Regional Environmental Change (2025) 25:53
https://doi.org/10.1007/s10113-025-02380-2

ORIGINAL ARTICLE

Cumulative worries in Sápmi—the interplay between climate change and other threats to reindeer herding in Sweden and Norway

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Received: 27 February 2024 / Accepted: 26 February 2025

Abstract

Competing land uses, climate change, and state regulations pose stress to Saami reindeer herders in Norway and Sweden. Saami reindeer herding is a nomadic tradition relying on huge natural pastures, often with long distance migration between seasonal pastures, and the foremost strategy to cope with changing environments has been flexible use of pastures. However, the adaptive space of reindeer herding is under pressure, which may threaten the sustainability of Saami reindeer herding both economically and culturally. The ability to adapt to external pressures has been of focus in several studies on reindeer herding, but few have analysed cumulative sources of worry as perceived by herders. Using data from a survey among reindeer herders in Norway and Sweden, we describe and analyse factors causing worry and cumulative concern. Overall, results show that differences in worry depend largely on country- and region-specific challenges, while other characteristics of the respondents, with some exceptions, do not significantly explain the degree of worry. A principal component analysis shows that underlying traits that could be interpreted as land use change have the highest factor loadings. Another principal component analysis of questions on the effects of climate change suggests that there are two groups of reactions among reindeer herders. One group of traits points to a general worry and insight that some undefined changes in management need to be done, while another set points to an insight that current reindeer husbandry is unsustainable, given the effects of climate change, and consequently a willingness to take concrete action.

Keywords Reindeer husbandry · Saami · Climate change · Worry

Introduction

Land conversion and climate change are of great concern for indigenous communities all over the world that depend on natural resources for their livelihood (Dong et al. 2011). Pastoral societies that rely on large areas are particularly vulnerable to changes in the natural environment and competing land uses (Dong et al. 2011; Vors and Boyce 2009). Reindeer pastoralism in Scandinavia is mainly practised by Saami people and is based on extensive land use and herd mobility (Johannesen and Skonhoft 2009; Bostedt 2001). It has existed for centuries and is still an important source of livelihood for many Saami communities and a basis for sustaining Saami culture (Fohringer et al. 2021; Jaakkola et al. 2018; Johannesen and Skonhoft 2011). However, decades of state regulations, changes in land use rights, conversion of land for competing uses, and increased disturbances in grazing areas have resulted in challenges for reindeer pastoralism and its ability to sustain and protect Saami cultural

Communicated by Feisal Rahman

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Published online: 04 April 2025

and economic values (Müller-Wille et al. 2006; Riseth and Vatn 2009).

Reindeer herding in Sápmi, the cultural region traditionally inhabited by the Saami people, relies on huge areas for access to natural pastures. Sápmi, where reindeer herding is practised, includes the sparsely populated northern parts of Fennoscandia, a region which stretches over four countries: Norway, Sweden, Finland, and Russia. The herds follow their yearly seasonal migration pattern, sometimes over large distances, between summer and winter pastures to cope with seasonal scarcity and shifting vegetation conditions (Johannesen and Skonhoft 2011; Pape and Löffler 2012; Tyler et al. 2021). This practice is also closely related to Saami cultural values, knowledge about reindeer behaviour, and adaption to natural environments.

However, Saami interests are often overruled by states and local governments, allowing conflicting land uses such as resource extraction, renewable energy development, recreational hunting and fishing, hiking, carnivore conservation, military activity, infrastructure, and expanding areas of second homes (Fohringer et al. 2021; Gallardo et al. 2017; Johannesen et al. 2019; Tyler et al. 2021). Such interventions create smaller and more fragmented pastures for reindeer and reduce herd mobility (Bostedt et al. 2003; Colman et al. 2013; Eftestøl et al. 2019; Johnsen 2016; Kivinen et al. 2012; Larsen et al. 2022; Panzacchi et al. 2013; Skarin et al. 2018, and 2015). Effects on reindeer herding vary across areas, seasons, and types of disturbance. Existing research has demonstrated a loss of ground and arboreal lichen, the fragmentation of pastures, stress, and reindeer avoidance of otherwise valuable pastures due to disturbance caused by competing land uses. Thus, the grazing land is disturbed by cumulative land-use pressures, which is well described in the grid-based mapping provided by Stoessel et al. (2022). Henceforth, we will use the term 'cumulative' to describe effects that might not merely be additive, but rather exceed the sum of the total effects through their interaction with one another. Despite these cumulative effects becoming increasingly problematic over time (Österlin and Raitio 2020), several examples demonstrate that permits for land conversion in reindeer herding areas are granted based on fragmented processes that fail to take these cumulative effects into account (Hausner et al. 2020; Larsen et al. 2016 and 2022). This pattern is also observed for other indigenous people and is often seen as caused by majority societies crowding out the extensive traditional land uses of certain minority groups (Ford et al. 2016; Valeggia and Snodgrass 2015; Acuña 2015; Lertzman and Vredenburg 2005; Booth and Skelton 2011).

Changing climate conditions exacerbate effects of conflicting land use changes by reducing the adaptive space of reindeer herding further. Rapidly shifting warm and cold periods during winter, coupled with a year-round increase in precipitation intensity, affect season lengths and foraging conditions for reindeer, causing disruptions to yearly migration cycles (Kelman and Næss 2019). Difficult winter conditions with ice-locked pastures decrease the accessibility of grazing and negatively affect the weight and survival of animals, although the earlier onset of spring can have a positive effect on reindeer productivity (Helgesen et al. 2024; Helle and Kojola 2008; Kitti et al. 2006; Kumpula and Colpaert 2003; Turunen et al. 2009; Tveraa et al. 2003). Although extent and strength in future projections of climate change vary across geographical areas, weather conditions are expected to change rapidly and frequently, implying more unpredictable and unstable herding conditions (Helgesen et al. 2024).

The purpose of this paper is to analyse and compare factors that cause worry or distress among reindeer herders with a special focus on comparing climate change with other factors. The paper uses data from a unique survey of reindeer herders in two countries included in Sápmi—Norway and Sweden—in 2022, focusing on differences in worry between the two countries. Although several investigated factors are specific to reindeer herding in Norway and Sweden, we see our contribution as relevant to the rest of Sápmi, as well as other extensive pastoral grazing systems practised by social minorities around the world. Recognising the impact of climate change on the worry and distress experienced by vulnerable indigenous populations is crucial, not only from a wellbeing and equity standpoint, but also in terms of how it affects their capacity to cope with and adapt to environmental changes. There is a limited understanding of how pastoralists perceive climate change and its effects on livestock production within their communities. In this paper, reindeer herders report on a large number of factors that may cause worry, including climate change, external pressure on land use, governmental regulations, and majority society attitudes towards reindeer herding communities. The paper aims to identify the main risks and compare the significance of climate change with other factors that cause worry or distress. Understanding the perspectives of reindeer herders on the future of reindeer herding and their expected coping strategies is essential, especially considering the extensive research on suicidal expressions among young Saami, as well as issues with discrimination and ethnic-related mistreatment (cf. Stoor et al. 2015; Stoor 2020; Jacobsson et al. 2020).

The rest of the paper is organised as follows. The 'Saami reindeer herding in Norway and Sweden' section gives a brief background on Saami reindeer husbandry in Norway and Sweden. The 'An overview of land use conflicts and climate change effects' section provides a literature review on the impacts of previous land use changes and historical and possible future effects of climate change. This section also reports on existing research concerning well-being among reindeer herders in Norway and Sweden. Next, the 'Data and methods' section explains the survey conducted among

reindeer herders in Norway and Sweden, while the 'Results' section presents the results. The final section gives concluding remarks.

Saami reindeer herding in Norway and Sweden

Reindeer herding can be traced back to the fifteenth century when wild reindeer were domesticated, and parts of the Saami people became herding nomads (Bostedt 2005; Johansen and Karlsen 2005; Riseth 2006). Pastures require extensive access to land to allow herders to follow the seasonal migration of their herds over huge areas to secure an appropriate balance of pastures (Johansen and Karlsen 2005; Bostedt 2001; Turunen et al. 2009; Pape and Löffler 2012). Historically, reindeer were an important source of milk and meat, and a main means of transport (Riseth and Vatn 2009). Over time there has been a considerable change in the Saami way of life and reindeer herding practice. From the mid-1960s, motorised vehicles were introduced, and reindeer herding gradually became more market oriented (Riseth and Vatn 2009; Bostedt 2001). State reform, subsidies, and quotas were implemented to optimise meat production and income (Riseth and Vatn 2009; Pape and Löffler 2012; Tyler et al. 2021). Gradually, the value of reindeer herding as a lifestyle and its importance to Saami culture were put at risk (Tyler et al. 2021).

Reindeer herding is an exclusive right for the Saami people in both Norway and Sweden (Johannesen and Skonhoft 2009; Bostedt 2001). Roughly 40% of Norway and Sweden is designated reindeer pasture, and Reindeer Husbandry Acts in both countries provide reindeer herders user rights to grazing land (Bostedt 2001; Moen 2008; Tyler et al. 2007).

Saami reindeer herding in Norway

In Norway, 3300 people are involved in reindeer herding, which takes place in four counties, from Trøndelag in mid Norway to Finnmark in the north (see Fig. 1) (NRHA 2022). Reindeer herding is divided into 70 reindeer herding districts, the formal management level responsible for ensuring that reindeer herding is managed according to government regulations (Helgesen et al. 2024; Næss et al. 2012). The Norwegian Reindeer Husbandry Act (15 June 2007 nr. 40) is the main legislation governing reindeer herding in Norway. It mandates that the state ensures reindeer husbandry is ecologically, economically, and culturally sustainable. This is understood as practices that are profitable, sustain the quality of grazing areas, and hence provide a sufficient livelihood for herders to maintain Saami reindeer herding and its cultural values for the future. The Ministry of Agriculture and Food (Landbruks- og Matdepartmentet) is responsible for overseeing reindeer herding.

A reindeer herding district consists of one or several reindeer herding units, which is the basic organisational unit in reindeer herding (Ulvevadet and Klokov 2004). There are 540 reindeer herding units (NRHA 2022). The Finnmark region is the main reindeer herding region, covering some 70% of herding units and reindeer population (NRHA 2022).

The reindeer population in Norway comprises some 220,000 animals (NRHA, 2022). Migration patterns vary across regions according to differences in climate, landscape, and vegetation. In Finnmark, reindeer migrate across huge areas between summer pastures close to the sea with mild climate and high precipitation and winter pastures in open mountainous areas with a drier and stable climate (Fig. 1) (Tveraa et al. 2007; Weladji and Holand 2006). Grazing patterns are more multifaceted in Troms, Nordland, and northern parts of Trøndelag. In Troms, some populations graze year-round on the islands, while others are moved inland for winter grazing (www.reinbase.no 2025). In Nordland and northern parts of Trøndelag, reindeer usually gaze in coastal areas during winter (www.reinbase.no 2025; Weladji and Holand 2006). Reindeer herding in Trøndelag is relatively stationary, with some populations having winter and summer pasture within the same geographical area, and some populations with shorter migration between inland winter and coastal summer pastures (Weladji and Holand 2003).

Saami reindeer herding in Sweden

In Sweden, around 4600 people are involved in reindeer herding (Sametinget 2023), which takes place in four counties, from Dalarna in mid Sweden to Norrbotten in the north. Reindeer herding is divided into 51 reindeer herding communities (samebyar), a management unit level approximately corresponding to a reindeer herding district in Norway. Each reindeer herding community, or RHC, has grazing rights in a specific area and includes several reindeer herding firms, similar to a reindeer herding unit in Norway. The reindeer population comprises about 250,000 to 300,000 animals (Sametinget 2023). Reindeer herding can be conducted all year round in mountainous parts of the counties of Norrbotten, Västerbotten, Jämtland, and Dalarna. In winter, reindeer herding can also be conducted in coastal areas of Norrbotten and Västerbotten.

Of the reindeer herding communities, 33 are classified as mountain Saami communities (Sametinget 2023). In this type of Saami community, reindeer herds are migratory and typically graze on pastures close to or in the mountain region during summer, moving to forests closer to the coast during winter where they mainly graze on lichens. In contrast, 10 reindeer herding communities are classified as forest Saami communities where grazing areas do not include bare mountain areas (Sametinget 2023). Like Trøndelag in Norway, reindeer herds are more stationary in these communities

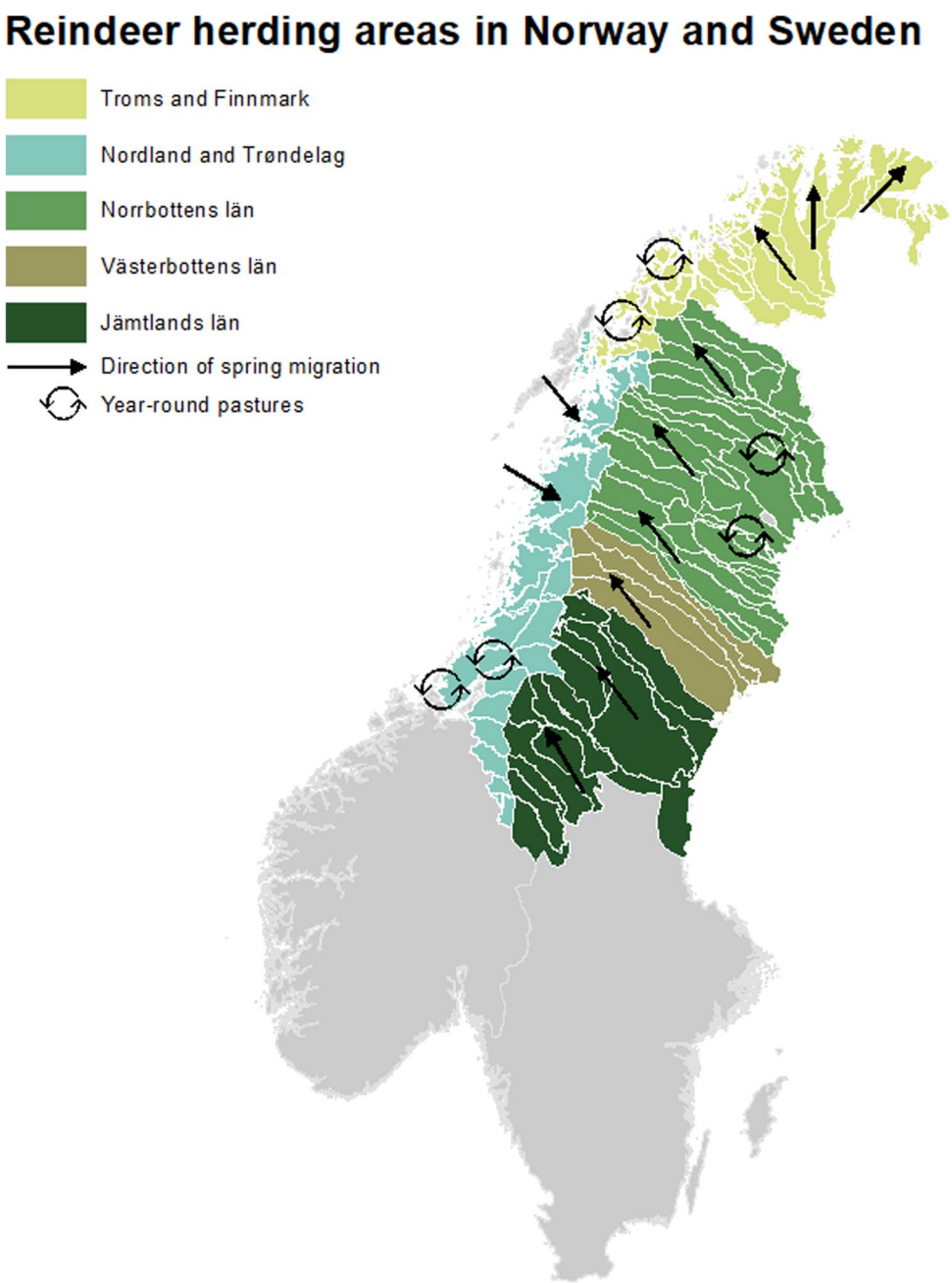

Fig. 1 Reindeer herding areas in Norway and Sweden, which correspond to geographical subsamples of the survey respondents. Within area subdivisions illustrate reindeer herding districts and reindeer herding communities in Norway and Sweden, respectively. Arrows indicate spring migration and year-round pastures (Source: Pape and Löffler 2012)

and graze in forestland all year round. Finally, in the eight concession reindeer herding communities in the easternmost part of Norrbotten, reindeer can be owned, not only by Saami, but also by other locals.

The Ministry of Enterprise and Innovation (Näringsdepartementet) oversees reindeer husbandry. However, since 2014, Saami matters in Sweden, excluding reindeer herding, have been handled by the Ministry of Democracy and Culture. The Swedish Reindeer Husbandry Act (1971:437) focuses on ecological aspects, requiring reindeer husbandry to maintain biodiversity and the long-term productivity of natural pasturelands (65a §). This Act also defines Saami rights to land, the organisation of herding, the activities of reindeer herding communities, the areas where herding can occur, and decision-making processes for internal and external matters (Löf et al. 2022).

An overview of land use conflicts and climate change effects

The Saami have been exposed to rapid technological change, pressure towards market orientation, and growing governmental regulations. This has disrupted reindeer herding and

negatively affected Saami communities through social exclusion, discrimination, and loss of traditional language (Eliassen et al. 2013). Previous studies have argued that such marginalisation causes stress and reduced health in indigenous communities (Eliassen et al. 2013; Curtis et al. 2005). For pastoral societies in general, it is argued that marginalisation often challenges their ability to adapt to external pressures from majority society, such as conflicting land uses and climate change (Reid et al. 2014; Manzano et al. 2021). This section gives an overview of consequences of land use conflicts ('Land use conflicts' section) and climate change ('Climate change effects' section) for reindeer herding and well-being of herders ('Effects on emotional well-being' section).

Land use conflicts

Major examples of land use conflicts affecting reindeer herding in Norway and Sweden include forestry, mining, conservation of large carnivores, renewable energy production, and climate change. Cumulative impacts from competing land uses pose challenges to reindeer herding (Rosqvist et al. 2022). Many conflicts are comparable between Norway and Sweden, as they usually represent a loss of access to pastures. In Sweden, reindeer graze in forest landscapes—mainly in wintertime—making forestry the land intensive industry with the largest overlap with reindeer pastures (Sandström et al. 2016; Österlin and Raitio 2020). The primary food source for reindeer during winter is lichen, on the ground and in trees (Bostedt 2005). Because other food sources are scarce in winter, lichen availability, especially in trees, is a critical factor for reindeer survival (Bostedt 2005). However, it is documented that the proportion of land classified as lichen-abundant in northern Sweden has declined by 71% over the 60 years preceding 2016 (Sandström et al. 2016). In Norway, winter pastures in major reindeer herding areas (the counties of Finnmark, Troms, Nordland, and Trøndelag) are usually in open mountainous areas where reindeer graze on ground lichen (Pekkarinen et al. 2022). Thus, the forestry-reindeer herding conflict is largely absent.

Mining is another of reindeer herding's key competing land uses in both Norway and Sweden (Larsen et al. 2016). Mining causes more extensive encroachment and disturbances to reindeer than the actual mine itself, as it requires road infrastructure and human activity to run extraction activities, and the degree of avoidance by reindeer increases by the level of human activity related to the mine (Eftestøl et al. 2019). Österlin and Raitio (2020) report that 80% of active metal mines in Sweden are located within traditional reindeer herding areas, and the accumulated area to mining has increased dramatically since the 1970s.

Wind power development is an ongoing conflict in both Norway and Sweden, and is likely to increase in the future as rural areas advantageous for future wind power development, in terms of wind conditions, overlap with reindeer herding areas (Knezevic et al. 2023; Szpak 2019; Wretling et al. 2022). Österlin and Raitio (2020) demonstrate a 20-fold increase in wind turbines in reindeer herding areas in Sweden between 2003 and 2017, and development of wind power plants is also increasing in Norway (Tømmervik et al. 2022). Stoessel et al. (2022) found that 3% of pastures in Fennoscandia is covered by wind turbines, but this estimate excludes potential zones of avoidance due to disturbances and pasture fragmentation caused by noise, roads, and disturbing human activity (Vistnes and Nellemann 2008; Skarin et al. 2018; Österlin and Raitio 2020). Studies show limited to strong negative effects on reindeer behaviour and pasture selection depending on geographical and seasonal differences (Skarin et al. 2018). Lundmark (2022) found that up to 12% of high-quality reindeer pastures are within wind turbine areas in Sweden, whereas Tømmervik et al. (2022) found that wind turbines covered about 5% of pastures in mid Norway (Trøndelag), while total loss including avoidance zones can be up to 25%.

Conservation of large carnivores in reindeer herding areas is another type of land use causing major conflicts in both Norway and Sweden (Risvoll and Hovelsrud 2016; Tveraa et al. 2014; Zabel et al. 2014). Lynx, wolverine, and golden eagle are the major carnivores causing loss of reindeer, and a positive relationship between claimed loss and predator densities has been found (Hobbs et al. 2012; Tveraa et al. 2014; www.rovbase.no). In Norway, just above 18,500 reindeer were verified lost to carnivores in 2022/23, corresponding to 8.5% of the total reindeer population prior to calving in 2023 (NRHA 2023; www.rovbase.no). Compensation payments in Norway are directly connected to the number of verified losses to carnivores, and a lack of proper estimates of losses has led to disagreement over compensation payments (Tveraa et al. 2014), whereas in Sweden, compensation payments are based on predator density, avoiding this problem (Zabel et al. 2014).

Climate change effects

More rapid and extreme variation in weather and shifting snow and ice conditions due to climate change exacerbate the negative effects of competing land uses on reindeer herding, reducing the adaptive space further. Climate change affects reindeer herding conditions both in summer and winter grazing seasons (Helgesen et al. 2024), but winter grazing conditions are critical for survival and productivity (Tveraa et al. 2003). Snow depth, snow crusts, and ice layers affect access to vegetation below and consequently the energy intake of the reindeer (Kitti et al. 2006).

Rosqvist et al. (2022), combining historical weather data from northern Sweden between 2013 and 2018 with herders' detailed observations of reindeer behaviour and migration, found that warmer winters resulted in more frequent icing, causing reindeer to seek alternative migration routes, including dangerous ones close to roads and railroad tracks, and areas that should be avoided in winter, to secure pastures for spring and autumn grazing. Furthermore, difficult winters caused stress in reindeer and dispersed herds, making it more demanding to locate and keep animals together. Difficult winter conditions are found to lower animal weights, the number of calves born and surviving, and adult survival (Tveraa et al. 2003; Kumpula and Colpaert 2003; Kitti et al. 2006; Helle and Kojola 2008; Turunen et al. 2009).

Spring, summer, and autumn grazing seasons are when reindeer gain weight. It is expected that climate change will cause snow to melt earlier in spring, prolonging vegetation-growing seasons (Markkula et al. 2019), while in autumn, frost will be delayed, and soil frost and snow cover will appear later than before (Loe et al. 2021). Such changes have also been reported by reindeer herders themselves (Furberg et al. 2011). Earlier onset of spring is expected to provide additional forage and increase reindeer weights (Aikio and Kojola 2003; Pettorelli et al. 2005; Bårdsen and Tveraa 2012; Tveraa et al. 2013; Albon et al. 2017) and reproductive success (Aikio and Kojola 2003). However, delayed autumnal frost may cause waters to freeze later making migration to winter grazing areas more difficult (Furberg et al. 2011). Helgesen et al. (2024) found a negative net effect of past changing weather conditions on reindeer weights and suggested that future climate projections following global warming above the Paris agreement will reduce net income in reindeer herding in Norway and Sweden.

Effects on emotional well-being

The combined effects of land use conflicts and climate change also affect emotional well-being. For example, Furberg et al. (2011) conducted interviews with Swedish reindeer herders and established a sense of grief for the future. Interviewed herders emphasised cumulative effects. Climate change itself was not considered a major threat to reindeer herding but rather yet another stressor. While interviewees described a high quality of life, they also mentioned considerable worry and anguish. Interestingly, interviewees also saw opportunities in climate change, not just threats. If climate change could, for instance, lead to snow-free winters, or extended growing seasons, it could provide reindeer with better pasturage during summer to survive more serious, but shorter, winters. Another interview study by Blåhed and San Sebastian (2021), focusing on the effects of mine establishment in Norrbotten, found that herders were already experiencing several symptoms related to psychosocial distress (anxiety, stress, worry) linked to the direct impact of the mine on their traditional way of life, threatening for many of them the total disappearance of their traditional way of living, and thus, their own identity.

Similar effects of environmental and other stressors have been documented in other pastoralist communities around the world. Cooper et al. (2019) showed that Ethiopian pastoralists have a diverse lexicon of words used to describe emotions in connection to their water security situation and show extreme worry and fatigue during dry seasons. See also Valeggia and Snodgrass (2015) for an overview of health issues pertaining to indigenous peoples.

Data and methods

Data

The data come from two surveys among reindeer herders in Sweden and Norway that focused on experienced effects of climate change, climate change adaption, and causes of worry and distress. Data were collected at the reindeer herder household level. The questions were identical in both surveys and were available in the national languages, Norwegian in Norway and Swedish in Sweden, as well as the northern Saami language in both countries.

The survey underwent extensive testing in focus groups with reindeer herders from both countries in March 2022. The survey was revised based on the feedback and launched in Sweden in June and Norway in September of 2022. The Swedish survey was available through the platform Netigate and the Norwegian survey was available through Nettskjema. We tried to avoid sampling during migration to increase response rates.

In Sweden, the link to the survey was distributed through the Swedish Saami National Association (Svenska Samers Riksförbund, SSR) and adverts in the online version of the Samefolket magazine. To increase response rates, a research assistant called the chairperson of (almost) all 51 reindeer herding communities. Sampling ended in December 2022 with 103 observations.

In Norway, the link to the survey was distributed to all reindeer herding unit leaders in late September (Trøndelag and Nordland) and early October (Troms and Finnmark) 2022, and through adverts in the Ságat and Ávvir magazines. To increase response rates, a research assistant called all 481 unit leaders in October and sent out reminder letters in December. Sampling ended in December 2022 with 76 observations.

The questionnaire was divided into six parts. The first part contained questions focusing on factors that create worry for reindeer herders, the importance of reindeer husbandry, and

the impacts of climate change on reindeer husbandry, as perceived by the reindeer herders. The second part contained questions on the willingness to adapt to climate change and follow-up questions to better understand these choices. The third part contained socioeconomic questions, e.g. age and gender, which was followed by questions about subsistence hunting and fishing. The final question was an interval question on reindeer herd size. This question was put last in the questionnaire and formulated as an interval question since item non-response on income and wealth questions in a survey is a common phenomenon in general and for pastoralists in particular.

Table 1 shows sample characteristics for age, the share of male respondents, the average reindeer herd size, and the geographical distribution of the respondents—variables for which means can be compared to national averages. However, finding recent comparative averages for Sweden, to allow comparisons of the sample relative to the whole population of reindeer herders, was challenging, but a 2003 report by the Swedish Board of Agriculture on reindeer herders and reindeer herding companies in Sweden provides some insights (Jordbruksverket 2003). This report shows an average age of Swedish reindeer herders of 49.5 years, with 62% being male, and an average herd size of 206 reindeer. This suggests that the Swedish part of the sample is representative in terms of age and gender but underrepresents herders with small herds. About 68% of the Swedish respondents were from Norrbotten, which comprises 77.6% of the population of reindeer herders, according to Jordbruksverket (2003); an additional 14 and 18% of Swedish respondents came from Västerbotten and Jämtland, respectively, comprising about 11 and 11.4% of the population, respectively. However, these national averages should be viewed cautiously, given the age of the source.

In Norway, 80% of reindeer herding units' leaders are men (NRHA 2022), with the majority above 30 years and 36% above 50 years (NRHA 2022). Compared with Table 1, the Norwegian sample may differ, but not very much, from the population of unit leaders in case of gender and age. Average herd size in Norway is 400 animals (NRHA 2023), consistent with the sample. About 60% of Norwegian respondents are from Finnmark or Troms, and close to 30% are from Nordland or Trøndelag. Corresponding population shares are 80% and 22%, respectively (NRHA 2023). Hence, northernmost areas may be slightly underrepresented in the sample.

Statistical methods

To better understand what drives observed worry patterns, we use a set of ordered logit models where we control for individual characteristics commonly used in the literature of environmental concern as well as characteristics capturing commitment to reindeer herding (Fransson and Gärling 1999). The ordered logit model, introduced by McKelvey and Zavoina (1975), is a designed to handle ordinal dependent variables.

The ordered logit model can be derived from a latent-variable framework. Consider the underlying process:

$$y^* = x\beta + \varepsilon$$

where y^* is the dependent variable, x is the vector of independent variables, β is the vector of regression coefficients to be estimated, and ε is the error term assumed to follow a standard logistic distribution. However, we typically do not observe y^*. For example, if y^* represents the degree of worry, we as researchers cannot observe this, but we can instead treat it as latent. What we often do observe is a measure of worry, e.g. the responses to a Likert scale question with response categories ranging from 'Very concerned' to 'Unconcerned'. With N response categories, we would expect to observe the following response (degree of worried):

$$y = \begin{cases} 0 \;\; if \quad y^* \le \mu_1 \\ 1 \;\; if \;\; \mu_1 < y^* \le y_2 \\ \quad \vdots \\ N \;\; if \quad \mu_N < y^* \end{cases}$$

Table 1 Sample characteristics (standard deviations within parentheses)

	Total sample	Sweden	Norway
Average age (years)	49.2 (11.28)	47.5 (12.89)	50.9 (9.19)
Share male respondents (%)	72.7 (44.73)	74.3 (44.02)	71.0 (45.70)
Average reindeer herd size (number of reindeer)	364.9 (184.99)	325.0 (213.92)	402.1 (145.42)
Geographical distribution	Troms and Finnmark counties (Norway)	24.5%	
	Trøndelag and Nordland counties	13.9%	
	Norrbotten County (Sweden)	37.9%	
	Västerbotten County (Sweden)	7.8%	
	Jämtland and Dalarna counties (Sweden)	10.0%	
	No response	6.7%	

Table 2 Ordered logit estimates for the ten worry factors with highest mean, showing odds ratios for each independent variable. The covariance matrix is adjusted for unspecified latent heterogeneity. *T*-values within parentheses

Variable	Wild carnivores	Climate change	Wind power expansion	Mining	Lack of fertile grazing grounds	Majority society's view on Saami	Expansion of built up areas	Diseases and parasites among the reindeer	Forestry	Road/traffic
Sweden (dummy)	2.261 (1.505)	2.602 (2.057)*	.461 (−1.706)	1.438 (.977)	2.318 (2.131)*	2.184 (2.147)*	1.294 (.767)	2.377 (2.112)*	40.170 (5.824)***	1.119 (.317)
Age (years)	1.004 (.236)	.993 (−.380)	1.015 (.852)	1.035 (1.857)	1.006 (.387)	.998 (−.122)	1.024 (1.434)	0.987 (−.827)	1.000 (.030)	0.995 (−.365)
Gender (male = 1)	.602 (−.786)	.207 (−2.849)**	.268 (−1.750)	.184 (−2.319)*	.439 (−1.762)	.250 (−2.741)**	.567 (−1.300)	.428 (−1.898)	.751 (−.622)	.777 (−.484)
Education (categorical. six levels)	.914 (−.457)	.912 (−.660)	.902 (−.585)	.958 (−.254)	.746 (−1.837)	.810 (−1.761)	1.015 (−.113)	.988 (.089)	.901 (−.736)	1.036 (.240)
Share of working time in reindeer husbandry (%)	1.010 (1.321)	.999 (−.062)	1.013 (1.828)	1.002 (.386)	.990 (−1.551)	1.006 (1.096)	1.004 (−.786)	.999 (1.618)	1.006 (1.063)	.997 (−.608)
Commitment to reindeer husbandry (dummy)	2.588 (1.784)	1.475 (.794)	1.575 (.980)	2.589 (2.013)*	1.545 (1.064)	1.191 (.356)	3.895 (2.911)**	1.475 (.390)	1.662 (1.910)	1.769 (1.181)
McFadden pseudo *R*-squared	.052	.066	.060	.067	.051	.048	.050	.044	.240	.011
No. of obs	130	129	127	130	129	127	127	128	129	127

The parameters μ_i represent the thresholds defining the observable categories, and these are estimated. The ordered logit model uses the observed y values, which are censored data on y^*, to estimate the parameter vector β through maximum likelihood estimation. The estimated coefficients indicate the direction and magnitude of the effect of each independent variable on the probability of the dependent variable falling into a higher category.

To obtain a better understanding of how different worries might be related to the same underlying worry or concern, we also use principal component analysis. Principal component analysis (PCA), originally invented by Pearson (1901) and later independently developed and named by Hotelling (1933), is a non-parametric method for extracting meaningful information from complex data sets. PCA provides a systematic approach to reducing a complex data set to a lower dimension, revealing the often hidden, simplified structures underlying the data.

When performing PCA, the first principal component of a set of p variables is a derived variable formed as a linear combination of the original variables that explains the most variance. The second principal component accounts for the most variance in the remaining data after the effect of the first component is removed. This process continues through p iterations until all the variance is explained.

PCA is particularly useful when many variables are highly correlated, and there is a need to reduce their number to an independent set. The first principal component can also be defined as the direction that maximises the variance of the projected data. Each subsequent principal component is a direction orthogonal to the previous components that maximises the variance of the projected data. We used a Promax rotation to allow for possible correlation between latent factors (see Table 3). To make interpretation easier, we have suppressed all factor loadings below 0.5, that is, they are not reported in the table because their influence on the factor is small. We only include the four factors explaining most of the variance.

Results

Importance of being a reindeer herder

Figure 2 shows responses to the question concerning the importance of being an active reindeer herder. Since the same question was asked in Sweden in Bostedt (2005), and later in Norway, in Johannesen and Skonhoft (2011), an excellent opportunity to compare across decades is evident. The four alternatives in Fig. 2 can be seen as an intensity scale with the alternative 'I will quit as a reindeer

herder if I get an occupation that will provide the same income', verbalising the lowest connection to reindeer husbandry as a profession, while the alternative 'I will not quit as a reindeer herder and it is important to me that the next generation takes over' demonstrates the strongest commitment. For both countries and time periods, the highest commitment was the most frequent response, with a majority of the respondents stating this alternative. A paired samples *t*-test (omitting nonresponses) shows an increase in commitment to the profession and lifestyle of being a reindeer herder in Sweden between 2005 and 2022, but not in Norway. There was also a significant difference between Norway 2007 and Sweden 2005, but this difference had disappeared in 2022. Thus, it seems like the intensity of commitment to reindeer husbandry has increased over the years in Sweden, with the significance of herding as a livelihood receiving similar importance across Sápmi.

Worry among reindeer herders

Figure 3 shows the distribution of responses to Likert scale questions on sources of worry for reindeer herders across regions in Norway and Sweden. The figure shows that the degree of worry among reindeer herders differs across regions depending on the cause of worry. However, the overall worry level is high—the average Swedish reindeer herder states the highest worry level on almost 40% of the 19 worry factors, and the average Norwegian counterpart states about 32% of the factors to be of highest concern. In general, a larger percentage of reindeer herders in Sweden expressed higher concerns compared to the herders in Norway for all factors explored here, except for wind power expansion and hiking tourism. The vast majority of respondents are 'Very concerned' or 'Concerned' about mining, wind power development, predators, disease, and climate change. There are some interesting regional and country specific differences. Swedish respondents are much more concerned about forestry, with about 70% stating they are very worried about forestry in the reindeer grazing areas, while the corresponding share in Norway is less than 10%. This is unsurprising, given that the assertion that Swedish forestry has fundamentally altered boreal forests in Sweden, adversely affecting Saami reindeer pastoralism, is well-established (Kivinen et al. 2010; Horstkotte et al. 2011; Korosuo et al. 2014; Sandström et al. 2016; Horstkotte and Moen 2019). The reasons behind the worry concerning forestry were expressed clearly in the interview study by Markkula et al. (2024), where participants highlighted that climate change and land use can have significant combined effects on reindeer herding. For instance, the combined impact of logging and extreme winter weather events is notable. Epiphytic lichen, which grows in old-growth forests, is a crucial source of winter forage for reindeer in Sweden, especially during winters when deep and hard snow or ground ice conditions prevent reindeer from digging for food. Logging in old-growth forests reduces the availability of winter forage and makes it even harder to adapt to extreme winter weather events.

Norwegian respondents instead show slightly more concern for the impacts of tourism. This is corroborated by the results from Vistnes and Nellemann (2001), who showed that during the 1998–1999 calving seasons in Reppari-jord Valley, in Finnmark County, Norway, reindeer were observed to avoid areas within 4 km of the tourist resort, an avoidance which was particularly notable among maternal females. The study's findings indicate that reindeer tend to steer clear of technical structures like power lines, roads, and tourist resorts, even when human traffic is minimal.

Variation is higher between countries and regions for many other factors. 'Lack of productive grazing areas' is a large concern in Norrbotten and Västerbotten in Sweden, which is likely connected to the presence of the forestry industry. Interestingly, worry about 'Regulatory change'—in the questionnaire specified as 'The influence of the state and the authorities on reindeer husbandry (e.g. laws and regulations)'—is strong in both countries, as shown in Fig. 3d—which can indicate that the government in both countries is regarded with some suspicion by reindeer herders. This is augmented by the worry about 'Society's view of the Sami', as seen in Fig. 3c, which is also high in both countries. Together, they paint a picture of a beleaguered livelihood. This is confirmed by the Truth and Reconciliation Commission, which was established in Norway in 2018 to acknowledge the consequences of the assimilation processes affecting the Saami, Kvens/Norwegian Finns, and Forest Finns. The commission's report, published on June 1, 2023 (Truth and Reconciliation Commission 2023), detailed the centuries-long injustices faced by the Saami populations in Norway. Additionally, the report emphasised that racism and negative attitudes towards the Saami people persist today. Discrimination is, however, not confined to Norway—indeed as demonstrated by Yasar et al. (2024), individuals who frequently use a Saami language outside of their family context are more likely to face discrimination in Sweden than in Norway.

As mentioned, to gain deeper insights into the factors influencing the worry patterns shown in Fig. 3, we employ a series of ordered logit models. We use 'Share of working time in the reindeer industry' as a proxy for income from reindeer husbandry, due to a high item non-response rate for herd size. Furthermore, we create an indicator for strong commitment to being a reindeer herder from respondents selecting the answer 'I will not quit as a reindeer herder and it is important to me that the next generation takes over' to the question 'How important is it for you to be a reindeer

herder?' Table 2 shows odds-ratios from these models focusing on the ten factors that caused the highest level of worry for respondents in both Sweden and Norway.

For all factors of worry, there are no significant differences related to age and education regarding herders' expression of worry. Unsurprisingly, Swedish herders are significantly more likely to state a higher degree of concern for the factor 'Forestry' relative to their Norwegian counterparts. We find no difference between Norwegian and Swedish herders when it comes to worry concerning carnivores, suggesting that differences in compensation payment schemes do not affect the degree of worry. Worry about mining and wind power expansion does not differ across countries. Swedish herders are, however, more worried about 'Climate change', 'Majority society's view on Saami', and 'Diseases and parasites among the reindeer'. Generally, male reindeer herders are less worried than females, and in the cases of 'Climate change', 'Mining', and 'Majority society's view on Saami' significantly less so. The commitment to reindeer husbandry significantly increases worry for both mining and expansion of built-up areas. Generally, odds ratios for this variable are high. Overall, these results show that what is driving differences in worry are mainly differences in the degree of exposure to challenges between countries. Other respondent characteristics, except for a few factors, do not significantly explain the degree of worry.

As mentioned, to better understand how various worries might be connected to a common underlying concern, we performed a principal component analysis (see Table 3). For both Norway and Sweden, none of the worry measurements load highly on more than one factor. In Norway, 'Wind power expansion', 'Mining', 'Railways', 'Border issues', and 'Climate change', all map onto the same underlying factor, that is, they correlate with the same latent factor. A similar story emerges in Sweden, where 'Wind power expansion', 'Mining', 'Forestry', 'Hiking', and 'Society's view on the Saami' map to the largest factor. A common theme in both countries is land use change; however, the type of land use reindeer herders worry about differs between countries. This likely reflects political processes and distinct differences between Norway and Sweden. In Finnmark, and to some extent Northern Sweden, the development of large wind turbine parks and mining is encroaching on reindeer pastures and historic land, whereas in Sweden, there are ongoing conflicts between reindeer herders and forest industry as detailed above. The impact of wind farms in Finnmark is documented by Eftestøl et al. (2023), who show that the avoidance distances estimated through GPS monitoring partially align with the reindeer herders' experiences, indicating reduced grazing pressure up to 10 km from wind power farms.

In both Norway and Sweden, 'Government influence and regulation' and 'Price of Reindeer meat' loads highly on the second factor. In addition, there are some concerns relating to 'Roads and traffic'. This suggests another common theme along the lines of regulation of the industry and its profitability. It is worth noting that this factor is moderately correlated with the first one in both countries, highlighting a possible connection between worry about land use change, and regulation and profitability.

Moving to the third factor component, we see some interesting differences between Norway and Sweden. In Norway, reindeer herders are more worried about competing uses of land by others, where 'Agriculture', 'Hunting', and 'Fishing' are sources of worry, whereas in Sweden, the third factor component includes 'Climate change', and possible effects of it such as (more) 'Diseases and parasites among the reindeer'. This latter point suggests that Swedish Saami see these three challenges as interlinked. Linking worry over diseases to the climate is reasonable, given that climate-sensitive infectious diseases, many of which zoonotic, are likely to increase with a warmer and wetter climate (e.g. Davidson et al. 2020; Rasmus et al. 2022). Understanding the final component in Norway is less clear-cut but could potentially reflect a geographic area with more conflicts, predation, and interactions with hikers. In Sweden, this is a 'perfect' match with agriculture.

It is clear from our analysis that Saami in both Norway and Sweden are broadly worried about land use changes, mainly from forestry, wind power development and mining, as well as government regulation, as they are worried about effects of climate change. This also resonates with views expressed in both our reference group and focus groups, where participants indicated that without loss of pasture and land use change, adapting to climate change would not be such an issue, so despite the relative urgency of climate change, land use change is, and feels, more immediate to those living with and of the land.

Perceived effects of climate change

To focus specifically on effects of climate change, a set of questions were asked focusing first on adaptations necessitated by climate change, and second on how climate change manifests itself to the reindeer herder. Figure 4 shows the distribution of responses to various statements about effects of climate change in percent for each country. Item nonresponse has been excluded in these figures to simplify comparison of actual responses between countries.

Evidently, more than 80% of both Swedish and Norwegian respondents have already to a varying extent had to change the way they conduct reindeer husbandry because of climate change. About 75% of the Swedish respondents, compared to nearly 55% of those from Norway, think that in the future, this will involve changing the size of reindeer herds, while about 70% of the Swedish respondents, and about the 55% of Norwegian ones, state that it will involve changes in the composition of reindeer herds.

Table 3 Principal component analysis of the worry factors. Pattern matrix, rotation method: Promax with Kaiser normalisation. Factor loadings below 0.5 suppressed, and analysis limited to four components

Norway				
Worry factor	Component 1	Component 2	Component 3	Component 4
Wind power expansion	.904			
Mining	.820			
Railways	.702			
Border issues between Norway and Sweden	.626			
Climate change	.547			
Government influence and regulations		.797		
Price of reindeer meat		.647		
Lack of fertile grazing grounds		.627		
Road/traffic		.621		
Expansion of built up areas		.587		
Agriculture			.754	
Recreational hunting			.718	
Recreational fishing			.658	
Internal cooperation among reindeer herders				–.707
Hiking tourism				.572
Wild carnivores				.569
Eigenvalues, % of variance	28.89	10.13	7.15	6.59
Component correlation matrix				
Component 1	1			
Component 2	.472	1		
Component 3	.405	.357	1	
Component 4	.298	.065	.083	1
Sweden				
Worry factor	Component 1	Component 2	Component 3	Component 4
Wind power expansion	.790			
Mining	.739			
Forestry	.591			
Hiking tourism	.563			
Majority society's view on Saami	.546			
Road/traffic		.760		
Government influence and regulations		.667		
Price of reindeer meat		.625		
Railways		.575		
Recreational hunting		.573		
Wild carnivores			.668	
Climate change			.660	
Diseases and parasites among the reindeer			.604	
Agriculture				.683
Eigenvalues, % of variance	23.69	9.48	8.34	7.54
Component correlation matrix				
Component 1	1			
Component 2	.400	1		
Component 3	.021	.10	1	
Component 4	.160	.061	.086	1

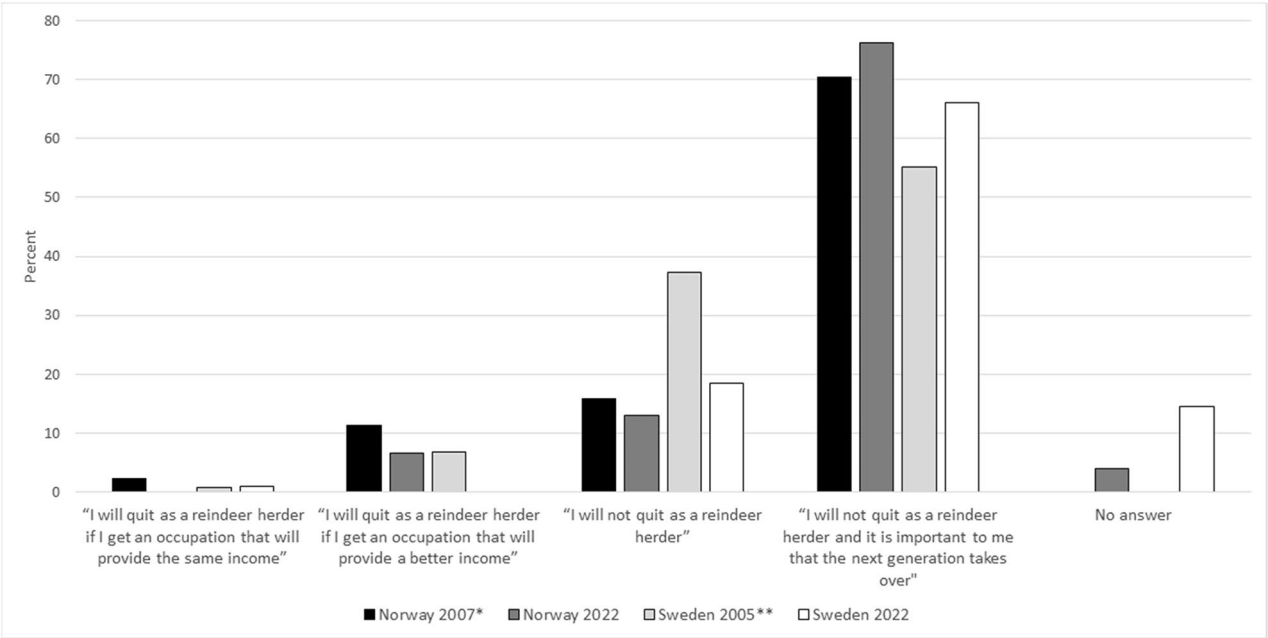

Fig. 2 Responses to: 'How important is it for you to be a reindeer herder?'

A large majority, almost 95% of the Swedish respondents and a comparative 90% of Norwegian ones, state to a varying extent that they are worried about whether future generations can continue with reindeer husbandry. This result echoes the results found in Markkula et al. (2024), where respondents stated that unpredictable weather patterns cause both immediate and long-term stress. When weather conditions are uncertain, herders feel the need to be 'prepared for everything'. In Markkula et al. (2024), respondents also expressed increasing concern about the future of reindeer herding as a livelihood. Many wonder if reindeer herding will still exist in 20 years. Some participants expressed worries that the combined impacts of climate change, land use, and economic issues might make reindeer herding seem like an impossible or undesirable way of life for younger generations.

These results should be viewed in contrast with the large majority who, in Fig. 2, state that it is important to them that the next generation takes over as reindeer herders. Only a minority, a little over 20% in Sweden and about 15% in Norway, *disagree* with the statement that reindeer husbandry, as it is practised today, is sustainable in the long run. Responses to the question of whether it is more important to have high slaughter weights or many animals show that in Sweden more than 80% of the respondents who answered this question agree with this statement. The corresponding figure in Norway is only slightly higher. However, it should be noted that item nonresponse was exceptionally high for this question in Sweden, indicating a reluctance to answer, and thereby the possibility that some felt forced to make this choice.

To better understand how these statements about climate change might correlate with the same underlying perceptions, a principal component analysis, using the same setup and rotation as above, was employed (see Table 4). In Norway, the analysis showed that factors can be grouped into three, where the first captures changes to how reindeer husbandry is practised and the possibility of future generations to continue with it; the second captures herd related views and changes, while the third alone captures the view on sustainability. In Sweden, the analysis revealed only two factors, the first capturing all but one of the statements, but with the highest correlations related to how reindeer husbandry is practised, and the second addressing the one about climate change. The previously mentioned study by Rosqvist et al. (2022) demonstrates how the new climate state compels adaptation of reindeer husbandry practice. Results indicated that weather and snow conditions significantly influence grazing opportunities and reindeer responses.

Interestingly, it appears that the view on sustainability of reindeer herding differs between countries. In Norway, the sustainability statement 'Reindeer husbandry, as it is practiced today, is sustainable in the long run' maps positively onto the latent factor, whereas in Sweden, it maps negatively onto the factor. This suggests that these opposite signs for

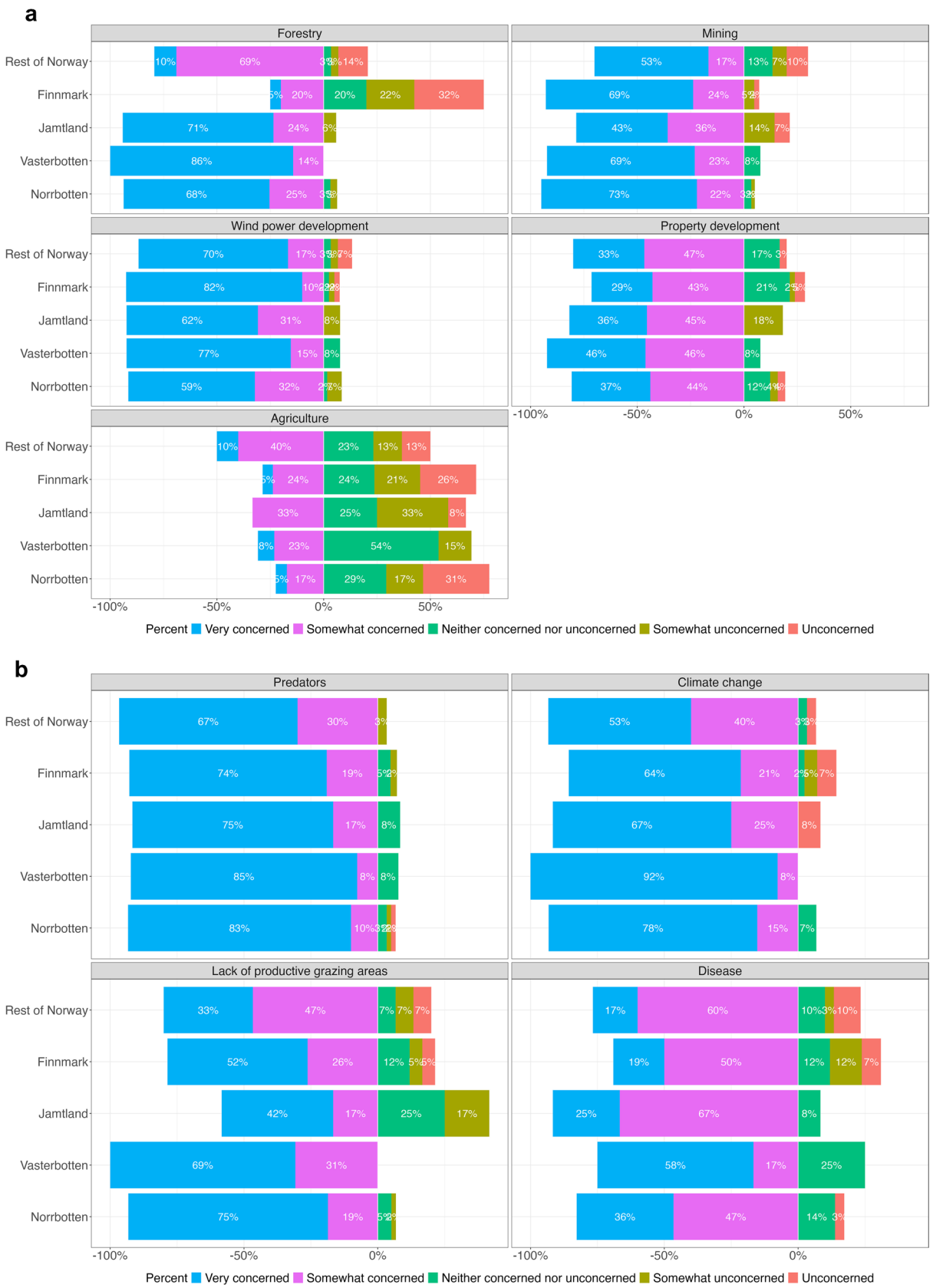

Fig. 3 **a–d** Worry factors by region in Norway and Sweden

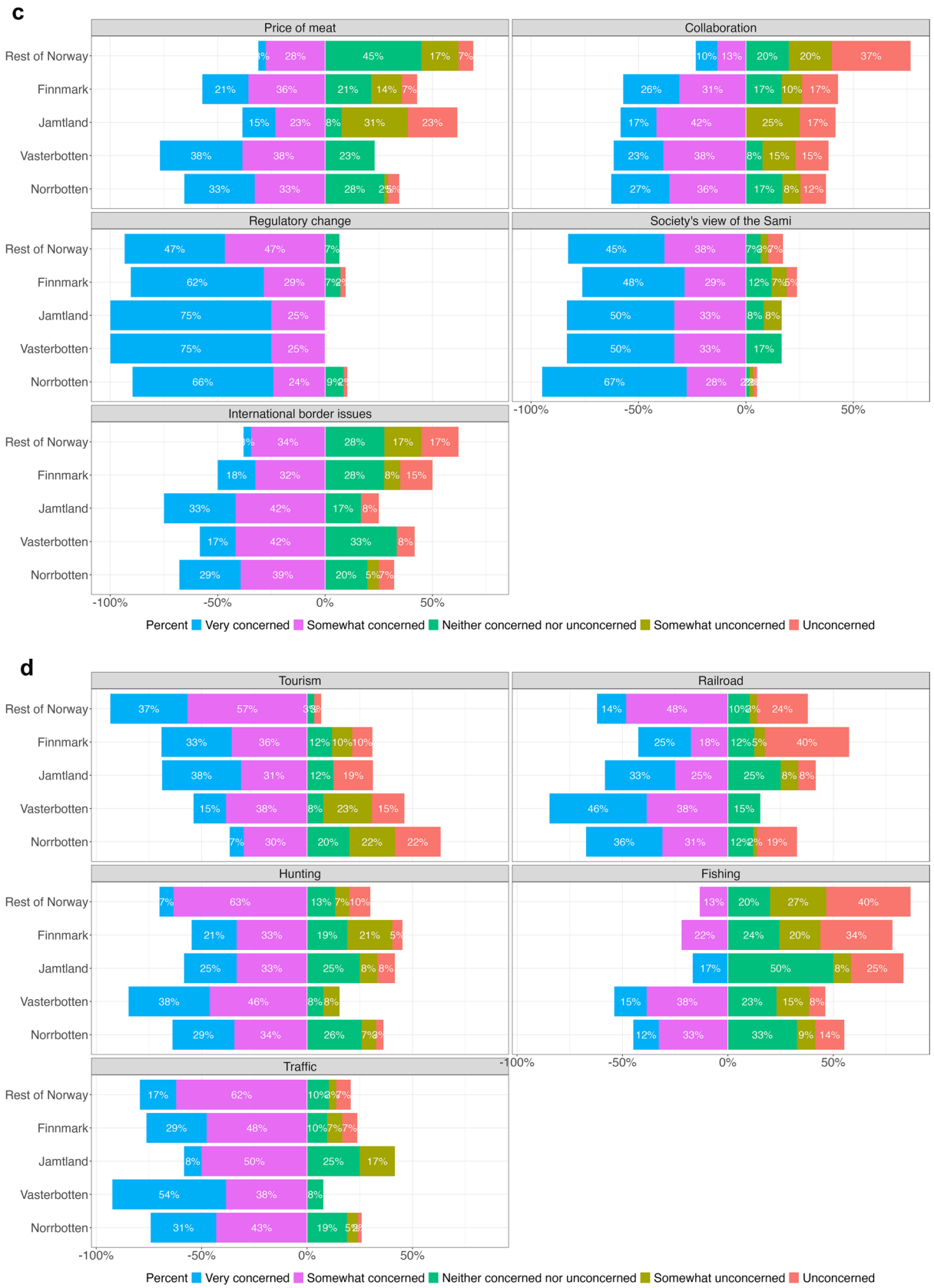

Fig. 3 (continued)

the same statement capture opposing views of the sustainability of the industry in the two countries, with Norwegian reindeer herders having a more optimistic view of the sustainability of reindeer herding.

Concluding remarks

In this paper, we analysed and compared various factors causing worry and concern among reindeer herders, using data from a unique survey conducted among herders in Norway and Sweden. Responses about the importance of being an active reindeer herder reveal a strong commitment to the profession, which is unsurprising since reindeer husbandry is a cultural keystone for the Saami people. Referring to earlier studies by Bostedt (2005) and Johannesen and Skonhoft (2011), we found a significant difference in commitment between Norway in 2007 and Sweden in 2005, but this difference had disappeared in 2022. This indicates that the intensity of commitment to reindeer husbandry has increased over the years in Sweden, making Swedish reindeer herders more like Norwegian herders in this regard.

When it comes to what causes worry among reindeer herders, responses to 19 different worry categories show that climate change is *not* the cause of the most worry in either country; rather, it is large carnivores that cause highest worry in both countries. This aligns with the perspectives shared in our reference and focus groups, where participants noted that without the pressure from carnivores and changes in land use, adapting to climate change would be less problematic. Therefore, despite the pressing nature of climate change, carnivores and land use change is perceived as a more immediate concern by those who live on and depend on the land. Overall, the tendency that can be ascertained from responses is that it seems like Swedish reindeer herders are more worried than their Norwegian counterparts—a comparison that we have not been able to find in the existing literature. However, generally, worry levels are high in both countries, and the fact that the average Swedish reindeer herder reports the highest level of concern for nearly 40% of worry factors, while the average Norwegian herder indicates about 32% of factors as highly concerning, is certainly alarming and demonstrates a high pressure on socio-psychological wellbeing. This analysis also demonstrates the connections between different sources of worry, implying that their interaction with one another exceeds the sum of the total effects.

Furthermore, the results demonstrate that considerable differences exist between the two countries. For Norway, not only large carnivores, but also wind power expansion, causes higher worry than climate change. However, the most striking difference between the countries concerns forestry as a worry factor, where worry is much higher in Sweden than in Norway. This makes forestry the third most important worry factor in Sweden, after large carnivores and climate change. This is not surprising, since Swedish forestry has fundamentally changed the boreal forests in Sweden, negatively impacting Saami reindeer pastoralism (Kivinen et al. 2010; Horstkotte et al. 2011; Korosuo et al. 2014; Sandström et al. 2016; Horstkotte and Moen 2019). When it comes to hiking tourism, worry in Norway is stronger than in Sweden, although this factor is not among the highest in either country. This aligns well with a study by the Nordic Council of Ministers (Øian et al. 2018), which shows that, in recent decades, Norway has encountered unprecedented challenges due to a growing interest in nature-based tourism.

Male reindeer herders seem less worried than females, while commitment to reindeer husbandry—as shown by a dummy constructed from the above-mentioned question concerning the importance of being an active reindeer herder—significantly increases worry. This is unsurprising, since full-time, or near full-time, reindeer herders are more exposed to external factors, given the lack of alternative means of income. Overall, results show that differences in worry depend on the level of exposure to different factors that vary between countries and regions, giving a nuanced picture between these different areas. Other characteristics of the respondents, except for a few factors, do not significantly explain the degree of worry. Concerning connections between worry factors, a principal component analysis showed that underlying traits that could be interpreted as land use change have the highest factor loadings. The second highest factor loadings concern worry about the reindeer herding industry, its profitability, and how it is regulated.

Focusing specifically on effects of climate change, results show that reindeer herders in both countries already have, to a varying extent, had to change the way they conduct reindeer herding because of climate change. A majority in both countries mean that in the future, both size and composition of reindeer herds need to change—although it cannot be discerned directly from the questions in what direction herds need to change. However, that the majority agree with the statement that it is more important to have high slaughter weights than many animals gives an indication that respondents are willing to reduce their herds. This somewhat contradicts the findings from Næss and Bårdsen (2013), who have shown that herders in Norway see herd size as an insurance against catastrophic winters. A principal component analysis of these questions suggests two groups of reactions to climate change among reindeer herders, either a general worry and insight that some undefined changes in reindeer management needs to be done, or an insight that current reindeer husbandry is unsustainable, given effects of climate change, and a willingness to take concrete action such as changing herd size or composition. A significant majority in both countries express concern about the future of reindeer

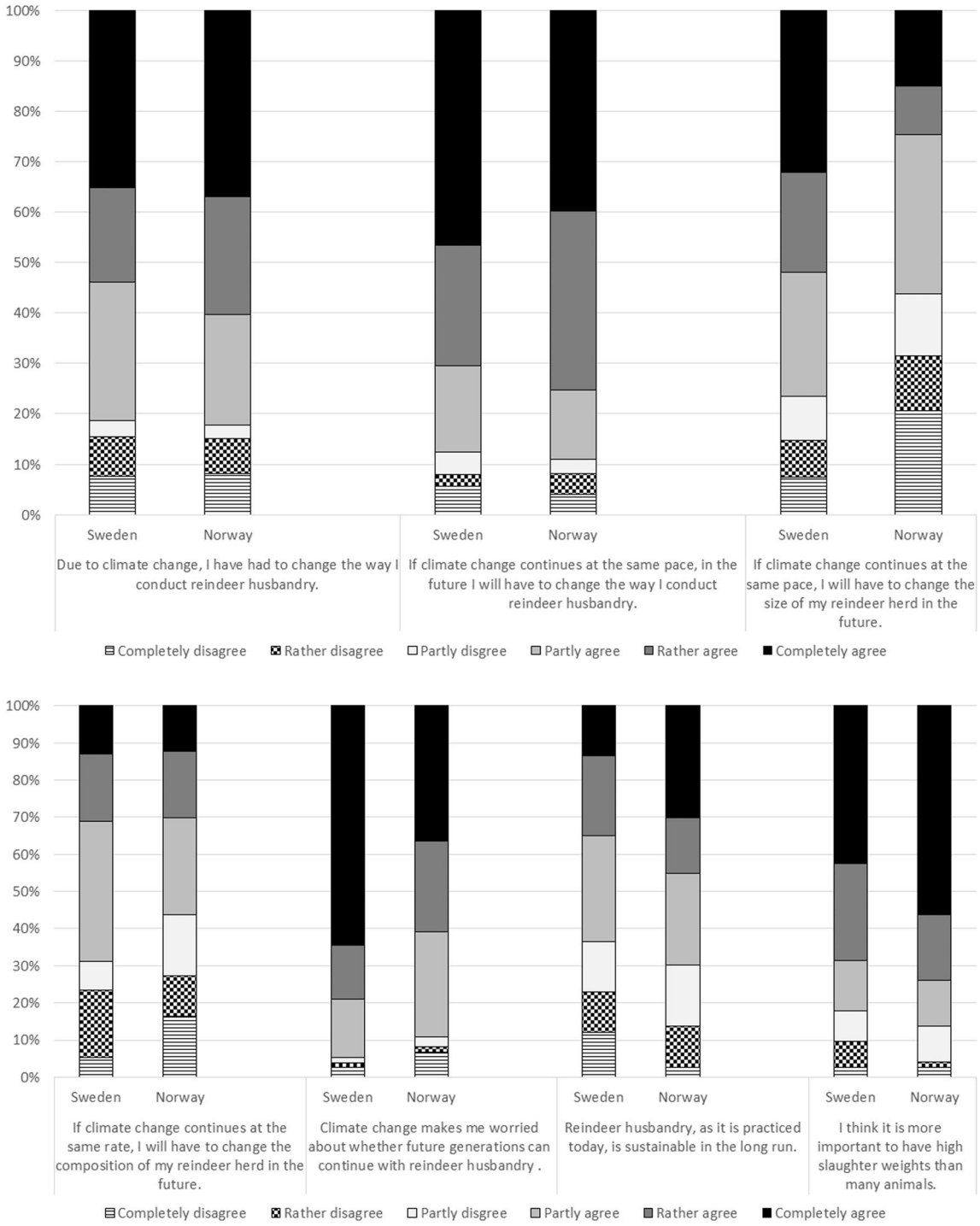

Fig. 4 Percentage distribution of response to various statements about the effects of climate change. No. of obs: Sweden = 103, Norway = 76. Note that item nonresponse has been excluded in these figures

husbandry for upcoming generations. This should be seen in light of the responses to the earlier commitment question, where most stated that it is important to them that the next generation continue as reindeer herders. Overall, the continuation of reindeer herding in a changing climate depends on the herding system's ability to adapt to unpredictable weather conditions (cf. Moen 2008). However, this adaptive capacity is now reduced due to the expansion of competing land uses and increased large carnivore pressure (Rosqvist et al. 2022).

The main strength of our analysis lies in the integrated cross-country approach to factors that cause worry and concern among reindeer herders, relating climate change to other factors. Results from the survey demonstrate that various factors act simultaneously, causing a combined/cumulative worry for the performance and future of reindeer herding. This is supported by the study by Stoessel et al. (2022), which indicates that about 60% of northern Fennoscandia is subject to cumulative impacts, with at least two co-existing land-use pressures. Although many synergies among these various pressures are unknown, we can still assume that their co-occurrence on grazing land will undermine the flexibility essential for the survival of northern pastoralism. Generally, the long-term resilience of traditional pastoralist livelihood strategies depends on the ability to ensure secure yet flexible access to land (Turner et al. 2016). That said, even though general patterns emerge from our data in our studied countries, there is still a high level of uncertainty in our results due to the low sample size.

The results demonstrate that reindeer husbandry is a livelihood under pressure from multiple drivers at the same time, ecologically, economically, and socio-politically; these partly interact and exacerbate each other, with a significant worry exhibited by currently active reindeer herders in Sweden and Norway regarding whether future generations can continue with reindeer husbandry. To improve this situation, some inspiration can possibly be gained from other countries in Boreal and Arctic regions. In Canada, the past two centuries have seen Native Americans largely excluded from forest management activities. This has begun to gradually change due to ongoing efforts in courts as well as to national and international recognition of the potential contribution of Indigenous Knowledge to sustainable forest management (McGregor 2002). Further north, indigenous Arctic organisations such as the Inuit

Table 4 Principal component analysis of the climate effects. Pattern matrix, rotation method: Promax with Kaiser normalisation. Factor loadings below 0.5 suppressed

Norway			
Statement	Component 1	Component 2	Component 3
Due to climate change, I have had to change the way I conduct reindeer husbandry.	.934		
If climate change continues at the same pace, in the future I will have to change the way I conduct reindeer husbandry.	.901		
Climate change makes me worried about whether future generations can continue with reindeer husbandry	.716		
I think it is more important to have high slaughter weights than many animals.		.776	
If climate change continues at the same pace, I will have to change the size of my reindeer herd in the future.		.770	
If climate change continues at the same rate, I will have to change the composition of my reindeer herd in the future.		.736	
Reindeer husbandry, as it is practiced today, is sustainable in the long run.			.873
Eigenvalues, % of variance	42.65	17.33	17.7
Component correlation matrix			
Component 1	1		
Component 2	.386	1	
Component 3	–.181	–.131	1
Sweden			
Statement	Component 1	Component 2	
If climate change continues at the same pace, in the future I will have to change the way I conduct reindeer husbandry.	.816		
Due to climate change, I have had to change the way I conduct reindeer husbandry.	.796		
If climate change continues at the same pace, I will have to change the size of my reindeer herd in the future.	.747		
I think it is more important to have high slaughter weights than many animals.	.694		
If climate change continues at the same rate, I will have to change the composition of my reindeer herd in the future.	.542		
Reindeer husbandry, as it is practiced today, is sustainable in the long run.		–.947	
Eigenvalues, % of variance	43.93	14.52	
Component 1	1		
Component 2	.339	1	

Circumpolar Conference (ICC) and the Alaska Eskimo Whaling Commission (AEWC) are currently building upon a strong success record of their past to confront the environmental problems of their future (Sakakibara 2011). In the case of salmon fishing in Alaska, Naves et al. (2015) showed that to respond to socioeconomic and ecological sustainability issues, fisheries management would benefit from recognising all perspectives and promoting the participation of all stakeholder groups and effective communication among them.

What these success stories have in common is that they demonstrate the importance of strong organisations among indigenous people, who are prepared to use the legal system as a last resort. It also shows the importance of having management and decision-making bodies who consider all perspectives in dialogue with the Saami communities, especially in the face of major land changes, such as, e.g. large-scale wind power development, or when extractive industries exert multiple pressures. The potential for such coordination certainly exists in both Norway and Sweden since the ministries governing reindeer herding—the Ministry of Enterprise and Innovation (Näringsdepartementet) in Sweden, and the Ministry of Agriculture and Food (Landbruks- og Matdepartmentet) in Norway—also govern many other land uses that impact the conditions for reindeer herding, e.g. agriculture and forestry. However, currently, many of the policy initiatives are not in dialogue with the Saami communities, e.g. the current Norwegian government push for a large-scale programme to reduce reindeer populations to a 'sustainable' level (Reinert & Benjaminsen 2015). The lack of dialogue is likely one of the explanations behind the high worry concerning 'Regulatory change' in both Norway and Sweden.

Overall, while our results demonstrate differences across geographical areas, Saami reindeer herders share a common hope for the future: That the next generation can uphold the traditional way of life.

Acknowledgements We are forever grateful to all the reindeer herders in Sweden and Norway who took their time to answer the survey and participate in focus groups and our reference group. We are also grateful for comments by an anonymous reviewer. All interpretations and conclusions are those of the authors.

Funding Open access funding provided by Umea University. The authors wish to thank the EU Biodiversa research project 'Future Arctic Lives' for its financial support.

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