatening situation. (Stammler 2008, 85). Since October 2006, Stammler writes, unprecedented snowfall and hard frost started, but on 6th November 2006 it rained for 12 h and right after that temperature fell to 40°C degrees below, which led to ice-crust development. 'We watched, – Stammler writes, – how reindeer with difficulty broke through the ice-crust to reach lichen and how they hurt their legs,' (Stammler 2008, 85). Other authors also wrote about that event. V.N. Adaev noticed that weather in Western Siberia became less predictable. In 2005 the rivers were covered with firm ice almost until New Year, but in 2006 hard frosts arrived in October, and were followed with intense snowfall. He also mentioned the 12 hours of rain on 6th of November 2006 which resulted in a firm crust of ice over the snow (Adayev 2007, 85–86).

Another winter problem is pasture degradation. Even if there is no crust over the snow, a lack of concurrence between the beginning of winter pastures grazing and appropriate weather conditions leads to an additional difficulty for the reindeer herders. Despite the fact that in recent years the winter cold has arrived later than usual, the reindeer herds still come to the winter pastures at the same time of year as usual. If it is still warm, and there lies little snow, the reindeer can eat almost all the moss on the pastures including the uppermost layer of soil. It seems that this way of using pastures is traditional one. V. Adayev points out the difference between the Nenets and Khanty practice of using pastures in tundra. Nenets let their reindeer eat all the moss on the pasture grazing their reindeer on the same place 'until it blackens,' but Khanty reindeer eat only tops the moss as they change their pastures much more frequently (Adayev 2007, 100). Traditionally Nenets reindeer herders offset the negative effects of this practice by changing the territories where they roam, with the intent of letting the used pastures lie fallow (Adayev 2007, 100). In warm and light snow conditions, pastures become degraded due to the easy access to forage to such an extent that the moss will not re-grow for a long time. As Denis says, at first he considered conditions were better with a warm winter with little snow because his reindeer can get moss and are always full. However the elder herders told him that in exploiting the easy access to their forage in winter the reindeer often eat the moss together with the roots which impoverishes the pastures. After that, as the elders said, the exhausted pastures can take 30 years to restore, if nobody touches them. Should the herder not have another territory to go to, in subsequent years he will nevertheless have to return to the same territory leading to further degradation.

The moss covered pastures, as Yuzhakov and Mukhachev write, are indeed the most vulnerable pastures in the North, and are especially difficult to restore. The researchers affirm that the growth of moss is only 3–4 cm per year, and the restoration of the overused pastures averages 20 years (Yuzhakov and Mukhachev 2001, 75). There is also a serious risk of permanent loss of winter

pastures suited to reindeer through overuse. Yuzhakov and Mukhachev point out the possibility of pastures de-lichenification, in other words, they affirm that overusing the moss pastures can lead to the replacement of lichen and moss fractions by grassy ones. This process is negative for the reindeer because it reduces the availability of high-energetic forage in the most arduous period of the year (Yuzhakov and Mukhachev 2001, 73).

There are also some social factors besides warming winters which contribute to pasture degradation, which is especially apparent in Priuralskij region in Yamal. Reindeer herders wish to avail themselves of the advantages of modern culture winter closer to the villages. The herders rest there and store the goods necessary for the next season, communicate with other herders, and so on. This leads to the congregation of big herds on the limited territory around some of the settlements, such as Laborovaya, Beloyarsk. In addition, the herds of the large reindeer farms (cooperatives, stock companies) spend winter on the unprofitable lichen nearby the same settlements and cause noticeable damage to the pastures. Wild reindeer never migrate for wintering in big herds. They graze in small group (20–40 heads) and rarely return to the places where they were before, in the search for new fresh pasture (Yuzhakov and Mukhachev 2001, 84).

The pastures and the routes of the herds' migration are traditionally distributed among the trading stations. Entitlement to specific territories is not fixed anywhere, it is only remembered, and usually herders try to occupy the same places as they did in the previous seasons. Formerly, if a herder broke this unwritten law and used someone else's territory, it was not aggressively contested and the place was conceded to the newcomer. However given current pasture shortages, relationships between the herders have become increasingly strained. Should a herder now dare to move his reindeer to someone else's place, it leads to mutual enmity. Diminution of the pasture area and pasture overexploitation can lead to the social conflicts. 'If my pasture has become impoverished by the end of winter,' says Denis, 'I need some other places where my reindeer can find at least some moss, but I must not move to the other people's pastures.' 'There are lots of mutual complaints, especially before spring, when everyone suffers a shortage of pastures. "You have too many reindeer and occupy too large pasture, but I have no place to go. You force me out!" So by spring, hostility appears among the reindeer herders.' Cases of crossing the invisible boundary between the adjoining herds have recently become frequent. 'If one herder's pasture has become impoverished, what he should do?' asks Denis. 'Where should he go? One herder moved his reindeer to someone else's territory, and there were quarrels and threats. I heard those threats. That herder's neighbour came to his *choom* and shouted: "If you are not going to be off, I will break your sledge, and I will beat you unmercifully! You will come out the worse for it! Only try to do it again!" That neighbour did not only threaten him, he also drove his reindeer from his territory. After that the rumour was spread among the neighbours, and the people blamed that herder, who tried to drive the alien reindeer away from his territory, protecting his pasture. Not the trespasser, but the victim was represented as the guilty one.'

Herders try to keep their herds at a certain distance from other herds to avoid the reindeer mixing as separating the herds by lasso is a difficult process. Territorial limitations on pasture land breeds resentment from private herd owners toward the big state farm herds for, in their opinion, the farm herds aggravate pasture degradation. 'The private herders,' says Denis, 'need reindeer to survive, to sell and buy some goods for their families, but nobody knows what the state grazes reindeer for. Are they grazing reindeer for money, for someone's profits, for all the country, for the district? I do not know what for! But it is they who have occupied the largest squares here!'

The social conflicts exacerbate pasture overuse. As the herder who comes to the winter pastures first is able to occupy the best place, the territorial distribution varies each year and competition ensues for the winter territories closest to the settlements. Traditionally, the proper time for coming to the winter pasture was early December but because of the concern over shortage of winter pastures, now the herders try to arrive much earlier, ahead of other herds. 'In the past, people gathered on the pastures by December, but now they are already there in October. There are no signs whose pasture is situated where, so that the first to arrive can occupy any place he chooses. The next one, who comes later, has to step aside. That is why they rush; they hurry to occupy, to take up a better place. If I arrive at the winter pasture in December, as I did it before, I will not be able to find an appropriate place. Soon the herders will arrive at the winter pastures in September or even in August!' The competition results in herds' remaining in the winter pastures much longer than before and aggravates winter pasture degradation.

A further condition, which contributes to pasture overuse, is connected to the end of the Soviet system and the subsequent transfer to the market economy. The planned system provided additional winter forage for the reindeer. The elder herder Pieter considers that in the Soviet time conditions were better for the reindeer herders because the Soviet collective farms brought some salt and some mixed additional fodder for reindeer. The specialists-veterinaries emphasized the importance of mineral additional fertilizing, which is especially important in winter and spring time. 'By spring the mineral dearth becomes redoubled by the acute shortage of micro-organisms in the forage, which the reindeer compensate because of the inner reserves of their organisms,' (Yuzhakov and Mukhachev 2001, 85).

Another reason, which restricts pasture access and exacerbates overuse is the seizure of some of the most important and unique pastures through the process of industrial development of the region, especially in Yamal. Thus warming winters interacts with other factors to contribute to further pasture degradation.

4.2.1.2 Winter Adaptive Strategies

In winter, the main reindeer herders' strategy concerns the search for additional pastures. To avoid the troubles with ice-crust the reindeer herder has to find the territories less touched with ice. To prevent pasture overuse in light snowy

weather he has to change the pastures more often than usual. 'Earlier it was much easier,' complains Denis. 'There was no necessity to fuss beforehand and to look for the fresh untouched places to circumvent such possible difficulties with ice crust.' The reindeer herder Ivan says the same about such searching for places free from crust: 'A herder should have high standard of knowledge, he should be a professional, "an academician" in order to be able to take everything into consideration, to be acquainted with everything, to know where and how he can go, to which direction and where exactly he is right now. Can you imagine what a spacious territory it is; and he must know each span of it.' With the first signs of an ice crust appearing over the snow, reindeer herder should scout the entire area around to know where to move the herd if necessary. Stammler mentions that in such circumstances, to which he was a witness in November 2007, the reindeer herders first tried to find out about ice-crust presence on the adjacent territories and than moved their herds to the less damaged places (Stammler 2008, 85). Denis says that sometimes he managed to find a proper place for his reindeer, but another herder also found the same place at the same time. When I asked about possible conflict between those two herders, Denis answered that the trouble was not a conflict; the real problem was to find an appropriate place.

4.2.2 Spring

4.2.2.1 Spring Exposure-Sensitivities

As our informants asserted, after warm winters and light-snowfall, the first heavy snowfalls have recently only appeared in spring, March and April. Sometimes the snowfalls last till June. In the local newspaper, they wrote that people had begun preparing for the holyday 'Winter Seeing-off' and the spring carnival 'Pancake week' begins, but only then people finally faced the real winter, and the frosts set in. The newspaper wrote that in the past all the signs of spring appeared at the same time. The sun after the polar night came into view together with the certain birds such as snow buntings, which were considered to be the messengers of spring. Now everything has been dislocated: the sun should be the sign of spring, but there is no warmth and the birds are late.

The heavy spring snowfall causes lots of problems for the reindeer herders. Despite the fact that March and April are really cold, the reindeer feel that it is already the time for thawed patches and green grass to appear, but instead they find only a hard crust of ice over snow. The herder Pieter said that reindeer felt discomfort at that time and began to run around ineffectively searching for grass. Denis affirms that 'in spring the reindeer do not want to eat moss any more; they scatter around and look for some verdure. They love snowdrops, flowers. They are tired of moss. But there is still no verdure, it is cold.' The veterinarians recommend that the herders spread the spring herd widely over the pastures and try not to disturb the reindeer so that they are able to

recuperate from winter nutritional deficiencies and to be well- nourished by the time mosquitoes arrive (Yyzhakov, 82). However, due to the recent long springs, reindeer, which continue to dig up moss from under snow, become weak and rapidly lose their weight.

Another feature of recent spring climate is weather instability. The herders affirm that in the past the weather was much more stable, it was cold in winter and the cold weather did not return after the arrival of the spring warmth. Recently everything has been intermixed. The cold, which did not come in its allotted winter season, commences later in spring. Especially dangerous for the reindeer is the occurrence of abrupt frost after the spring thaw causing the formation of an ice crust over the snow or ground. In such cases the reindeer are unable to get forage from under the snow. This phenomenon has become more frequent in recent years. In 2007 Stammler was witness to a period of February rain, which resulted in an ice-crust covering the entire south of Yamal. He wrote that as a result, during spring migration to the north, all the herder brigades which spent winter in forest tundra had to traverse spaces covered with ice-crust. A lot of reindeer weakened and as a consequence that year[3] herders lost 30% of their herd (Stammler 2008, 86).

The most crucial spring period for the reindeer herder is calving. The weight of calves rapidly increases this time. The herders explain that after the warm weather has set in the female reindeer give birth onto thawed patches, free from snow, however in recent years, there have been two main threats to the reindeer. Firstly, following the birth of the calves, warm weather has arrived too quickly leading to fast snow thawing precipitating sudden floods. Water inundates everything around, and the 'small calves try at first to follow their mothers, but then they remain behind and get stuck in the brushes. Poor things, they hang around over the bushes' and perish (Ulyana). Another trouble of the late springs is that the calves are born into cold weather. Some reindeer give birth in their usual time (mid-April), but it is still really too cold for the new-born calves. The herders say that in case of cold weather some reindeer can refrain from giving birth, but most calves are born either into the cold weather possibly soon followed by frost. In those cases some calves die, as the herder Pieter says, before their mothers even have time to lick them. Even if the birth process successfully happens in a warm period, sudden return of the cold and snowy weather may be life threatening to the calf. 'Sometimes the snow in spring is up to my chest,' Pieter says, 'How reindeer can find their forage? The reindeer are digging and only their tails stick out of snow. But not one calve is visible under the snow.' 'Sometimes sudden snowstorm begins after calves are born.' Pieter considers that current spring weather instability is the most dramatic he has seen in his working life.

[3] In the beginning of the same winter season, that is in November 2006 there was also rain which resulted in ice-crust. The lost of 30% of reindeer was a consequence of these two winter (November and February) rains. (Stammler 2008, 86).

Even if the calves born into the cold weather survive, many of them are likely to die later. As Stammler noted, 'it is important for the deer that the weather is warm enough and that the female finds a snow-free patch of ground where the newborn lies during its first few hours of life, if it lies on snow, it can catch cold or get pneumonia, and generally dies soon afterwards. In 2001, due to cold weather and snowstorms (*burany*) in Northern Yamal, more than half of all newborn calves died in the household I was staying with. Many neighbours told the same story' (Stammler 2005, 110). The herder Denis elucidates why it happens. 'If it was warm and suddenly snowstorm comes, it harms the calves' lungs. They are not yet strong enough and ready to breathe in the snowstorm and then their lungs 'swell up' after that. Denis considers that not a single calf born before the snowstorm would be able to survive. Pieter described a blizzard which started immediately after calving. There were already lots of newborn calves and some additional herders came to help us with the calves but suddenly an intense snowstorm broke out, and nobody could leave the *choom*. People had to sit indoors the entire day. By the end of blizzard, there was snow up to their chests and of calves were covered with snow and had died.

4.2.2.2 Spring Adaptive Strategies

In case of heavy snowfall herders' adaptive strategies consist in searching for places with less snow and better protection from heavy winds such as a hole, a river bank or a mountainside. The main thing is, as they said, not to leave the herd on the flat. To avoid the danger of losing the reindeer during a spring blizzard, the herders have to stay with their herds constantly and to watch the animals. The herder Peter told me: 'When it whirls, and I cannot see anything, I must not stir a step from my reindeer's side; otherwise I risk losing the entire herd. I have to follow them every moment. Once I dropped my stick (trochee), [4] and it was covered with snow in a moment and I had to go farther with no trochee.' If because of unstable weather ice-crusts may appear necessitating as search for less damaged pastures. The herder Denis complains that for him it is a hard-work going around looking for the new places for his reindeer. 'But that herder, who is too lazy to do it, risks losing his reindeer,' he says. 'If a herder was lazy today and did not go to search for a better pasture, his reindeer are doomed to death!' The herders pessimistically said to me that in spite of all their attempts and diligence, they have lost reindeer in such weather conditions and have no ideas how to avoid tragedies involving the death of reindeer, and especially their new-born calves.

To lessen the risks connected to instable spring weather during calving, additional workers come to the tundra to help the herders; however this can only partially improve matters. In instances of floods following calving the workers collect those calves at risk of drowning. The calves try to seek safety on

[4] Stick which is used for driving reindeer.

the tops of knolls and in bushes, but only a few of them, as the herders say, can be actually saved. A similarly ineffective method of rescuing calves is used after heavy snowfalls. Herders try to determine the place of location those calves, which are covered with snow, by watching their mothers. If a female reindeer circles a certain place, it means that the calf is there under snow. There also can be found small holes in the snow which serves as a sign for a herder to dig there to find calf. Unfortunately, as my informants said, most of the calves dug out that way, were already frozen and dead.

4.2.3 Summer

4.2.3.1 Summer Exposure-Sensitivities

All informants affirm that recently the summers have become much hotter than usual. Sometimes hot weather lasts for short periods for only for a week or a month, Ulyana says, but people and reindeer suffer from it. Herders recollect it as one of the most difficult times of the year. The hottest time is usually, as they say, in the end of July, but after August 2nd (the day of the saint prophet Ilea) Nenets await cooler and foggier conditions. On that day some games and competitions are arranged. Denis says that this day everyone and everything in nature breathes with relief, because the troubles of the hot summer are already behind and the long-awaited coolness has come. Hot weather is considered to be no less disastrous in the tundra than a winter ice-crust. The anthropologist Andrew Golovnev describes one of the sultriest summers in Yamal this way. 'Heat in tundra is rather tormenting then blessing. . .. In the central part of the peninsula in latitude of the mouth of the Yuribei River it was possible to bathe and to lie in the sun. ... It was difficult to breathe, and each unnecessary movement caused perspiration. The Nenets elders were lying in their *chooms* being half-sick and refused even to talk. When they went out of the *choom* (for all that they did not forget to put on their fur jumpers) they could hardly walk,' (Golovnev 1995, 310). Not only reindeer, but people also did not adapt well to the higher temperatures and barely modified their traditional way of life or habits, such as changing their fur dress to something cooler. Both in the Nenets Autonomous Area and in the Yamal-Nenets Autonomous Area informants complained that in summer they suffer from dry weather. They told us that the pastures can be burnt by the sun and subsequently the valuable moss fodder would fail to recover and be replaced by some other sort of vegetation instead. Golovnev confirms that in latitude of the Yuribei River it became possible to find glades of ripe cloud-berry, but many of the grassy and moss pastures, best suited to reindeer, had been burned down (Golovnev 1995, 310).

Due to arid summers many lakes in the tundra have dried out leaving only some small puddles in the place of the former deep lakes. Olga says: 'There was a big lake over there. You could see it before, but now there is only a puddle on that place left. All the lakes have become shallow.' Golovnev writes that the

permafrost marsh hummocks are now thawing out and slipping down under the riverside and lakeside slopes. He also refers to the rumours that in one place a landslide crushed a reindeer and in another place it destroyed the sacred worship place (Golovnev 1995, 310).

Summer heat negatively influences reindeer health. One of the troubling features of summer is water shortage. According to Denis, reindeer prefer to drink water from sources that smell of soil such as bogs, ponds or partially dried up lakes. They refuse to drink lake water as the clean lake water does not have taste they like, but in dry hot summers the bogs and ponds are almost completely dried out. This causes lots of problems and sickness for the reindeer. Mostly, as the herders affirm, they suffer from heart and lung diseases.

Summer heat itself wearies reindeer and renders them sick. Reindeer lack sweat-glands, and are thus unprotected against the heat. As the herder Ivan explained, any scratch or abrasion can become a cause of suppuration and serious sickness for the reindeer impaired by the summer heat. The herder Denis affirms that it has become almost impossible for reindeer not to hurt their legs in recent arid summers. 'Because of aridity, even twigs have become dry and sharp, they can injure reindeers' legs, and it causes sickness.' The prevailing summer disease is '*kopytka*' disease, which is accompanied by the cracking of reindeers' hooves. This disease can affect reindeer in any season, but in summer and especially those hotter than usual, *kopytka* becomes more common and is transmitted further.

Another disease, exacerbated by climate change, is bronchopneumonia. It affects those calves which are born before the arrival of snowstorms in spring, but it may also occur in too hot summers. Despite of summer heat, there are still some places where snow can be found. The reindeer weary of summer heat rush towards the snow and because of the sudden change of temperature encountered they get bronchopneumonia. During summer some herders may not notice anything wrong, however as autumn approaches the disease can adversely affect the animals. As explained by the *choom*-worker Ulyana, the effects of bronchopneumonia may be revealed during slaughter. Ulyana told me that during the latest slaughter they selected two calves, because they were smaller than others, and decided to kill them. Her role was to cut reindeer carcasses, to cut out their liver. It happened that she had to butcher the two small calves. 'I took out their internals. What do you think? The hearts were completely covered with pus. I managed to cut out of the entire heart matter from one of the calves, but I could not even find the heart of the other one. Everything inside it was totally overgrown with something. It was right that they decided to slaughter them, because they would not be able to survive the winter as the temperature drops.' The main specialist of the farming department in the Nenets Autonomous Area[5] said that because of animals' diseases the farmers received eight kilograms less meat from each reindeer than usually due.

[5] Sergey Kiselev

A further summer related problem, which may intensify with climate change, is reindeer emaciation due to harassment from mosquitoes and other blood-sucking insects. The intensity of mass attacks by blood-sucking insects can be so strong that its can lead to the death of reindeer which stray from the herd. Denis relates: 'There are lots of mosquitoes and swarms of midges. They torment reindeer. They totally cover them. Insects stop up their eyes and other open places. The reindeer become rabid and franticly run around. It is really difficult to calm them. They are not able to stay at one place.' Trying to escape the insects, reindeer bunch into the big compact circles and revolve like a big 'merry-go-round' instead of seeking a better pasture. As a result, the reindeer trample down strips of the summer pastures to such extent that, as the informants say, not one blade of grass is left there. The hotter the summer is, the less the reindeer eat. The herders affirm that in really hot weather reindeer do not even eat at all until it becomes cooler and then they rest and graze quietly.

A further concern caused by excessive summer heat is that calves are often separated from their mothers whilst attempts are made to escape the insects. Efforts to find each other are hampered by tiredness which harms the calves' health, due to loss of milk.

Computing the really shocking loss of calves in summer 2007, Kiselev explains that climate change is responsible for the most part. He writes: 'I can say that in 2007 the weather really blighted our reindeer herders. Because of hot July the deer farms lost a lot of the young growth. In several farms the loss consisted more than 500 heads. Generally, in the Nenets Autonomous Area, non-productive loss of the young growth was 3,500 heads. It is a big number! Each of the calves perished could give an animal yield next year. In meat equivalent the loss consisted nearly one hundred tons of meat' (Kiselev 2007c, 4).

Because of climate warming other dramatic changes are happening in the regions where Nenets live. On the one hand, there are floods and, on the other hand, fires. Some lands on the Barents Sea coast are inundated to such extent that in 2001 the inhabitants of one of the villages Staryi Varandey were removed from there by force. To the south of the Nenets Autonomous Area there are summer fires. The herders say that the peat bogs and forest-tundra catch fire in summer, and smoke travels to their location. In addition, animals such as bears, polar foxes, gluttons (wolverine), escape to the tundra to evade the fires in forested areas. Some of these animals are predators, dangerous for the reindeer and others (like polar foxes) are the carriers of diseases to which reindeer are vulnerable. In some places, the fires also ignite the winter pastures. Moss, a valuable reindeer forage source may take up to 30 years to restore following a fire, which further aggravates the lack of winter pastures.

Another disturbing feature of climate change is the appearance of such phenomenon as summer tornados and hurricanes. The elders affirm that they do not remember any such incidents in earlier days, and everyone says that these are signs of climate change. Nowadays, as my informants say, tornados have become frequent. The summer winds can be so strong, they say, that they even blow cloudberries off their stalks. Maria remembers that once, on a quiet sunny

day they noticed that the water in the lake began 'boiling' and waves appeared. By the evening the heavy wind 'struck'. 'One of our herders wanted to strengthen our *choom,*' she said, 'but he did not have time for that. He flew away together with the *choom*. Nobody could hold that *choom;* indeed there was no time for that.' Fortunately nothing too bad happened to that herder. Ulyana remembers that once, at night, when all her children and she were sleeping in bed, she awoke to discover that there was no *choom* above her, and that they were all already lying in the open air. The blast tore off her *choom* and carried it away. 'I did not even have time to put my dress on; I just quickly wrapped myself up into a blanket. No *choom* any more! It has been taken away! The stove fell right to the bed. Fortunately I had water nearby to put out the fire. There was no *choom*, and mosquitoes attacked us. Disgraceful mosquitoes! Our neighbours were more successful. They did not sleep and had time to grasp their *choom*.' After that case Ulyana could not sleep quietly any more and woke up with any capful of wind. Once, as Ulyana said they were preparing for travel and had packed all their goods. They then saw the tornado coming and hid their children under the sledges. Lucky, they said, the whirlwind did not carry their children away. Another time when they noticed the tornado approaching they had time to put in place additional measures to secure their *choom,* but, as Ulyana remarks, it only partly helped them: 'The puff was so strong that one side of the choom was raised. I grabbed the poles inside the choom. How could I hold them in place? No strength to hold them! The wind could carry them away together with me.' Ulyana considers it was a miracle that her *choom* was not carried away that time.

Tornados are not dangerous for the adult reindeer, but as the herders say, they can carry away a calf. The herders affirm that some of their calves were taken away by the wind. Sometimes hurricanes are accompanied by hail. The herders described hailstones as large as hen eggs. Big hailstones can hurt both people and reindeer. If people are not in *chooms* during hailstorms, they hide their children under the sledges.

Information concerning the variation in summer fog conditions differed according to region. Yamal Nenets did not notice any change in foggy weather. They affirm that after August 2nd, when it becomes cooler, the fog begins. On the contrary people from the Nenets Autonomous Area assert that recently there have been fewer fogs than before. Ulyana explains that in foggy weather it is difficult for a herder to gather his herd. 'When a reindeer has a possibility to eat, it does not look at other reindeer. To eat and especially to eat something extremely tasty like mushrooms is the main thing for it. So each reindeer goes wherever it wants. As a result, it can lose its herd, stick to someone else's herd or stay alone.' In foggy weather it is more difficult for the herders to look after their reindeer and prevent them dispersing. Ulyana remembers foggy weather which lasted for more than three weeks. 'It was such a feeling that we were closed within a locked lodgement and that we do not have place enough. Later when everything was over we felt that it became easier to breathe, we could see a wide space around: other chooms, sea and ships.' Foggy weather is also

unpleasant because of an increasing intensity of blood-sucking insects. In fog conditions mosquitoes are active even at night and it is tiresome both for the herders and for the reindeer. Therefore any decrease in foggy weather as a result of climate warming is a positive development.

4.2.3.2 Summer Adaptive Strategies

The current adaptive strategy employed to counter the diseases aggravated by hot arid summer weather is veterinary medicine. The administration of the Nenets Autonomous Area and the Yamal-Nenets Autonomous Area began to distribute medicine to prevent *kopytka*. The herders are given special training in how to use the medicine and heal their reindeer. 'Zoo-technicians explain to us what we should do in case of that disease,' Denis said. 'So, all the herders know everything. When we did not have that medicine, a lot of reindeer perished. But now there is not such big loss of herd. We have even some increases of livestock. I am interested in treating my reindeer well. If I had treated my reindeer well in summer, I preserved their lives. Next winter I can slaughter them, sell their meat, and buy a new apartment for my family.'

Current adaptive strategies against the attacks of the blood-sucking insects consist in the following. First, the herders try to drive the reindeer to a high and windy pasture. This is in accordance with natural reindeer behaviour. In the cases of insect harassment they try to escape for open windswept places.[6] In such places there are fewer insects and is cooler for the reindeer. Thus for the herder, the main priority consists in watching for the wind direction. 'If you lost your attention and stopped watching the reindeer,' Denis explains, 'your herd will have moved toward the wind and you could loose it. When it is hot, the reindeer go against the wind. Trying to run away from the mosquitoes, they are searching for the more windy places. In our herd, there are usually two herders on duty, five male reindeer in their harnesses, and two dogs following. In the evening and in the morning we exchange the herders, the reindeer and the dogs. April to July are the 4 months of the most intensive work.' The second approach to managing insect attacks addresses gadfly infestation. The main specialist in the farming department Sergey Kiselev said that veterinary measures help to reduce reindeer morbidity from gadfly invasion. The herders confirm that prior to treatment there were more gadfly larvae in reindeers' skin, but after the injections the number of gadfly lessened.

Feeling pity towards the animals suffering from heat and insects, the herders use some less effective means, for example sometimes herders even take reindeer into the *chooms* to allow them to rest from the heat and insects. In the *chooms* the animals stay well and quietly, the herders say.

[6] 'If the weather is too hot reindeer tend to stay no the windy slopes and the tops of the mountains the whole day and come down to the valleys to feed only' (Kitti et al. 2006, 151).

Current adaptive strategies to address summer tornados and hurricanes consist in careful watching the weather in order to strengthen the *choom*. People have observed new tornado forewarning signs. They say that the lake water becomes reddish and moves as if it is boiling. Unfortunately they regret that they can only see the signs too late, when there are only several minutes left before the whirlwind starts. At the same time they complain that strengthening the *choom* is not always enough to protect it against the strong wind. My informants proved that whirlwinds and hurricanes are new and recent phenomena in their respective areas. The traditional Nenets *choom* is not adapted to such weather cataclysms. The elders never mentioned any whirlwinds. There was nothing like that in the earlier days, they say; otherwise people would have adapted the traditional *choom* to such extreme scenarios.

4.2.4 Autumn

4.2.4.1 Autumn Exposure-Sensitivities

All our informants affirm that autumns have become warmer and longer. The stable blanket of snow does not appear in mid-October, as before, and similar to spring the weather is characterized by temperature instability. After plentiful snowfall there can ensue thaws and even rain, followed by either an ice-crust formation or snow disappearance. Oleg explains that this it is especially noticeable in the latitude of Krasnoye village, however to the north of Krasnoye the weather is usually colder. Nevertheless, all the regions have registered a change of climate, weather instability (winter rains and sudden frosts after them), and in the most recent years, very little snow until the New Year.

Autumnal inconstancies in weather and especially ice-crusts create real difficulties for the reindeer to survive. As Pieter said, trying to get food, reindeer injure their muzzles against the icy crust; they hurt their legs against ice to such an extent that they tear fur off their legs. Weather instability in autumn negatively influences reindeer health and some perish. Ulyana said that the reindeer looked quite healthy at that time, but suddenly some of them got sick and unexpectedly died. She remembers her son's reindeer, which seemed healthy and well-fed. It was prepared for slaughtering ('and nobody burdened it with any job'), but before slaughter, it started losing its weight ('it suddenly became slender and slim') and just before the slaughtering date it died. It happened, as Ulyana considers, because it often rained that time in autumn, rather than the usual freezing weather. This case is quiet common, and many reindeer die before slaughter. The regional newspaper reported that the farm 'Voshod' ('Sunrise') went bankrupt. This was due to a drastic fall in the number of reindeer brought to slaughter. Instead of the expected 950 reindeer, only 91 heads were slaughtered (Kiselev 2007c, 4).

Warm temperatures may cause serious losses to the reindeer herders in one of the most critical periods of their activity, during the slaughter period. In the Soviet times, those chosen for slaughter were outrun to special places, such as

Naryan-Mar city or to some villages, because the meat could be sold immediately in those population centres, thus avoiding unnecessary meat transportation. However because of the late freezing-up of rivers many long-established herd migration routes have become impenetrable.

4.2.4.2 Autumn Adaptive Strategies

Reindeer herders have found different approaches to adapt to these stresses. The first is to delay the slaughtering campaign.[7] The herders kept their herds whilst awaiting cold enough weather, which did not arrive, and only then drove them to the slaughtering place. In 2006 the regional newspaper of the Nenets Autonomous Area wrote that the slaughtering campaign turned out to be really abnormal. It started only on December 12–15th, which is a month and a half later than usual (Kiselev 2006). In the following year, 2007, the newspaper had to write again, 'Because of the warm weather anomaly, the slaughtering campaign started much later than usual,' (Kiselev 2007b). Kiselev writes that because of the present cataclysms in nature, they had to prolong the process of reindeer meat storage until February 10th. He writes that even the elders do not remember such a delay of the slaughtering campaign. It started three weeks later than usual and lasted for almost 4 months (Kiselev 2007c, 4).

The negative result of the postponement strategy is that during autumn the reindeer usually become thinner. Thus delay in slaughter, in addition to the hardship and distances travelled to reach a slaughter facility, contribute to loss of reindeer weight. In 2006 the regional newspaper wrote that because of the slaughtering delay the herds can lose weight, but only by a negligible margin. Next year the newspaper's tone became more serious, and stated that due to the warm weather anomaly and the slaughtering delay, the herders incur losses, as reindeer appreciably lose their weight (Kiselev 2007a). The farm 'Izhemskij olenevod' ('Reindeer herder of Izhemsk') brought to slaughter more reindeer than expected, but despite this the total weight was 15,000 kilograms less than anticipated.

Another climate adaptation strategy is the practice of building special service centres for slaughtering, supplied with refrigerators and essential equipment for meat preservation. As Kiselev emphasized, the establishment of such service centres is a way to make reindeer herders' work less reliant on the vagaries of the weather (Kiselev 2007b). The positive outcome is that in having such centres the herders are freed from the necessity of driving the slaughter herd long distances. A reindeer husbandry support project delivered storage refrigerators to several herders, and the newspapers optimistically reported that as a consequence, even in the above-zero temperature the quality of reindeer meat should not be

[7] Stammler also wrote about the same trouble, which is doubled by the climate warming. 'The earlier slaughtering is done the better will be the slaughtering weight and the meat quality. However, early slaughtering is risky, since a rise in temperature to 0°C or above can destroy the entire meat stock in the absence of large freezers and processing facilities' (Stammler 2005, 117).

impoverished (Kiselev 2007b). Unfortunately not all the herders were provided with either service centres or refrigerators. It was assumed that the several neighbouring teams could gather at one service centre. However this underestimated the effect of the unpredictable weather. The refrigerators were prepared in the village of Krasnoye, but by the appointed date none of the neighbouring teams, even the closest ones, had brought their herds. This was because the river near Krasnoye, even by December, was still not coated with ice (Kiselev 2007b). This adaptation strategy actually failed because it did not take into account other exposure-sensitivities (like possible late river ice-coating).

A further negative point with respect to the specially equipped slaughter centres is native peoples' attitude to the slaughtering process. Despite the fact that there are slaughter centres right near them, the Nenets herders prefer to slaughter their reindeer themselves. Denis explained it this way: 'I drive my reindeer to such centres only in extreme cases, if I do not have enough assistants in my team. In the slaughtering centres they kill the reindeer sorely and cruelly. I would not like to watch how they were killing those reindeer, which I myself have bred. The people, who work there, do not care about the reindeer. The reindeer should be slaughtered in the right way. When I was a boy, my grandfather told me: "Never kick reindeer! Do not beat them if you have no any serious reasons for that! Do not also beat dogs!" Otherwise you will lose all your reindeer, and your grandchildren would not have any reindeer any more. People should not kill reindeer cruelly!'

The third adaptation alternative is meat transportation, organized by the local administration. This strategy was based on the supposition that the reindeer can be slaughtered far from the service centres, and then transported by helicopters or where possible, by the heavy haulers. In some cases this plan failed because of a sudden and unpredictable rise in the temperature. In autumn 2007 some herds, which were far from any service centres, started slaughtering at the allotted time in the expectation that of meat transportation by the helicopters, however after slaughtering the weather suddenly turned warm and a lot of the meat was spoiled. Khanzerova described it so, 'We feel sorry for the reindeer herders from Kanin. They are really unlucky this year, because their slaughtering campaign was conducted in the warm spell. There was lack of the refrigerators, and the meat lost quality,' (Khanzerova 2007). Thus the strategies described above, to adapt to warm autumns, are not effective enough because they do not take into consideration the entire complexity of exposure-sensitivities.

4.3 Phenological Shift

One of the results of the climate change is the shift of two seasonal cycles, the natural cycle of changing seasons and the reindeer life cycle. The two cycles had previously comprised an integrated system. However now autumnal

warmth lingers and spring comes later, it is as if time has drifted. At the same time the reindeers' biological clock and some social habits have not shifted in tandem. The old herders continue wearing their fur clothes in the hot summer weather and the female reindeer carry on giving birth to their calves in the allotted time in spring, when the sudden fall of temperature provides little opportunity for their calves to survive. The integrated system of weather-reindeer-human interconnectivity has become dislocated.

In early spring it is important to move the herd to the calving pastures in good time. As Yuzhakov and Mukhachev indicate, 'delay in reaching winter pastures can lead to the fact that mass calving would begin far from the calving pastures. It will inescapably lead to calve mortality, especially if on the way to the summer pastures there is a water barrier,' (Yuzhakov and Mukhachev 2001, 81). Recently at the time when the herd should be moved to the calving pastures it has still been cold. Really high snow cover prevents migration to and lack of available spring grass in the calving pasture provides a further reason to delay the herd in the winter pasture. As the herders affirm there is no moss either, it would not be possible to feed the reindeer in the spring pasture prior to the arrival of stable warmth. Thus because the late spring migration is delayed an additional burden is placed upon the critical moss winter pastures. The month for migration to the North was traditionally April, but now migration may be postponed till late May. As a result calving happens in the winter pastures, and consequently calves have to make the perilous journey to the North, overcoming hazards, including tundra river crossings. This contributes to significant calve mortality.

Another shift happens in summer. Due to the delay in leaving the winter pastures, the herds are not able to reach the high, open and windier summer pastures before the arrival of blood-sucking insects. 'By the end of June', Denis explains, 'I supposed to be close to the summer pastures, but because of those delays I am still in the beginning of my road to them. This road runs through the low-lying lands, and the blood-sucking insects' flight begins when my reindeer are least protected against them.' In addition to the insect attacks and heat, the reindeer have to carry the heavy sledges loaded by the provisions bought in the village and stocked for the entire period of migration. As a result of these factors, the loss of concordance between the seasonal rhythm and the life cycle of the herd makes the late migration to the summer pastures much more difficult than usual.

Regardless of these impediments, the herder has little alternative but to bring the herd to the summer pastures. Denis elucidates that the area between the winter and summer pastures has lots of disadvantages in comparison with summer pastures. Firstly, it is situated in the hilly forest-tundra, where it is not easy to watch all the reindeer, whereas the summer pastures are located in the plains, where one can watch the reindeer far around. Secondly, unlike in the summer pastures, there is not enough wind in the forest-tundra, and hence lots of blood-sucking insects. Thirdly, the grass in the summer pastures is much better for reindeer than the forest-tundra vegetation.

It would seem intuitive that because of climate change the reindeer summer season should be prolonged, however it is paradoxically shortened. The herd not only comes later to the summer pastures, it has to leave earlier than usual. Our informants referred to the two reasons for that. First, the habitual mode of the activity is still strong. The herders have no foreknowledge about the temperature of the coming autumn. Should the freezing weather arrive at its usual time, unlike in recent years, they risk not reaching the winter pastures in time. The second reason is the increasing competition for the use of winter pastures, especially for those ones situated near the villages, as they say 'near the civilization.' Attempting to occupy the winter pastures closest to the villages before the other herds, the herders bring their herds there much earlier, 'Now in October and in November the herds are already wintering. Why do they start wintering so early? They all want to stay closer to the civilization!

As moving to the winter pastures has shifted to an earlier date, and because the duration of the stay in summer pastures has shortened, people, reindeer and dogs do not have enough time to rest in summer pasture. 'I have just come here (to the summer pasture)', complains Denis, 'but I already have to return back. I return not rested. When I went to the summer pasture, mosquitoes tormented me, but when returning, I have troubles with the lame reindeer afflicted with "*kopytka*" '.

4.4 Discussion and Conclusion: Historical and Future Exposure-Sensitivities and Adaptive Strategy

From our informants' perspective, some features of climate change, and unusual weather phenomena are not completely new in their regions and, with the exception of tornados, have happened in the past. The information about similar events was preserved in the historical sources. Those sources kept the information about fires in taiga zone, which occurred on account of natural factors such as an abundance of dry wood due to long periods of hot and windy weather. The researchers consider that because of human activity fires have become more frequent since the 17th century, but they lack evidence to prove it. There does however exist some data concerning forest fires in 1826, 1840, 1860, 1900–1901, and 1926 (Gololobov 2000, 230; Polyakov 2002, 68). This indirectly points to possible excess summer warmth in those years present also in the tundra.

The formation of ice-crusts over the snow is also not a completely new experience for reindeer herders, but as Adayev emphasizes, in the past ice crusts did not occur over such large areas as has been seen in recent years, and it is evident that the frequency of such events has noticeably increased (Adayev 2007, 85–86). The historical records have noted periods distinguished by warmer temperatures. This includes the second quarter of the 18th century, as a result of a change in winter temperatures. This warming was more considerable in higher latitudes (Khantemirov and Surkov 1996, 271). Only since the mid 20th century has warming been so rapid and temperatures reached such high figures (Adayev 2007,

19). Additional information has been preserved about cold periods. According to A.M. Maloletko, the late 16th and early 17th centuries saw a stable and prolonged fall of temperatures with moderate levels of precipitation. The first quarter and the last decade of the 17th century were very inclement and the peak of the cold spell was reached in 1770s. The 19th century, especially its beginning and the first decades of the 20th century were also sufficiently cold (Maloletko 1999, 47).

The disasters resulted from unstable weather and sudden warming were in the past very rare, and stories about them, as about other extraordinarily events, passed from one generation to another. Our informants affirm that nothing, to their knowledge, similar to the recent climate changes has ever been observed before. The intensity of abnormal weather phenomena is increasing, and what was earlier infrequent is now becoming constant.

The administration has refused to acknowledge that some herders' troubles were caused by climate change. At the same time they recognized the existence of stresses such as pasture degradation, loss of meat during slaughtering, and discussed possible preventative measures. The adaptation strategy they suggested transpired to be unsuitable for coping with the real reasons underlying the difficulties. According to our informants, the administration proposed a reduction in the reindeer livestock population, which would solve, as they thought, the problem of winter pastures shortage, and require the resettlement of some herders to the villages. The herds to be initially cut were private herds, and the state herds were to be preserved. That proposal raised vehement objections amongst private herders who did not accept the official position concerning the administrative means for lessening number of the herds and the means of to restore the pastures. Although in official meetings climate warming is not mooted as a serious concern pertaining to the loss of reindeer, in confidential conversations, the herders do emphasize its significance. The implications of restrictions and reductions in the population of private reindeer livestock have ensured that the herders are fraught with the threat of not only losing reindeer but also their jobs. 'If you have lost your herd,' Denis says, 'if you remain with no reindeer, you would be nothing! You would not be fit for any other job. Your entire life would be broken. You would not be able to think about anything else apart from it. You have children to bring up, you have some other troubles! It would be intolerably difficult! Now even with no official reduction of the herds, the cases when the reindeer herders lose their reindeer, happens more and more frequently.'

The private herders can themselves cope with some of the difficulties caused by climate change, because the foundation of their adaptive capacity has always involved the flexible use of the vast tundra territories and openness to economic innovations (Adayev 2007, 85). Despite the fact that each herd became accustomed to its own migratory route, herders have periodically change the location of the seasonal pastures in order to reduce the burden on the natural resources (Adayev 2007, 97–98). In extreme cases herders may chose wintering places far to the north from the regular winter pastures. Delaying the slaughter date, as a contingency against seasonal dislocation, is yet a further example of the adaptability of reindeer herding praxis.

The situation is complicated by the combination of both climatic and anthropogenic factors, which threaten the reindeer herding economy. The reindeer herders have experienced an increased burden being placed on the environment and habitat in the tundra, and an increasing dependence on external economic and cultural influences. All those factors threaten the traditions of Nenets reindeer herding. Despite the acknowledgement that reindeer herding should be considered as highly adaptive, both with respect to natural and anthropogenic influences, today it is confronted by an especially hard test, because the level of unfavourable impacts affecting reindeer herding is currently extremely high (Adayev 2007, 89). My informants consider that those external negative factors are going to accumulate, and their prognosis concerning the future is rather pessimistic. When I asked the elders how they thought climate change would affect the future reindeer herding economy, they usually said that the conditions would progressively get worse. If everything continues in the same way, some of the herders say, we are going to lose reindeer husbandry in about 30 years. The similar prognosis was received by the other researchers from their informants; 'As it gets warmer and warmer, the permafrost will melt and our land will be a permanent swamp and we won't be able to do anything – no pastures, no hay fields, just the high areas will remain, if it continues, then the permafrost areas will stop being frozen and it will all melt,' (Crate 2009, 143).

The threat of global warming to reindeer husbandry in the Arctic tundra is clearly recognised by those herders and associated officials who are directly confronted by the predicaments caused by the climate change. However the risks are underestimated by those whose position is further removed from the realities faced by reindeer husbandry. Nevertheless one can surmise that the anthropogenic factor, responsible for some of the negative consequences of warming, also has the potential to correct some of the harm caused to reindeer husbandry through climate change. The further development of transportation and additional mechanisms for communication, an improvement in the network of slaughtering service centres, and the provision of veterinarian medicine can help reindeer herders better adapt to climate challenges.

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