Chapter 2
Framing Adaptation to Rapid Change in the Arctic

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Abstract A safe operating space for Indigenous reindeer herders in the Circumpolar North must be the main priority for the governance of the Arctic and sub-Arctic territories in times of rapid changes on reindeer pastures. It also includes establishing reindeer herders' adaptive capacity to these changes. Anthropogenic impact on the earth system has reached a scale where it is no longer possible to exclude abrupt global environmental change. Indigenous reindeer herders' sustainability implies adaptive capacity that allows reindeer herders to operate safely. The Intergovernmental Panel on Climate Change highlights that the protection of grazing lands represents the most important adaptive strategy for reindeer herders under climate change. While the Arctic is rapidly integrating into the global economy, reindeer herders must face multiple socio-economic conditions and effects of assimilation past and present. This chapter addresses adaptation perspectives important for the future of reindeer husbandry and frames adaptation to rapid change for reindeer husbandry via Indigenous perspectives, insights, and knowledge.

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2.1 Introduction

> By listening to each other with respect and with a sincere desire to understand, together we can create an even better society. In October, I was in Kautokeino during a ceremony where a historical treasure of great value to the Sámi people was returned to the Sámi, where it belongs. It was a reminder of the importance of culture, language, and history for a people's identity. It also reminded me of something that always strikes me in conversations with Indigenous peoples – whether it is in Norway, Canada, Australia, or the Amazon: Indigenous peoples have for thousands of years been dependent on the interaction with nature and all living things to survive. They possess valuable knowledge that is important to all of us. Large societies and Indigenous peoples around the world benefit from listening to each other and working together to safeguard what must be a common goal: To manage the earth's resources in a way that allows the generations after us to live good lives. (King Harald V of Norway 31.12.21)

Climate change has created unprecedented extreme temperatures in the Circumpolar North, such as in Eastern Siberia, where the temperature has increased by more than 6 °C in the past 30 years. Further, the surface air temperature in Kautokeino has increased by approximately 3°C in the spring in the past 100 years (Hanssen-Bauer et al., 2023; Popova et al., 2023). The increase in the frequency of the freeze-thaw and rain-on-snow events – *Goavvi* in Sámi or "the bad year caused by the ice and snow on the reindeer grazing pastures" – has increased from once every 50–100 years to frequencies on decadal times (Eira et al., 2018; Johnsen et al., this volume). These events have devastating consequences with losses of reindeer as the herd cannot reach their food: the lichen beneath the frozen surface contains the essential carbohydrates of life. These conditions are exacerbated by the fact that the ~1 °C increases in global surface temperatures are incrementing at rates ~4 times in the high north (Jacobs et al., 2021; Rantanen et al., 2022), and particularly in the Circumpolar Arctic (Hanssen-Bauer et al., 2023). The temperature in June 2020 set a record of 38 °C in the city of Verkhoyansk, in the Sakha Republic of Russia, where a record Arctic temperature was observed by the World Meteorological Organization (WMO). This led to wildfires in Siberia which were documented to be larger in area than all the rest of the world's wildfires combined. (Popova et al., 2023; Gerasimova et al., 2022). These scientific observations and studies in the Siberian Arctic are replicated in Western Canada, where in June 2021, the city of Lytton recorded an extreme temperature of 49.6 °C that burned the city to the ground and ignited a series of wildfires.[1] Parallel similar occurrences are reported in Alaska, Canada, and the Scandinavian region (Sjostrom & Granström, 2020).

Indigenous reindeer herders in the Circumpolar North are facing climate and socio-economic changes already impacting the economies and cultures of reindeer husbandry (Degteva et al., 2017; Hanssen-Bauer et al., 2023). A safe operating space (Rockström et al., 2009) for the herders must be the main priority for the

[1] https://www.bbc.com/news/world-us-canada-57678054

governance of the Arctic and sub-Arctic territories in times of rapid changes in reindeer pastures. Loss of grazing land and biodiversity threaten the economic and cultural well-being of the herding societies. Competing land use and climate change are threats to the pasture lands of Sámi reindeer herding. Reindeer pasture areas are exposed to the development of infrastructure, hydropower, mineral exploration, recreational cabin areas, and wind power (van Rooij et al., 2022).

Since 2011, about 50% of the biodiversity of reindeer calving grounds has been lost. It is expected to be reduced by another 10% in the scenario for 2030 in Finnmark in Norway (van Rooij et al., 2022). Infrastructure development on the Barents Euro-Arctic region depleted 25% of former reindeer pastures; in Finnmark, the figure reaches 35% (Jernsletten & Klokov, 2002). Every year the coastal areas in the north of Norway lose 1% of the traditional Sámi summer pastures; it is approximately the amount of grazing land used by one nomadic family in summer (Magga et al., 2011).

Reindeer husbandry management in Fennoscandia showcases social-ecological systems incorporating social, cultural, ecological, and economic values (Mathiesen et al., 2013). Landauer et al. (2021) reviewed the comprehensive literature and interviews with herders revealing that land use, climate change, and governance drive the emergence of social-ecological systems' tipping points in Finland's reindeer husbandry. Successful management depends on the quantity and quality of pastures to secure animals' health and welfare (Landauer et al., 2021). Thresholds for traditional boundaries for Indigenous reindeer husbandry in the Circumpolar North have not yet been identified, nor has their adaptive capacity.

Pasture conditions, climate, and societal changes are transforming the reindeer husbandry's operational environment. These inescapable facts lead to a central reality: it is essential to develop and implement adaptation strategies and practices that explicitly address the consequences of the unprecedented weather and climate changes in the Circumpolar Arctic. Adaptation strategies should directly address the challenges faced by the Indigenous reindeer husbandry cultures. Nymand-Larsen et al. (2014: 1594) refer to the protection of grazing land as "the most important adaptive strategy for reindeer herders under climate change". This chapter seeks to set a framework that details the reindeer husbandry's traditional knowledge, culture, and language as a central foundation for adaptation (Fig. 2.1).

2.2 Defining Adaptation

Sámi reindeer herder Mathis N. Eira, from Karasjok in Norway, spoke about the effects of climate change in the Sámi Parliament in 2021: "*reindeer herders in Norway have through their history adapted their practice repeatedly to the extent that they are not able to adapt any further*". In nature, adaptability requires variability because one never knows who, in a changing environment, has the capacity to take us into the future. In many businesses, for example, the chief bottlenecks to growth and adaptability are often the quality and distribution of leadership. Our organizations and communities need distributing leadership, with and without authority (Heifetz et al., 2009). Adaptation "usually refers to a process, action, or outcome in a system (household, community, group, sector, region, country) in

Fig. 2.1 Yamal Nenets reindeer herders working with the herd during spring migration. (Photo: E.I. Turi)

order for the system to better cope with, manage or adjust to some changing condition, stress, hazard, risk, or opportunity" (Smit & Wandel, 2006). The Intergovernmental Panel on Climate Change (IPCC) defines adaptive capacity as "*the ability of systems, institutions, humans, and other organisms to adjust to potential damage, to take advantage of opportunities, or to respond to consequences*" (IPCC, 2014). Because "adaptive capacity" refers to the underlying capacity to adjust to changing conditions, it can be considered an important expression of resilience (Arctic Resilience Report, 2016: 9). "Transformative capacity", on the other hand, implies a capacity to embrace more fundamental and far-reaching changes (Folke et al., 2010). This should not, however, be confused with transformation in societal resilience (Arctic Resilience Report, 2013). In this sense, resilience can be described as an essential underpinning of both adaptive and transformative capacity. An inability to adapt or transform implies a lack of resilience, and therefore an inability to successfully navigate a chosen trajectory in pursuit of goals within the broader cycles of social-ecological change. IPCC (2022) defined adaptation as the "*process of adjustment to actual or expected climate and its effects, in order to moderate harm or exploit beneficial opportunities*". Nelson et al. (2007) refer to *"...a process of deliberate change in anticipation of or in reaction to external stimuli and stress*." Climate adaptation capacity in Norway is defined by NOU (2010) as the ability of a system to adapt to climate change, including natural climate variations and extremes to limit potential damage, exploit any benefits and opportunities that arise, or deal with consequences. Climate adaptation implies autonomous adjustments through ecological and evolutionary processes.

There is a growing interest across the science community (National Research Council, 2002) and in the assessments of knowledge communities (Sullivan, 2019) to fully integrate the knowledge gained in the classical scientific community (Wolinsky, 2008) with the insights (Degteva & Nellemann, 2013) contained in Indigenous Traditional Knowledge (ITK) (UN FCCC, 2013). IPCC (2014, 2022) integrates the findings of the Fifth Assessment Report (AR5) and Sixth Assessment

Report (AR6) and emphasizes the increasing importance of Indigenous, local, and traditional knowledge as providing vital knowledge-based perspectives in international assessments and as insightful resources and practices to adapt to climate and global change, stating:

> Adaptation planning and implementation at all levels of governance is contingent on societal values, objectives, and risk perceptions (high confidence). Recognition of diverse interests, circumstances, social-cultural contexts, and expectations can benefit decision-making processes.... Indigenous, local, and traditional knowledge systems and practices, including Indigenous peoples' holistic view of community and environment, are a major resource for adapting to climate change, but these have not been used consistently in existing adaptation efforts. Integrating such forms of knowledge with existing practices increases the effectiveness of adaptation [...] There is increasing recognition of the value of social (including local and Indigenous), institutional, and ecosystem-based measures and of the extent of constraints to adaptation. (IPCC, 2014: 19)

Developing the capacities to frame adaptation strategies to address rapid change in the Arctic depends on using foundational scientific perspectives and insights from Indigenous and Traditional Knowledge.

2.3 Reindeer Herder's Perspectives on Adaptation and Developing Resilience

Adaptation knowledge is nested in and governed within the Indigenous society in the Circumpolar North and is based on Indigenous peoples' traditional knowledge, perspectives, and insights. The Sámi traditional knowledge of terrestrial ecosystems' health and integrity in northern Norway is based on the Norwegian and Sámi ways of knowing as described by Meløy (1989). Sámi adaptive knowledge perspectives have rarely been included in research about resources and management of ecosystems, in local planning for change, or in impact assessments in Norway. Ruong (1967) pioneered studies of the Sámi traditional knowledge. Eira (1994) started a discussion on traditional knowledge of reindeer herding and Magga et al. (2009) – on environmental conditions of reindeer husbandry. Magga et al. (2001) investigated Sámi perspective on animal welfare. Reindeer herding practices represent sustainable exploitation and management models originating in the terrestrial ecosystems of the North. They are based on generations of accumulated experience, conserved, developed, and adapted to the climatic and administrative systems of the Arctic (Oskal et al., 2009). Various aspects of these observations and adaptations are reflected in a rich vocabulary of Sámi terms and concepts about ecosystems health and integrity in the understanding of snow, reindeer, and environmental factors (Eira, 2012a). People describe the environment in terms of their local experience and their routine daily interactions with it (Eira, 2012a, b). These descriptions are incorporated into Indigenous languages constituting unique reindeer herders' terminology (Eira et al., 2013; Eira et al., this volume). For Sámi reindeer herders, snow is a prerequisite for mobility, tracking, visibility, and availability of pasture plants

during seasonal migrations. Eira et al. (2013) discovered that herder's snow knowledge is more holistic and integrated into the ecology of the herd and pastures than the international standard snow terms. The analysis stressed the richness and accuracy of Sámi snow terminology and concluded with the two snow change knowledge systems: the Sámi traditional knowledge and scientific knowledge (Eira et al., 2013). Turi and Keskitalo (2014) and Turi (2016a) discussed major barriers to using traditional knowledge in the Norwegian governance of Sámi reindeer husbandry. It is necessary to integrate traditional knowledge at the early stages of policy formation to overcome such barriers. Sectorial fragmentation in national and regional government administration challenges cumulative long-term effects of land-use changes in decision-making. The extensive character of reindeer pastoralism and its dependence on different pasture types requires monitoring and recording of any changes in land use. Institutional governance, economic conditions, and other regulatory practices affect reindeer herding cultures and traditional knowledge (Eira, 2012b; Turi, 2008, 2016b; Eira, 2012a). Eira et al. (2016) documented the social traditional knowledge of Sámi reindeer pastoralism. In Finland, Magga (2014) described the two types of reindeer husbandry: Sámi and Finnish. The latter reports the overriding rationality of meat production (Heikkilä, 2006), while on the former presents a reindeer husbandry family enterprise, which is versatile in its use of the surrounding natural resources, and the internal Sámi herding management system of customary rights and the local reindeer herding communities.

When Norway started the modernization of reindeer husbandry in the late 1970s, Sámi women were in danger of losing their traditional right to own their animals (Margit Hansen Krone and Karen Anna Logje Gaup, personal discussion). In the Sámi culture, the women had always been strong and continued to keep reindeer even after getting married. In *siida*, a traditional Sámi management system, each family member had individual reindeer marks. In 1978, Norway introduced reindeer husbandry licenses to make the industry more profitable. The original plan was that only one person in the family could keep the reindeer earmark, which became a critical starting point for the mobilization of the Sámi women's movement (Margit Hansen Krone and Karen Anna Logje Gaup, personal discussion). The change of just one reindeer mark per operating unit would have favored the men in the reindeer husbandry. As a result of this process, Sámi women might have lost the right to an independent business base, therefore, weakening their economic and social rights. According to Margit Hansen Krone (personal discussion), a compromise was made: those women who had already had their marks could continue to have them if, for example, they were married to the primary owner of the license (Halsaa, 2013). Such gender role changes in Sámi reindeer husbandry reduced the adaptive leadership of the reindeer herders.

Arctic change implies a synergy of challenges and opportunities. Indigenous communities, however, often find themselves at a disadvantage. The negative impacts of the cumulative land use and socio-economic conditions often overshadow possibilities for positive local development in terms of the communities' capacity to be proactive and lead local actions (Oskal et al., 2017).

Reindeer herders' adaptation strategies are focused on applying flexibility (Arctic Resilience Report, 2013), continuous adaptations to changing environmental and weather conditions (following Turi, 2008; Reinert et al., 2009, Eira et al., 2018), and minimization of risk through fostering diversity in social organization, economy and through understanding biological diversity (following Magga et al., 2011; Arctic Resilience Report, 2013; Benjaminsen et al., 2015). Increased knowledge about the food culture of Arctic Indigenous peoples is the key to adaptation to Arctic change, building resilience, and maintaining the cultures and societies (Fig. 2.2).

Indigenous reindeer herders' resilience is about finding ways to strengthen their societies – from within. It is about using their own knowledge and developing their own societies. For example, local opportunities can be achieved if food governance networks, regulations, and praxis of those regulations are aligned with the Arctic realities (Oskal, 2022; Oskal et al., 2017, 2021; Oskal & Pogodaev, 2019). When reindeer herders talk about resilience – *Dávggas* – which in Northern Sámi means elastic, resilient, flexible, and tough, we are fundamentally talking about socio-ecological systems as recently defined by Reyers et al. (2022). If the theory of resilience is not correctly understood and applied, there is a danger that programs and practices touted to be about resilience may be misleading, unethical, or even eroding resilience (Reyers et al., 2022). In the concept of resilience, socio-ecological systems can withstand changes as shocks and still recover, but only up to certain limits (Arctic Resilience Report, 2013). In addressing resilience, one must ask: resilience of what? and resilience to what? These elaborations must be very concrete, and therefore, questions about the "resilience of Indigenous peoples" quickly end up meaningless. When discussing the resilience of reindeer herding in Norway, we could, e.g., discuss the introduction of the oil-based economy as a shock, or unpredictable critical events (Eira, 2012b). What are the effects of reindeer herders' resilience to the effects of the transition to the oil economy? How could reindeer herders uphold sustainability after oil? There is a danger that the concept of resilience could be disconnected from nature and used for other purposes. How could reindeer herders bounce back from shocks and disturbances, or perhaps even

Fig. 2.2 Nenets reindeer herding brigade on the Yamal peninsula in early June 2009. Drying bread on the sleds after a long spring migration showcases the importance of a family-based economy. (Photo: S.D. Mathiesen)

develop forward? Inherent in change are both challenges and opportunities, producing both winners and losers. The reality of reindeer herders however is that they are not in a good position to utilize arising opportunities, being swamped in the current problems of the day (Oskal, 2022).

2.4 Adaptation as a Solutions Strategy

Reindeer pastoralism, the ancient model that maintained sustainable exploitation and management is based on accumulated experience and adaptation strategies to the climatic and political/economic transformations. In the research project, EALÁT (Magga et al., 2011), research focuses on understanding the adaptive capacity of reindeer pastoralism to climate variability and change and on the integration of reindeer herders' knowledge in the study and analysis of their ability to adapt to environmental variability and change (Oskal et al., 2017). The EALAT research highlighted that temperature variations lead to more "freeze-thaw-freeze" cycles that in turn result in the icing of the forage plants. Therefore, having more animals in the herd, for instance, sterilized ones, also becomes a more widespread practice in reindeer husbandry as an adaptation tool for herd structure management (Eira et al., 2018). Castrated males serve a special purpose in the herd in icy conditions because, due to their larger size, they are more able to easily break through ice layers in the snow, facilitating access to food for females and calves (Mathiesen et al. 2022). In addition, the presence of these males has a calming effect on female reindeer and calves, making herds easier to control (Tyler et al., 2007). Regulation of the herd structure through male reindeer castrations represents an integral strategy for future climate change adaptation.

Empowering Indigenous peoples through self-government and self-determination arrangements, including ownership and management of land and natural resources, is key to addressing the challenges of climate and other environmental and globalization changes (Fondahl et al., 2015). Increasingly, there are compelling reasons for the national governments of the Arctic states to work toward Indigenous peoples with the powers, resources, information, and responsibilities they need to adapt to climate change (Corell et al., 2019: 44).

The Arctic Climate Impact Assessment (ACIA, 2005) states that the vulnerability and resilience-building capacity engages various cultural perspectives. Corell et al. (2019) note: "*A reindeer herder will most likely define the vulnerability of their communities differently than would an outsider assessing the same socio-economic community. Evaluation of the exposure, sensitivity, and adaptive capacity of the human–environment system will require the scientific and Indigenous knowledge perspectives, observation, and participation of Indigenous peoples who are part of the human-environment system. These local perspectives can help identify important locally-oriented stresses, local human-environment challenges, and outcomes*

that they seek to obtain. Indigenous reindeer herders will inevitably identify changes in their cultural system, describe coping and adaptive capacities, monitor environmental and social phenomena and articulate their perspectives and findings" (Corell et al., 2019: 44).

Some Arctic peoples already have political and management systems that could assess the impacts of climate change. These systems allow local and regional governments to act and deal with its consequences: for instance, land claims in Alaska and Canada and the establishment of regional governments in Greenland and Nunavut (Corell et al., 2019). Such political changes change the ways of management of the living and non-living resources with more local involvement and decision-making authority at the local or regional levels. Eurasian Arctic Land Cover and Land Use in a Changing Climate study explored the interactions of the land-cover and land-use change in the Arctic which is experiencing the most profound consequences of global warming (Gutman and Justice, 2011). The climate warming in the Circumpolar North and the Arctic region affects both the landscape and human activities, and hence human dimensions are an important aspect of the topic (Maynard et al., 2010). Environmental pollution and climate warming produce irreversible damage to the Arctic ecosystems. State-of-the-art remote satellite sensing combined with GIS is used for monitoring current land-cover changes and potential scenarios for the future (Maynard & Conway, 2007).

Innovative co-management regimes that allow for the sharing of responsibility for resource management between Indigenous and other users in the Arctic states are allowing the nations of the Arctic region and Indigenous peoples of the North to manage and regulate resource use in a way that incorporates Indigenous views and traditional resource use systems (Heininen & Southcott, 2010). MEMA Database provides examples of documentation regarding the 'meaningful engagement' of the Indigenous and local communities in the Arctic. Indigenous communities, scientists, and policymakers can work together to tackle the Arctic climate change challenges and embrace the opportunities caused by globalization. The rapid change in the Arctic continues to pose new challenges to managing and regulating societies that live in the region leading to the following adaptation strategies in the reindeer herding societies:

Co-production of knowledge is an adaptation strategy in which the academia and Indigenous reindeer herding peoples can apply an ethical and systematic co-production framework for sustainable adaptation (Näkkäläjärvi & Juntunen, 2022; Stith et al., this volume).

Adaptation through feeding in winter. Reindeer are highly adaptable ruminants with digestive mechanisms that enable them to utilize large seasonal changes in the nutritional quality and availability of forage that are a characteristic of northern habitats (Mathiesen et al., 2005). Reindeer pastoralism in Norway was based on the sustainable use of natural pasture (Mathiesen et al., 2000). Especially in winter, when access to forage is restricted by crusted snow or ice, feeding has

been more common, and therefore the reindeer husbandry is adapting to new feeding strategies. The provision of small amounts of supplementary feed can improve survival in winter and increase the degree of tameness of the herd. The consequences of increased use of expensive feed for the resilience of the system have yet to be investigated (Johnsen et al., this volume; Mathiesen et al., 2022).

Adaptation through changing the herd structure. Reindeer herders have traditionally maintained a high phenotypic diversity in the herds. The Sámi concept of a "beautiful" reindeer herd – *čáppa eallu* – encompasses diversity, which reflects an adaptation strategy aimed at reducing vulnerability to the consequences of unfavorable and unpredictable conditions (Magga, 2006). In this way, the so-called unproductive animals have special roles, which contribute to the productivity of a herd: creating a serene atmosphere in the herd, digging up snow and icy crust, and improving animal welfare. For example, reindeer herds in Finnmark in the 1960s would include up to 50% of adult male reindeer, many of which were castrates. Today, reindeer herds in Finnmark have about 10% bulls. Another example of adaptation practice is castration. Castrated male reindeer do not come into a rut, are calmer, heavier, and are better at finding lichen in the snow. We suggest that the reintroduction of castrates in Norway could be a strategy for the survival of individual animals and the herd (Skum et al., 2016; Mathiesen et al. 2022). The adaptive consequence is the transition from calf slaughtering to the slaughtering of the 1.5 years old males and old females.

Adaptation through the protection of critical grazing land and migration routes. Adaptation involves maintaining nomadic pastoralism. A continuous loss of pastures and critical migration routes has and will lead to a situation in which there will always be "too many" reindeer and herders in an area. Movement beyond this negative focus requires lifting the general level of competence locally through research and training. This will also involve a paradigm shift in terms of the perception of and importance attached to reindeer herders' traditional knowledge and landscape management (Vistnes et al., 2009). It is important to develop courses in the training of Indigenous peoples to adapt to the degradation of grazing land.

Adaptation through an improved economy. For reindeer herders, adaptation is about securing their own control over the most valuable parts of their value chain (Krarup Hansen et al., 2022; Eira et al., this volume; Reinert & Oskal, 2022), Recently, Reinert et al. (2022) investigated the adaptation potential in *Entrepreneurship in a Changing Arctic*: by analyzing Siberian Reindeer Herders and access to the Northern Sea Route (NSR) and new markets. The researchers see potential in developing reindeer herding in the NSR region through the creation of local products rather than competing with imported industrial beef and pork production (Reinert & Oskal, 2022). Adaptation to an improved economy should include a strengthening of the family-based reindeer husbandry (Fig. 2.3).

Fig. 2.3 Adaptation to climate change in reindeer husbandry must include protection of grazing land and avoid blocking of migration routes and calving ground. (Photo: S.D. Mathiesen)

2.5 Institutions as Essential Elements of Addressing Change and Adaptation Strategies

Climate change, along with other environmental changes of significant importance, has brought forth a wide array of pilot projects and experimental programs as well as proposed actions, roadmaps, and pathways toward the future. These solution-oriented ideas have brought forth new initiatives by industry and businesses, actions to limit fossil fuel emissions, and studies of adaptation strategies at local and regional levels by Indigenous cultures and have raised significant political attention pro and con. The outlined below is posed as a potential framework that seeks to structure solutions in what might be called a "Solutions Space". This framework argues that there are five basic elements, inter alia, within which solutions to climate and environmental change might be more effectively managed and implemented, including:

Type 1 Solutions based on Enhanced Knowledge: Advancing knowledge and understanding by embracing and using both scientific and Indigenous reindeer herder's knowledge to frame the collective understanding of the future of the nexus between humans and the natural world and by structuring deeper understandings and monitoring, including comprehensive and integrative assessments which should include a master program in reindeer husbandry.

Type 2 Solutions based on Extending Adaptive Capacities: Developing enhanced and innovative adaptive capacities by understanding the consequences of the change and building resilience into natural and socio-economic systems in regions of reindeer husbandry.

Type 3 Solutions by Understanding Root Causes of Change: Identifying and addressing the root causes of the change and developing mitigation strategies and implementation practices together with the reindeer herders and Indigenous knowledge holders.

Type 4 Solutions that Inform and Extend Understandings: Change requires enhanced strategies and practices in reindeer husbandry that diffuse and communicate broadly fundamental causes of and strategies to build resilience in the Indigenous societies.

Type 5 Solutions that support Decision-Making: Develop methodologies and practices that support policy development, governance practices, and best-practice dialogue with appropriate real-time analysis of options and alternatives. One example is the GIS based "Reindeer Mapper" by NASA for Environmental observations by reindeer Herders (Maynard et al., 2010) and the Arctic Council Circumpolar Local Environmental Observer Network (CLEO).[2]

2.6 Future Adaptive Leadership

Climate and socio-economic change are now evident across the Arctic and are particularly evident in reindeer herding cultures and their traditional areas (McCarthy et al., 2005; Magga et al., 2011; Larsen et al., 2014) and will require immediate adaptive solutions for societal opportuni ties (Burgess et al., 2018). Reindeer herding cultures and their traditional knowledge are affected by institutional governance, economic conditions, and other regulatory practices. It is important to increase the flow of information and insights about Circumpolar reindeer herding and how resource conflicts could be avoided by including local Arctic societies and rights holders at an early stage of planning in the industrial development projects (United Nations Economic and Social Council (ECOSOC), 2012). Anthropogenic pressures on the reindeer pastures have reached a scale where abrupt global environmental change can no longer be excluded (Tyler et al., 2007, 2021).

Reindeer herding communities have challenges to develop their knowledge and insights into practical adaptation strategies. In Finland, reindeer herders report that forestry has massive impacts on reindeer husbandry. It has reduced the quality of pastures. "They have been logging everywhere. There is no lichen anymore! It is gone. We could only keep about 500 reindeer if they were left on their own. They would starve in January without supplementary feeding", one reindeer herder reported (Landauer et al., 2021). Supplementary feeding requires more time by reindeer herders in Finland, workforce, and money. For financial reasons – an economic tipping point – in particular, large-scale supplementary feeding is not always possible, only emergency feeding (Turunen & Vuojala-Magga, 2014; Landauer et al., 2021).

When a system of reindeer husbandry has lost its adaptive capacity and consequently reached its tipping point, it is described as a sharp or abrupt change in the climate variables or biological variables where one after the tipping point often enters a state that one cannot say in advance what will happen. With the

[2] https://oaarchive.arctic-council.org/handle/11374/2608

supplementary feeding of reindeer in Finland, there is the risk of diseases involved, and reindeer are becoming tame and more dependent on herders (Turunen & Vuojala-Magga, 2014). Landauer et al. (2021) note that this is how one of their interviewees perceives an economic tipping point which, in this case, is determined by the financial capacity to have supplementary feeding and workforce given that old-growth forests decrease due to extensive land use:

> It would be extremely costly to feed our 8,000–9,000 reindeer in this area, and it would also require an additional workforce. But if there are no arboreal lichen pastures, we must feed our reindeer. Reindeer have difficulties with digging in very harsh conditions when there is an icy snow cover. Arboreal lichen is the only natural forage in winter. If it disappears, we will reach a critical point in reindeer management in this area. (Turunen & Vuojala-Magga, 2014)

Yet expanding the number of herders is perceived as redundant because it results in the alternative tipping point. However, some might see this as a source of additional income (Heikkinen, 2006; Dana & Åge Riseth, 2011; Landauer et al., 2021).

Heifetz et al. (2009) explored the distinctive theory of adaptive leadership: Why is change difficult for example in Sámi reindeer husbandry in Western Finnmark in Norway? Many know the adage: people resist change. In fact, this is not entirely true. People do not resist change, per se; people resist loss (Heifetz et al., 2009). Change can involve various kinds of losses, yet when people know that change is good for them, they embrace it. In nature, adaptability requires variation because one never knows who, in a changing environment, has the capacity to take us into the future. In many businesses, for example, the biggest bottlenecks for growth and adaptability are often the quality and distribution of leadership. Our organizations and communities need distributing leadership, with and without authority (Heifetz et al., 2009).

Berkes & Jolly (2002) analyzed the adaptive capacity of Indigenous communities and featured integral long-term coping strategies of the Arctic Indigenous Peoples:

(1) group size mobility and flexibility; (2) seasonal harvest and resource cycles flexibility; (3) knowledge of the local environment; (4) networking and information-sharing mechanisms for risk mitigation; and (5) trade between communities (Berkes & Jolly, 2002). Arctic human and environment systems have a long history of coping with and adapting to social and natural changes (McCarthy et al., 2005).

In 2004, Arctic Council Ministerial meeting in Reykjavik, Iceland adopted the Arctic Climatic Impact Assessment (ACIA) where one chapter was written in co-production of knowledge with the team around Association of World Reindeer Herders (WRH) and Harvard University researchers: “Climate change in the context of multiple stressors and resilience” (McCarthy et al., 2005). One direct follow-up of the ACIA report was the Norwegian Government’s establishment of the International Centre for Reindeer Husbandry (ICR) in close cooperation with the Association of World Reindeer Herders in Kautokeino in 2005. It is an example of adaptive leadership that made it possible to lift the reindeer herders’ traditional knowledge in research, education, and development of adaptation strategies for reindeer husbandry.

Founding president of WRH Johan Mathis Turi has expressed reindeer herders' perspectives of adaptation in the following way:

> We have some knowledge about how to live in a changing environment. The term «stability» is a foreign word in our language. Our search for adaptation strategies is therefore not connected to «stability» in any form but is instead focused on constant adaptation to changing conditions. (Oskal et al., 2009)

Furthermore, Johan Mathis Turi has expressed his reflection on adaptation: "*At one of the Arctic Council meetings, the head of ACIA, Dr. Robert Corell, presented a preliminary report on climate change and its effects. For my part, I did not get much of what he said since I do not speak English as well. Eventually, however, he came up with a formula that was so simple and informative that even I began to sense the scope of what he was saying. It showed a universal concept of adaptation. It struck me then that this simple formula, which by the way looked like this:* ***V (vulnerability/raššivuohta) = I (impact/váikkuhus) – AC (adaptive capacity/heivehanmunni)*** *was an exact and precise description of the concept that reindeer husbandry has traditionally built its existence on. The most amazing thing about the formula, however, was that in all its simplicity it also contained instructions on the most common way to respond to changes"* (Mathiesen et al., 2007 as adapted from Turner et al., 2003).

The International Polar year 2007–08 (IPY) provided a clear mandate for the participation of Arctic Indigenous knowledge. Furthermore, the ICARP II conference in Copenhagen in 2015 concluded that there had been a paradigm shift in Arctic research towards a holistic and multidisciplinary approach, which includes the human dimension, Indigenous insights, and a more integrated understanding of the Arctic as part of the world (Eira, 2012a, b). IPCC (Larsen et al., 2014; IPCC, 2022) allowed authorship from Indigenous communities within the Arctic, which resulted in the IPY EALAT initiative – Reindeer Herders Vulnerability Networks Study, which brought forth new adaptive knowledge and insights (Eira, 2012a, b; Turi, 2016a, b; Magga et al., 2011; Maynard et al., 2010; Oskal et al., 2009) (Fig. 2.4).

Fig. 2.4 Indigenous reindeer herders from the Circumpolar North met in Guovdageaidnu for a joint training program on the use of traditional knowledge to protect biodiversity at the Sámi University of Applied Science and International Centre for Reindeer Husbandry (2017). (Photo: S.D. Mathiesen)

In 2020, the Association of World Reindeer Herders, the International Centre for Reindeer Husbandry, and the University of the Arctic EALÁT Institute signed a new agreement with the Belfer Center for Science and International Affairs at Kennedy School of Government at Harvard University to establish a platform for discussing the most pressing Arctic challengers, bringing together Indigenous and non-Indigenous stakeholders, and developing leadership training for Indigenous youth.

Emerging Indigenous leaders and Indigenous scholars across the Arctic as well as communities on the frontlines of Arctic climate change and globalization are working in three vital areas:

Arctic Indigenous Youth Leadership Seminar Program: in 2021, a joint effort by the International Centre for Reindeer Husbandry, the Arctic Initiative at the Harvard Kennedy School, the Association of World Reindeer Herders, Arctic Council Indigenous Peoples Secretariat, and the UArctic EALÁT Institute building on earlier cooperation, resulted in a training seminar for Indigenous leaders. Hold in memory of Professor James McCarthy and his strong dedication to the Arctic, the seminar addressed resilience, adaptation, and leadership, and aimed at competence and confidence building for Arctic Indigenous youth for a more sustainable future in the Arctic and beyond.

Arctic Knowledge Systems Study Group: Working with the Harvard Arctic Initiative and groups of Harvard graduate students investigating how especially traditional Indigenous knowledge and knowledge systems can strengthen society resilience (i.e., robustness towards shocks and crisis).

Arctic Resilience Forum: The Arctic Resilience Forum 2020, co-organized by the Arctic Council and the Arctic Initiative at Harvard Kennedy School's Belfer Center, hosted an Indigenous Youth Leadership session, which was focused on Indigenous resilience leadership, representing Indigenous youth leaders from Alaska to Yamal and linking with the ongoing EALLU project.

The Northern Sustainable Development Forum, a permanent international platform for discussing sustainable development in the Arctic and the High North, hosted an international seminar on the Intellectual Property Rights of Indigenous Peoples' Knowledge, Cultures, and Languages in the time of digitalization supported by the World Intellectual Property Organization (WIPO). The seminar discussed different types of knowledge of the Arctic Indigenous peoples including food heritage and new approaches to the adaptation in the Arctic concluding with the following needs:

1. to the Arctic Council to promote closer cooperation of all Permanent Participants on Indigenous peoples' intellectual property issues.
2. to develop more specific international legal norms regarding intellectual property, protection of the use of traditional knowledge, and other elements of culture, taking into account the specifics of the Indigenous peoples' knowledge.
3. to the scientific community, when documenting the traditional knowledge of Indigenous peoples, obtain the prior and informed consent of native speakers of the language and culture, which reflects a specific intention to use the materials received.
4. to conduct workshops on the protection of intellectual property rights of Indigenous peoples with the WIPO support. (International Centre for Reindeer Husbandry, 2021)

Both scientific, traditional, and Indigenous experience-based knowledge, knowledge transformation, education, and training of the future Arctic leaders are key factors for the future sustainability of reindeer herders' societies and their adaptation (United Nations Economic and Social Council (ECOSOC), 2012). It is imperative that all available forms of knowledge are included when developing adaptation strategies to climate change in reindeer husbandry. Renewable industrial activities and new strategies for ecosystem services in the Arctic must respect the rights of Indigenous reindeer herders. The Indigenous peoples of the Arctic must be awarded the possibility to adapt to the changing environment and seek sustainable societal opportunities.

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