Chapter 2
Adaptation to the Future Climate in Sámi Reindeer Husbandry: A Case Study from Tromsø, Norway

Kia Krarup-Hansen and Berit Oskal-Somby

Abstract Climate projections for Northern Norway show an increase in winter temperatures in the nearest future. What are the consequences of such rapid changes for Sámi reindeer husbandry? How can herders adapt? This case study, just outside Tromsø in Northern Norway, seeks to answer these questions by analyzing local climate history and interviewing herders. In the 1950s, a herd of Sámi reindeer changed both summer and winter pasture grounds. Subsequently, changing especially winter pasture grounds from inland Kautokeino to the coastal areas near Tromsø challenged both reindeer and herders. As a result, in Troms, the herders had to develop adaptation strategies to manage herding in winters with a high frequency of rain-on-snow conditions, large amounts of snow, and decreased access to reindeer pastures. The situation in interior Finnmark, where they were located originally, is historically different: less snow and colder temperatures. However, future climate projections show that the herders in Finnmark could face today's situation in Troms within the next 50 years, with warm winters and high precipitation. Reindeer herders in Troms adapted to the new climate by changing their herding systems and increasing supplementary feeding. Yet their adaptive capacity is constrained by different external factors discussed in this chapter. The future of reindeer herding in both Finnmark and Troms, Northern Norway, depends on cooperation with authorities to protect the grazing land and provide herding flexibility.

Keywords Reindeer herding · Climate change · Encroachment

K. Krarup-Hansen (✉)
UArctic EALÁT Institute at the International Centre for Reindeer Husbandry, Guovdageaidnu/Kautokeino, Norway

UiT The Arctic University of Norway, Tromsø, Norway
e-mail: kia.k.hansen@uit.no

B. Oskal-Somby
Reindeer herder, Mievki-Stuoranjárga/Mauken-Tromsdalen Reindeer Pasture District, Tromsø, Norway

S. D. Mathiesen et al. (eds.), *Reindeer Husbandry*, Springer Polar Sciences,
https://doi.org/10.1007/978-3-031-42289-8_2

2.1 Introduction

Most Sámi reindeer husbandry in Norway is located in Finnmark, but reindeer husbandry is also practiced in Troms, Nordland, and Trøndelag. This case study investigates one reindeer herding unit that herds their reindeer close to Tromsø in Troms, Northern Norway—the Mievki-Stuoranjárga/Mauken-Tromsdalen reindeer husbandry district (RPD) (Fig. 2.1).

We focused on the loss of pastures and the impact of climate change. Initially, the studied Sámi reindeer herders herd their reindeer near Guovdageainnu/Kautokeino in Finnmark during the winter. In the 1950s, they moved their herd to the coastline of Troms, which has different climate conditions compared to inland Finnmark (Figs. 2.2a and 2.2b).

Nowadays, herders in the district have to cope with warmer and more unpredictable winters in Mievki/Mauken with frequent rain-on-snow events and a greater amount of snow (Vikhamar-Schuler et al., 2010; Hanssen-Bauer et al., 2023; van Rooij et al., 2023). Sámi reindeer herders refer to the melting and freezing snow cycle "when the snow melts, and the water freezes to form a hard coating of ice on the ground and plants" as *bodneskárta* (Eira et al., 2023). If followed by a period of cold weather, it forms strong ice layers (*geardni*) on the pasture plants or in the snow. Such weather events "lock" pastures making it nearly impossible for the reindeer to reach the feed and act as grazing barriers. In severe cases, this could lead to the starvation of reindeer (Halfpenny & Ozanne, 1989; Putkonen & Roe, 2003; Eira, 2012; Eira et al., 2012).

Fig. 2.1 The reindeer herd on migration between their winter pasture in Mievki/Mauken and their summer pasture in Stuoranjárga/Tromsdalen. The city of Tromsø is seen in the background. (Photo: Kia Krarup-Hansen)

Fig. 2.2a Orientation of Stuoranjárga/Tromsdalen, Mievki/Mauken, and Finnmark, Norway. (Map: downloaded and modified based on data from Kartdata, Geovekst, reindrift)

In addition to the effects of the coastal winter climate, this reindeer husbandry district has experienced substantial encroachments and disturbances over the last 70 years. Urban development of Tromsø city, sprawling ski and cabin resorts (Danielsen & Tømmervik, 2006), and modernized agricultural activity have shrunk the pasture lands in the area. Place-based studies help understand the complex nature and local dependencies of the social and ecological changes experienced in the area (Turner et al., 2003). A better understanding of the local stresses and vulnerabilities from the reindeer herders' perspective could assist in framing adaptation strategies based on Indigenous and traditional knowledge (Corell et al., 2019; Tonkopeeva et al., 2023). The Arctic Climate Impact Assessment (ACIA, 2005) showed the necessity to engage various cultural perspectives, including reindeer herders (McCarthy et al., 2005), in analyses of vulnerabilities to climate change.

Climate projections suggest that the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD is vulnerable to future climate change as their mean midwinter air temperature is moving closer to the freezing point within the next 50 years. As the winters are crucial for reindeer survival and reproduction, and climate projected studies predict the most remarkable changes in winter (Hanssen-Bauer et al., 2009; Hanssen-Bauer et al., 2023), this chapter will focus on the winter pastures in view of rain-on-snow events and snow precipitation. In the case of Finnmark, with increasing temperatures and precipitation (Benestad, 2008) and urbanization sprawling (Tonkopeeva et al., 2023), this investigation of the reindeer herders' adaptive strategies might help shape the adaptation strategies for reindeer husbandry in future Finnmark.

This research involved analysis and comparison of the future ambient temperature and precipitation projections for the area of Troms and Finnmark; the author conducted semi-structured interviews with the herders in a respective herding district. Information obtained within the interviews was mapped with the given projections. Interviews were conducted in Norwegian and Sámi and then translated into English by the author.

Fig. 2.2b Map of Stuoranjárga/Tromsdalen summer pasture district (red) and Mievki/Mauken winter pasture district (blue). (Map: downloaded and modified based on data from Kartdata, Geovekst, reindrift)

2.2 Study Area

Since the dissolution of the union between Sweden and Norway in 1905, cross-border reindeer herding has been controversial (NOU, 2007). Before 1950, the Oskal family herded their reindeer on the territories between Aidejávri near Guovdageainnu/Kautokeino in winter and Àkšovuotna/Øksfjord on the coast of Finnmark in summer (Fig. 2.2a). Due to limited grazing land around Kautokeino already in 1950, they applied to use the pastures in what is now known as the Stuoranjárga/Tromsdalen reindeer husbandry district. In 1950, they started a 4-year-long journey from Aidejávri to Stuoranjárga/Tromsdalen (Fig. 2.3).

Since the winter of 1957, the Oskal family has moved between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen outside Tromsø, as shown in Figs. 2.2b and 2.4 (Berg, 1991).

Before World War II, herders from Gárasavvon/Karesuando in Sweden used Stuoranjárga as summer pastures. Then the Mievki/Mauken pasture area worked as calving ground for reindeer on their annual trek from Gárasavvon/Karesuando to the coast. The historical use of these pasture areas is described by Sveen (2003).

Today, the usage of the pasture area of Mievki/Mauken is legally restricted to the period between October 15 and May 15 and Stuoranjárga/Tromsdalen April 15 and January 15 (Landbruksdirektoratet, 2020). The growing season on the coast is longer, and here the reindeer have access to a wider variety of forage (Hanssen-Bauer et al., 2009; Warenberg et al., 1997). Thus, the summer pastures in Stuoranjárga/Tromsdalen are rich; the calves of the Oskal family became larger after they moved

Fig. 2.3 Berit Oskal with the reindeer in lead when the Oskal family moved with their herd from Aidejávri in Finnmark to Stuoranjárga in Troms in the 1950s. (Photo: the Oskal family)

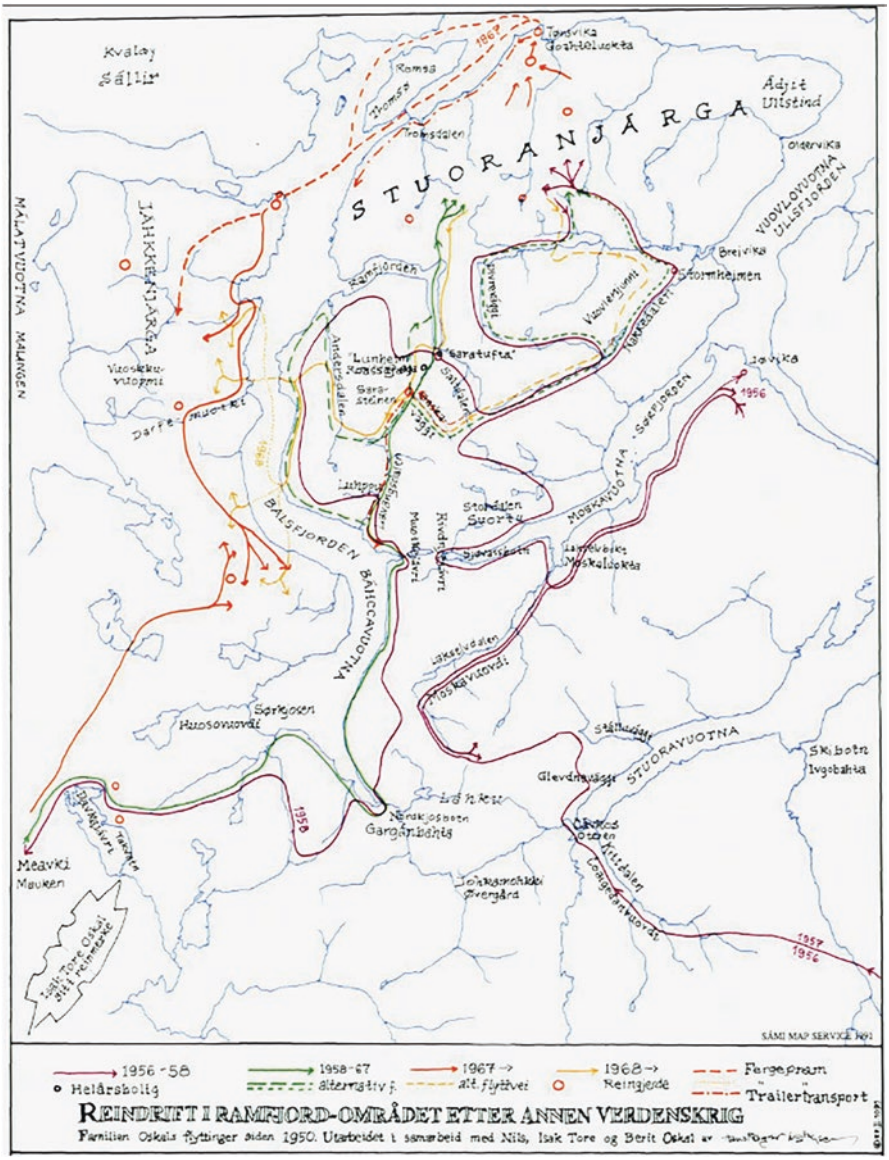

Fig. 2.4 Migration routes used by the Oskal between Mievki/Mauken and Stuoranjárga/Tromsdalen RPD from 1956 until today: 1956–1958 (purple arrow), 1958–1967 (green arrow), 1967–today (red arrow), alternative migration routes (yellow arrow), boat or truck transport (dashed line), fence (circle). (Representation of illustration made by cartograph Hans Ragnar Mathiesen in cooperation with herders of Mievki/Stuoranjárga RPD published in Berg, 1991, 76)

there from Finnmark (reindeer herder B). In autumn, the nutrient content of the summer pastures is low, and the mild winter on the coast often leads to "locked" pastures. The higher and steeper mountains at the coast also increase the risk of avalanches making the Stuoranjárga/Tromsdalen pasture area unfavorable for winter grazing (reindeer herder A; Berg, 1991).

The summer-winter pasture migration routes used by the Oskals since the 1950s appear in Fig. 2.4 (Berg, 1991 p. 76). In the 1960s, the reindeer husbandry district and their reindeer migrated along Balsfjord on the mainland (purple line, Fig. 2.4). However, the expansion of agricultural areas and the increased traffic along the coast made them revert to another migration route (yellow arrow in Fig. 2.4). Today they move the reindeer using an old military seagoing landing craft (Figs. 2.5a and 2.5b) from Tønsvik to Balsnes/Vikran in Malangen (dashed red line in Fig. 2.4). From here, the reindeer trek to Mievki/Mauken for the winter (Berg, 1991).

The loss of calves in Troms reindeer pasture area is high (53%) compared to, e.g., West Finnmark (42%) and East Finnmark (34%) (Landbruksdirektoratet, 2020). This is despite the high quality of the summer pastures and, thereby, higher slaughter weights in Troms. Higher calves' losses might be caused by increased predation and difficult winter grazing conditions. Due to the latter, reindeer, for example, are allowed and need to roam freely in search of pasture plants. The pasture area per reindeer for the Mievki/Stuoranjárga/Mauken-Tromsdalen RPD is higher than for Finnmark districts (1.47 vs. 2.9 reindeer/km^2; Landbruksdirektoratet, 2020).

Fig. 2.5a Reindeer waiting to be transported by an old military seagoing landing craft between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen. (Photo: Kia Krarup-Hansen)

Fig. 2.5b Reindeer transported using an old military seagoing landing craft between winter pastures in Mievki/Mauken and summer pastures in Stuoranjárga/Tromsdalen. (Photo: Kia Krarup-Hansen)

2.3 Outlining Climate History

The warm North Atlantic Current greatly influences the Norwegian climate. The Norwegian coast receives temperate sea air with westerly winds, and the air temperatures here are well above the temperatures observed in Alaska or Siberia at the same latitude. The Norwegian coast experiences moderate daily and annual temperature fluctuations (Hanssen-Bauer et al., 2009). Since the topography of Mauken RPD variates, with pastures at sea level to above 1300 meters, significant local variations in temperatures, wind and snow conditions, snow depth, pasture plants, and pasture access exist.

In general, the winter in Mievki/Mauken in Troms is much warmer (−10 °C) compared to more continental Guovdageainnu/Kautokeino in Finnmark (−16 °C) (Fig. 2.6).

Mievki/Mauken in Troms also receives far more winter precipitation than inner Finnmark (Fig. 2.7), 150–400 cm against 25–100 cm of snow over the winter, respectively (Fig. 2.8).

In addition, frequent rain-on-snow events in Mievki/Mauken occur due to winter temperatures near 0 °C. Figure 2.9a illustrates warm weather events during midwinter in Tromsø. In Kautokeino, the winter temperature is, on average, 2 °C lower today than in the early 1970s, though the temperature remains well below the freezing

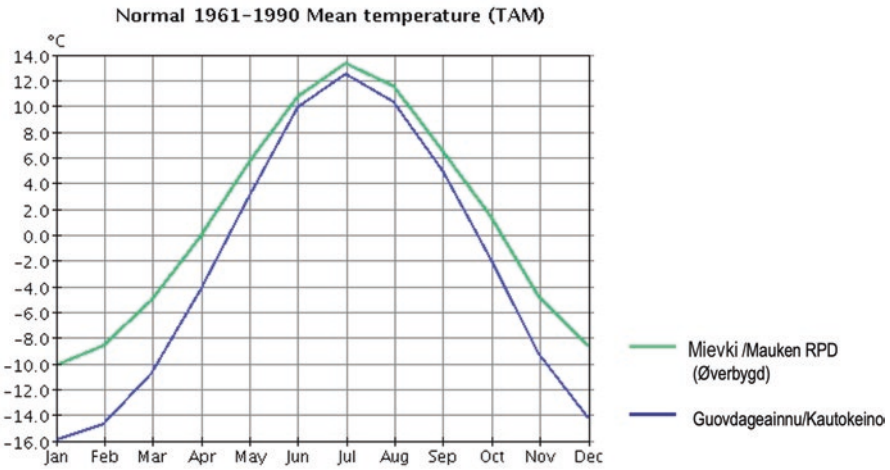

Fig. 2.6 Mean monthly air temperature (1961–1990) in the Mievki/Mauken RPD in Troms (Øverbygd, weather station no. 89800) and Guovdageainnu/Kautokeino in Finnmark (weather station no. 93700). Norwegian Meteorological Institute

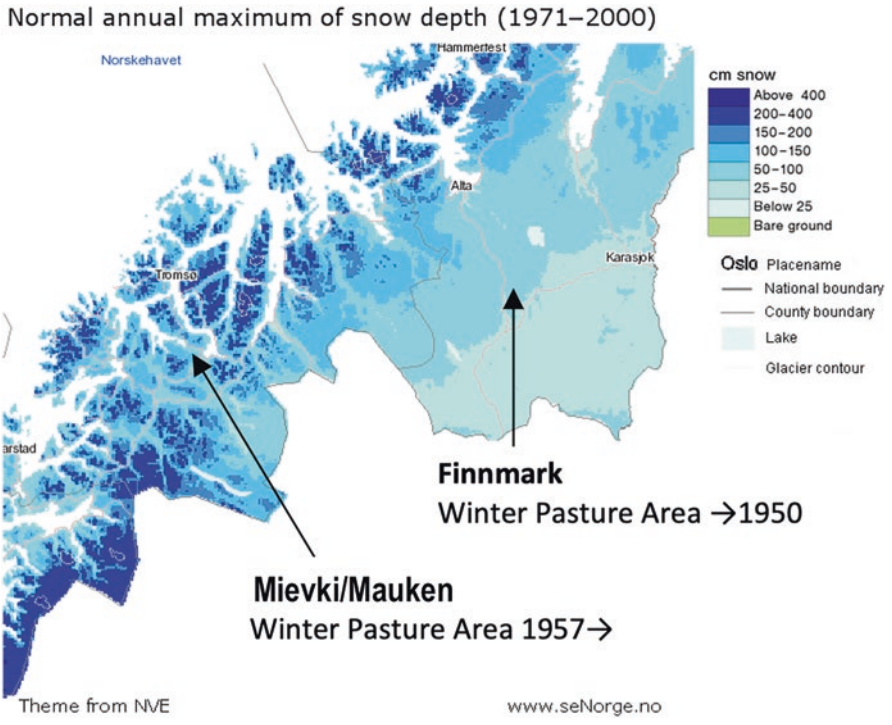

Fig. 2.7 Normal precipitation (1961–1990) in the Mievki/Mauken RPD in Troms (Øverbygd, weather station no. 89800) and Guovdageainnu/Kautokeino in Finnmark (weather station no. 93700). Norwegian Meteorological Institute

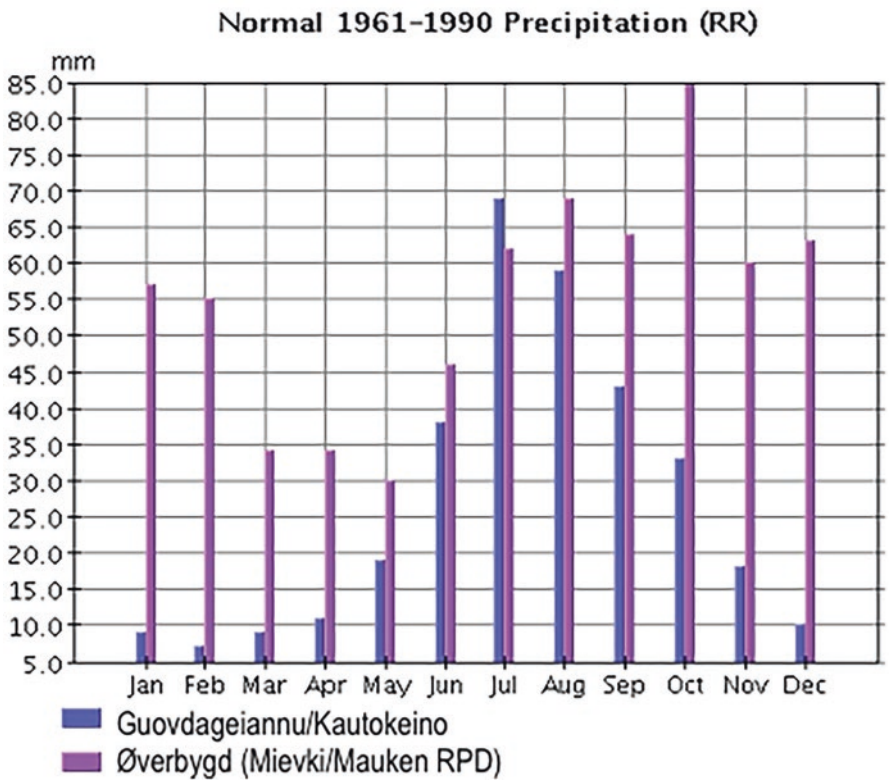

Fig. 2.8 Normal annual maximum of snow depth (1971–2000) for Troms and Finnmark, Northern Norway. www.senorge.no

point over the same time period (Fig. 2.9b), eliminating the risk of critical rain-on-snow events. The frequency of rain-on-snow events in the Mievki/Mauken RPD is lower compared to Tromsø (Fig. 2.9a) but higher than in Kautokeino (Fig. 2.9b).

In Northern Norway, there has been a clear trend in annual temperature and precipitation alterations over the last century (Hanssen-Bauer et al., 2009). In Troms, the winter temperature has increased by 0.8 °C (Fig. 2.10a), whereas the spring temperature has increased as much as by 1.3 °C (Hanssen-Bauer & Nordli, 1998). The increase in winter precipitation has been greatest in Northern Norway, rising by 28% in Troms (Hanssen-Bauer & Førland, 1998).

Herders in Mievki-Stuoranjárga/Mauken-Tromsdalen noted that winters have been "different" since 1981, with an increase in rain-on-snow events: "I remember 1980/81 as the first mild winter standing out in my memory…in February there was no ice on the lakes and the ground was bare at the winter pastures in Malangen" (reindeer herder A). This observation correlates with the trend in Fig. 2.10a starting from the beginning of the 1980s. As shown in Fig. 2.10a for Bardufoss (Mievki/Mauken RPD) and Fig. 2.10b for Guovdageainnu/Kautokeino, mean midwinter

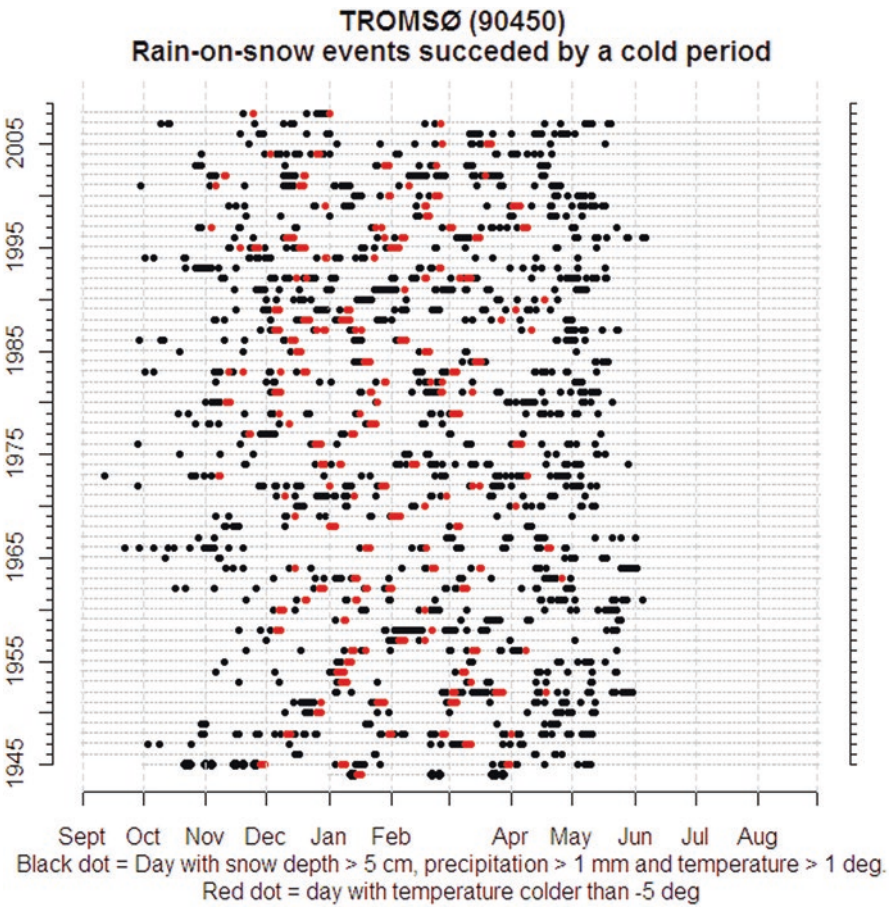

Fig. 2.9a Rain-on-snow events throughout the year in Tromsø from 1945 to 2009. (Report from the Norwegian Meteorological Institute no. 6/2010; Vikhamar-Schuler, 2010)

temperature fluctuates a lot from year to year. The increasing trend for Mievki/Mauken is closer to the freezing point compared to Guovdageainnu/Kautokeino (Figs. 2.10a and 2.10b).

> Even though we have had mild winters over the last 30 years, some periods in spring have been cold and with a great amount of snow. That is a change. Before when the spring came, it stayed with rain and thawing (reindeer herder A).

Difficult spring conditions can be particularly problematic for reindeer because their fat deposits are at their lowest at that time of the year (Larsen et al., 1985). At this time of year, their pregnancy is at its highest. Studies have shown that the highest reindeer losses occur with the three following scenarios: (1) early winter locked pastures, harsh late winter, and late spring; (2) early winter locked pastures, large areas of

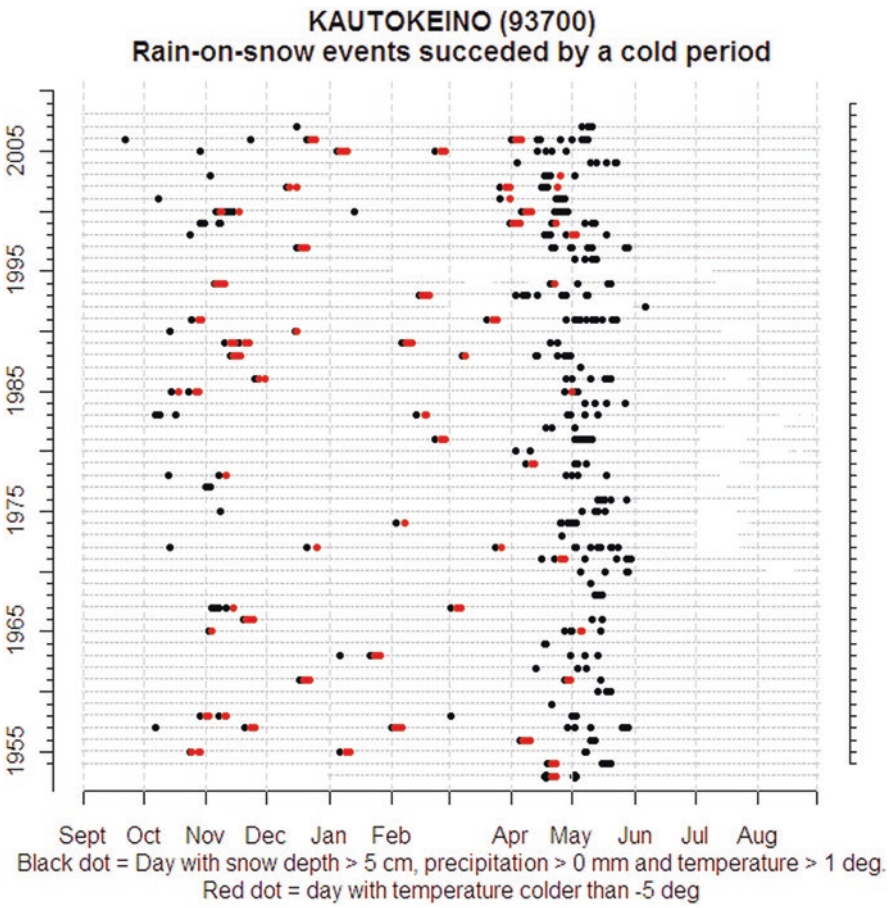

Fig. 2.9b Rain-on-snow events throughout the year in Kautokeino from 1945 to 2009. (Report from the Norwegian Meteorological Institute no. 6/2010; Vikhamar-Schuler, 2010)

locked pastures, and late spring; and (3) heavy snowfall followed by mild weather and frost (Lie et al., 2008).

2.4 Climate Change Projections: What Is to Expect?

Precipitation and temperature are critical factors for accessing pasture plants in winter (Benjaminsen & Svarstad, 2010). Projecting climate could help outline the future prospects of reindeer husbandry in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. However, as noted by Førland et al. (2009), it is essential to be aware that local and regional climate projections are affected by multiple factors, such as unpredictable internal natural variabilities that might weaken downscaling techniques. Thus,

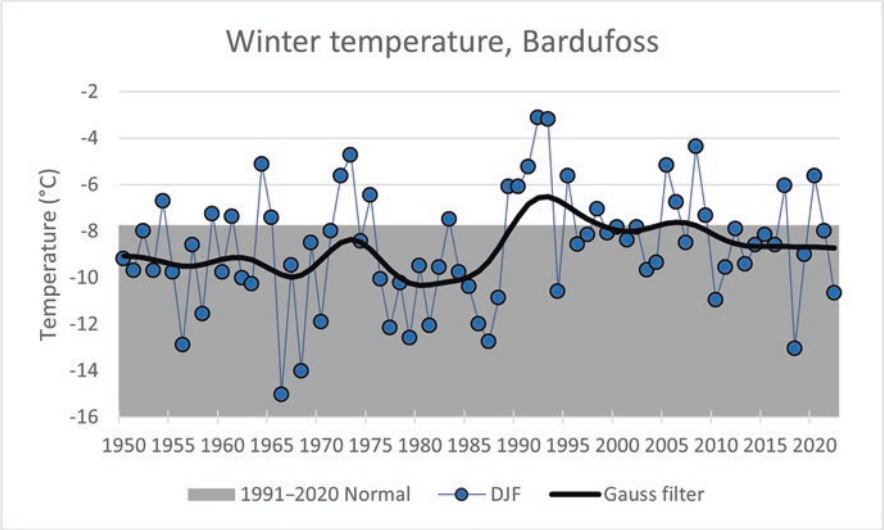

Fig. 2.10a Historical fluctuation in mean midwinter temperature (DJF; December, January, and February) from 1950 to 2020 in Mievki/Mauken (Bardufoss), Troms. Norwegian Meteorological Institute

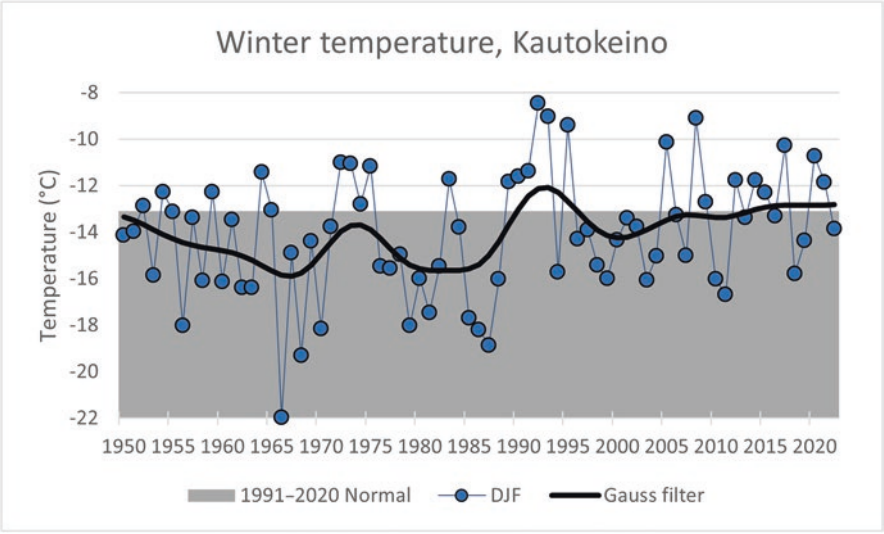

Fig. 2.10b Historical fluctuation in mean midwinter temperature (DJF; December, January, and February) from 1950 to 2020 in Guovdageainnu/Kautokeino, Finnmark. Norwegian Meteorological Institute

the significant climate and topography variations in Mievki/Mauken could affect the future climate remarkably.

Nevertheless, overall scenarios projected for the winter in Northern Norway are the following:

Highest temperature increases in the interior parts of Finnmark.
Lowest temperature increases in coastal areas such as Troms (Hanssen-Bauer et al., 2009).
Thus, the consequences of future climate change will differ for Mievki/Mauken in Troms compared to Guovdageainnu/Kautokeino in inner Finnmark.
In Tromsø, near Stuoranjárga/Tromsdalen, the mean winter temperature is expected to rise from −5 °C to +2 °C (Benestad, 2008).

In Mievki/Mauken (Bardufoss weather station), the mean midwinter temperature (December–February) could rise to −1 °C by 2100 (Fig. 2.11a, Benestad, 2008). A mean midwinter temperature near the freezing point could boost the number of rain-on-snow events and lead to more extended bare ground periods. Both will affect the pastureland usage practices and reindeer survival. Conditions might be similar to winter conditions in Tromsø (Stuoranjárga/Tromsdalen) today.

In Guovdageainnu/Kautokeino, the mean winter temperature could rise to −10 °C by 2050 (Fig. 2.11b; Benestad, 2008). This is the average winter temperature in Mievki/Mauken today. Thereby, 30 years from now, the districts in Finnmark could face similar climate hardships as the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD.

Increased spring temperatures could reduce the snow season, particularly in coastal areas, by as much as 2 months. In Mievki/Mauken (Bardufoss weather

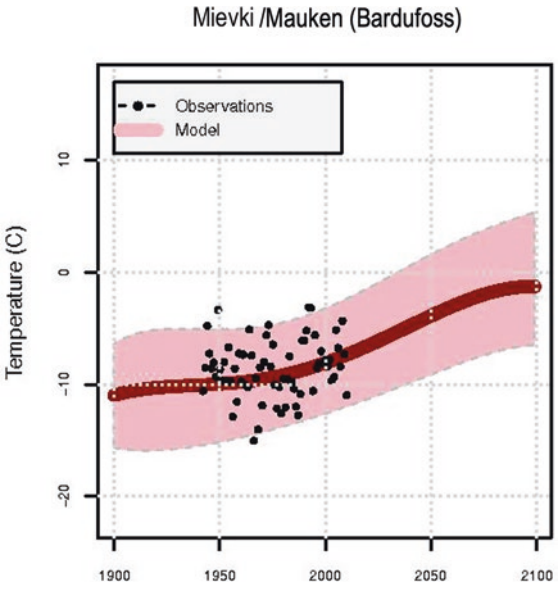

Fig. 2.11a Midwinter (December–February) temperature observations and projections from 1900 to 2100 for Mievki/Mauken (Bardufoss) in Troms. Downscaled IPCC models SRES A1b, estimated on the inclusion of reduced emissions by Benestad (2008)

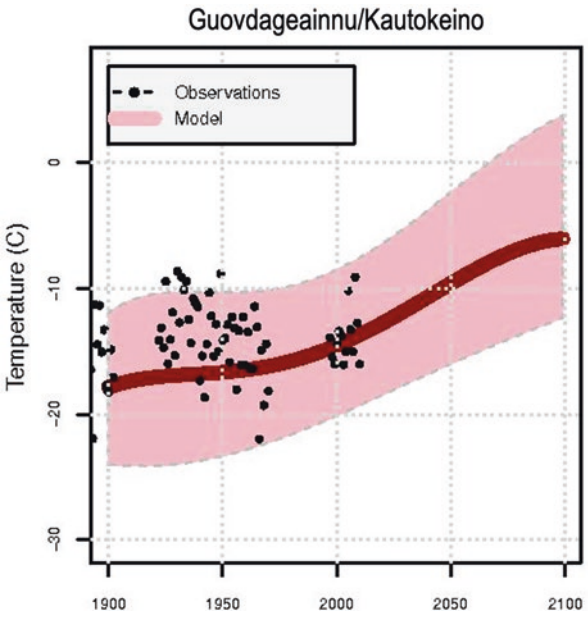

Fig. 2.11b Midwinter (December–February) temperature observations and projections from 1900 to 2100 for Mievki/Mauken (Bardufoss) in Guovdageainnu/Kautokeino. Downscaled IPCC models SRES A1b, estimated on the inclusion of reduced emissions by Benestad (2008)

station), mean spring (March–May) temperatures are projected to increase by +6 °C by the year 2100 (Benestad, 2008). In Guovdageainnu/Kautokeino, spring temperature is projected to increase, shortening the snow season by 1 month (Førland et al., 2009). An early spring or a late winter could be advantageous for the reindeer as pastures would be more accessible. However, for the herders, milder and more unpredictable weather during the spring and autumn migration is challenging: snowmobiles cannot drive across unfrozen lakes, streams, and lots of bare ground (reindeer herder A).

The winter precipitation is projected to increase by 12.7% in Troms and 15.6% in Finnmark from 1961–1990 to 2071–2100 (Hanssen-Bauer et al., 2009). For the reindeer in general, dense snow cover is not an issue as long as they have free access to the ice-free ground (reindeer herder A). To some extent, grazing in deep snow cover is strenuous, affecting the animals' energy loss (Fancy & White, 1987).

2.5 Climate Change: Herders' Ways to Adapt

The central question is whether changes in herding practices can diminish the potential impacts of climate change. Adaptation strategies could help reindeer herders. Flexibility lies at the core of reindeer husbandry: when working with the herd, the herder seeks to increase benefits and avoid undesirable situations.

Increased rain-on-snow events could, perhaps, to some extent, be compensated by an earlier melting and a longer growing season. Reindeer can extend their

calving by some weeks if pasture conditions or access is scanty (reindeer herder A). However, the compensation depends on the reindeer's capacity to adapt to early spring regarding the correlation between calving, pasture quantity, and quality. An elderly herder in Mievki-Stuoranjárga/Mauken-Tromsdalen RPD notices that today's estrus begins several days earlier than 40 years ago. That could signal a reindeer adaptation strategy to early spring.

What are the options for the herders in the face of current changes? Let's have a look at the alternative herding systems. Today's climate in Nordland and Northern Trøndelag is similar to the projected climate for Mievki-Stuoranjárga/Mauken-Tromsdalen approximately 100 years from now. Herders from the coastal Northern Trøndelag winter pasture area do not recall rain-on-snow issues (Lie et al., 2008). Trøndelag's seasonal migration is the opposite of Troms and Finnmark's. In summer, the reindeer pasture at the far coast; they pasture further inland, higher up the mountains in winter. Replicating the herding practices of Northern Trøndelag might also act as an adaptation strategy for the studied area in the future.

Once, the Oskal herders let the herd overwinter in Stuoranjárga/Tromsdalen because pastures in Mievki/Mauken were locked. Herders mentioned that it was a positive experience. In contrast, "*the winter of 2011 was probably the worst because the winter pastures* [in Mievki/Mauken] *were locked for a long time, with many rain-on-snow events starting already in November*" (reindeer herder A). The number of calves born the following summer was insignificantly low. During winter 2012, herders reported that the reindeer stayed in Malangen long, and the pasture conditions were favorable. Herders suggest that the best practice for a similar winter would be to let the herd scatter from Malangen. Malangen is the coastal area of their winter pasture grounds (Fig. 2.2b). Having several optional pastures is crucial during challenging winter conditions when pastures are locked.

Another adaptation option is supplementary feeding. Reindeer husbandry value depends on the ratio between the pasture and animal population. Supplementary feeding can maintain this relationship between those two so that more reindeer survive even though the pasturelands are or have been reduced due to losses or ice-locking. Over the last decades, the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD has supplied the herd with an increasing amount of supplementary feed during the winter. However, supplementary feeding is costly. It might become a sustainable adaptation strategy for the district's herders if (1) the feed is improved, (2) the taxes on feed are reduced, or (3) the government subsidizes supplementary feeding.

We have described several adaptation strategies for the herding district investigated. The expected increase in rain-on-snow events and its consequences could perhaps compensate for a longer growing season, but the critical factor is the flexible pastureland use.

2.6 Coping with Non-climate Drivers of Change

Coping success depends to a large degree on their freedom of action. Most non-climate influences, which affect the district's vulnerability, lie within spheres under the regulation of the Norwegian government: predation, encroachments, meat, feed, and other prices, subsidies, and production limits. All these constraints reduce the herders' ability to respond creatively and productively to a changing climate.

Until 1974, there were few lynx and wolverines in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD; while the state allocates compensations for reindeer lost to predation, the onerous documentation required to demonstrate loss seems capricious to herders, and as a result, only a minority of lost reindeer are compensated.

The traditional diversity of herd composition has been a long-term coping strategy to reduce its vulnerability. In the 1950s and 1960s, the composition of the herd was different than it is today (reindeer herder A). Since 1976, the Ministry of Agriculture has governed reindeer husbandry similarly to the industrial, agricultural production systems. This has been done, for example, through subsidies for calf slaughtering with a desire to achieve the most outstanding possible production (Reinert, 2006; Reinert & Oskal, 2024). As a result, today's herd primarily consists of productive female reindeer, whereas in the past, a much more significant proportion of the herd was male (Degteva et al., 2024). Male reindeer play an essential role in keeping the herd together, protecting against predators, and accessing ice-locked pastures. Subsidies might have had the opposite effect of what they had initially aimed at. An unbalanced herd structure also led to the disproportional distribution of the reindeer (reindeer herder A). This illustrates the consequences of the government's management that fail to listen to the reindeer herders and utilize their traditional knowledge.

However, the loss of pastureland is one of the most significant threats to reindeer husbandry in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. On the coast, 35% of the land is influenced by human activity; see Fig. 2.12 (UNEP, 2001).

If the expansion continues at this rate, this will increase to 80% by 2050 (Lie et al., 2006). Due to their proximity to Tromsø, continuing expansions might significantly constrain the adaptive capacity of the herders in the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD. The district has experienced increased encroachment in both summer and winter grazing areas. Challenging weather conditions demand maintaining the size of the Mievki/Mauken winter pastures. Pasture loss intensely increases the district's vulnerability. In addition to the ski and cabin resort development (Målselv Fjellandsby), military firing ranges cause the most significant encroachment and disturbances of the winter pastures, accounting for approximately 30% of the central part of the winter pasture area (Andersen et al., 2007; Reindeer at War, 2006; Danielsen & Tømmervik, 2006).

These military and tourist encroachments will significantly negatively affect reindeer husbandry in the area: the number of reindeer would have to be reduced by 233–433 animals (Danielsen & Tømmervik, 2006; Andersen et al., 2007). While the compensation may seem high, the loss of pastureland would increase the amount of supplementary feeding (Fig. 2.13a and 2.13b). Expenditures for feeding are

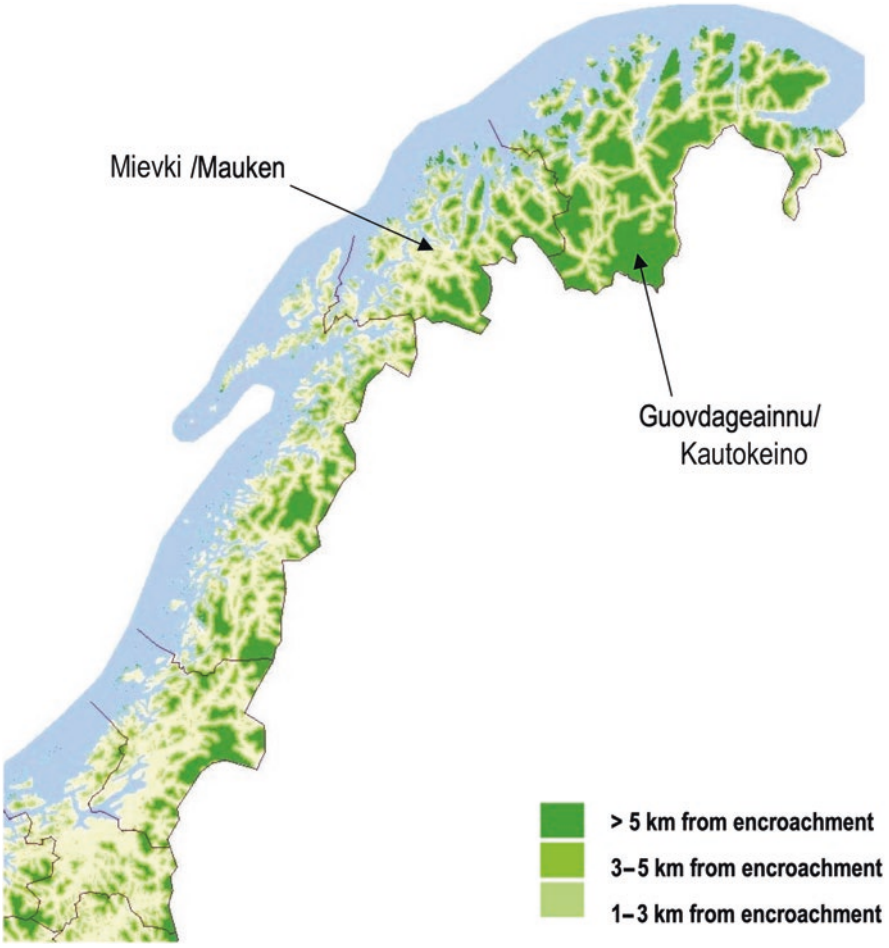

Fig. 2.12 Encroachment-free areas (green) of Northern Norway. (Norwegian Environment Agency, 2013)

currently 500 000–600 000 NOK annually and would likely expand over time as these developments progress (Reindeer at War, 2006). The herding district might face challenging years ahead if rain-on-snow events also increase.

> When we have no money left, we would have to decrease the feeding, and then we will feel the consequences of these encroachments. Then some of us would be forced to stop herding (reindeer herder A).

Bit-by-bit encroachment may have a limited individual effect but, taken together, lead to significant cumulative effects reaching the tipping point of sustainable reindeer husbandry (Landauer et al., 2021; Nelleman et al., 2003). For example, developments along the migration route used before 1967 (see green line in Fig. 2.4) changed their migration route (Fig. 2.14) and limited the herders' coping and

Fig. 2.13a Supplementary feeding of the reindeer in Mievki/Mauken RPD. (Photo: Kia Krarup-Hansen)

adaptive capacity. In the future, the cumulative effect might be increased loss of reindeer, increased mixing with neighboring districts' herds, increased need for feeding, and increased need for herding (reindeer herder A). Thus, one cannot simply consider each encroachment individually.

Several pasture alternatives available in Mievki-Stuoranjárga/Mauken-Tromsdalen RPD make the district less vulnerable, but should the encroachment continue, the situation might change dramatically.

2.7 Conclusion

Reindeer husbandry is paramount for Sámi culture and communities whose livelihoods depend on the Arctic (Brännlund & Axelsson, 2011). In the last decades, reindeer husbandry has experienced rapid change in every facet of the herding system regarding technology, economy, and organization. Yet the landscape management, including the migration system, has changed very little. Considering the predicaments Mievki-Stuoranjárga/Mauken-Tromsdalen RPD is facing today and the projected future warm climate, it is high time to evaluate the internal organization for herders to be able to migrate with their herd in the future. It is a unique case study since it investigates the reindeer herding district close to Tromsø with its urban

Fig. 2.13b Supplementary feeding of the reindeer in Mievki/Mauken RPD. (Photo: Kia Krarup-Hansen)

activities. Climate projections show that even within 50 years, reindeer herding districts in Finnmark will face the climate challenges currently experienced in Troms today.

It is difficult to predict how all the impacts on reindeer husbandry in the district affect each other. We suggest that a more thorough and detailed investigation of the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD's vulnerabilities and bottlenecks to change is needed. Such studies are also crucial for the herders in Finnmark, considering the projections that indicate similar challenges there as in Troms today.

The vulnerability of the Mievki-Stuoranjárga/Mauken-Tromsdalen RPD might be mitigated if the herders' operational flexibility is increased. Freedom of action will enable herders to work aligned with nature as it has been in traditional reindeer husbandry for millennia. Embracing the benefits of the day and age, such as transportation or supplementary feed, is also reported helpful. The local consequences of future climate changes in this reindeer herding district are still heavily dependent on decisions yet to be taken at different authority levels. It remains to be seen if these include the voices of reindeer herders, as reported in the present case study.

Fig. 2.14 Herders and reindeer on their annual migration in Malangen, Troms. (Photo: Kia Krarup-Hansen)

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