Challenges to Adaptation in Northernmost Europe as a Result of Global Climate Change

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Global warming will continue, and the Arctic is expected to warm at twice the global average rate (Intergovernmental Panel on Climate Change 2007). The most pronounced changes will occur during winter with increased precipitation, more precipitation falling as rain, and a

shorter snow period (Intergovernmental Panel on Climate Change 2007; Roderfeld et al. 2008). These changes will have far-reaching consequences for ecosystems and for the people dependent on their services and may serve as an indicator of environmental change and an “early warning system” for other parts of the world (Arctic Climate Impact Assessment, Symon et al. 2005). We assessed the likely changes in the provision of goods and services from natural and seminatural ecosystems (i.e., excluding urban, industrial, and agricultural land) in the Barents region—the northern parts of Norway, Sweden, and Finland, and northwestern Russia—as a consequence of anticipated climate changes during the twenty-first century. This region includes approximately six million people in an area the size of France, Portugal, Spain, and Germany together, totaling 1.75 million km²; 75% of the territory and population is Russian. Several indigenous peoples and minority groups, such as the Sami, Nenets, Vepsians, and Komi, live in the region (Barents Information Service 2008).

Globally, the Barents region is the Arctic region that is the most geographically complex with the most infrastructure and great cultural, social, and political heterogeneity. Its economy depends heavily upon the extraction of natural resources (Barents Information Service 2008). We foresee that many provisioning ecosystem services, including forestry, hunting, fishing, and gathering, will improve as a result of, for example, the higher survival and reproduction of the populations of many species, whereas other services will deteriorate due to habitat loss, invasion of nonnative species, and altered species interactions (Chapin et al. 2006). Regulating services, such as water cycling, will also change, with a predicted increase in discharge, leading to the potential production of more hydroelectricity (Lehner et al. 2005). Human societies should be able to cope with most of these changes by

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drawing on existing global knowledge. However, effects of climate change will interact with other large-scale developments, such as urbanization, globalization, increasing resource demands, and increasing risks of pandemics, leading to synergistic effects that will affect subsistence-dependent local and indigenous communities and modern societies differently. Such a “double exposure” is likely to challenge people’s adaptive capacity and produce both winners and losers, depending on the access of different groups to resources for adaptation (O’Brien and Leichenko 2000).

Global climate change will also produce threshold effects or “tipping points” (Lenton et al. 2008) of major importance for the Barents region. The foremost example is the melting of the polar ice cap, leading to predictable access to the Northern Sea Route (Fig. 1). This will greatly increase the potential for extraction of previously inaccessible resources in the far north. Transport costs between Europe and Asia could be reduced by as much as 50% compared to the currently used shipping lanes via Suez or Panama (Ragner 2008), with the added benefit of safety from piracy. Increased transport in the region may bring both economic benefits and increased pollution risks. Effects of thawing permafrost on infrastructure and shortened seasons for winter ice roads could create additional detrimental threshold changes, particularly in remote Russian fishing communities that depend upon airports and winter roads for their communication (Keskitalo and Kulyasova 2009). Warming winters and high fuel prices might effectively isolate these communities, making sustainable living difficult. Many of these communities are not connected to public electricity lines, but depend on local mini-power stations that run on oil (Keskitalo and Kulyasova 2009). The low capacities of these stations and high costs of oil and oil delivery make food storage during winter reliant on below-freezing weather. Warm winters and winters with frequent thaws may ruin stored food and make societies more vulnerable (Keskitalo and Kulyasova 2009). Large-scale trawler and transport companies may benefit from changes in climate, whereas local communities are more negatively impacted. Resource extraction, such as forestry, mining, and oil and gas drilling, will also become feasible in new areas with a warmer climate, posing additional problems for local subsistence-based communities, whose land use may become increasingly restricted by, for example, mine spills and pipelines (Meschtyb et al. 2005).

Despite major changes to natural conditions and challenges to the current ways of living, the Barents region may remain a fairly hospitable and benign living environment in a global context (Parry 2000). It has the potential to be politically stable, harboring more people than today and offering relatively abundant natural resources. Changes in

Fig. 1 Map showing the distance reduction offered by the Northern Sea Route compared to the current route (modified from a presentation of new sea routes following global climate change, which is available at <http://maps.grida.no/go/graphic/northern-sea-route-and-the-northwest-passage-compared-with-currently-used-shipping-routes>). The location of the Barents region (shown in brown) is indicated by the blue ellipse

this region will probably be affected to an increasing extent by changes in climate and land use and political instability elsewhere. For example, it is likely that climate change refugees (Sachs 2007) will move from, for example, southern Europe where water shortage and heat surplus cause living conditions to deteriorate (de Wrachien et al. 2006). For similar reasons, tourism destinations may change from southern to northern Europe (Bigano et al. 2006). Such immigration could potentially reverse present trends of urbanization and farmland abandonment in the Barents region. However, increasing populations may also lead to increased exploitation and fragmentation of natural resources and increased conflicts with local use. The practice of indigenous reindeer husbandry, for instance, traditionally requires extensive areas for natural grazing and migration and may be threatened by increasing fragmentation due to competition with other uses. The fragmentation of areas and increasingly intensive forestry also pose questions for long-term biodiversity conservation (Keskitalo 2008).

The high vulnerability to climate change and natural resource extraction of people who depend on local ecosystems is not unique to the Barents region. The problems now emerging in the Arctic are also relevant to the rest of the world, where poverty and high population densities in many regions further restrict adaptive capacity (Varis 2006). We deduce five strategies that we believe are necessary for society to adapt to these new conditions: (i) Adaptive conservation of natural ecological communities that facilitate species movements. The current system of isolated nature reserves must be turned into a network by adding new reserves and ensuring that interreserve connections are available (Hannah 2008). Simultaneously, measures must be taken to make sure that exotic species are

not favored. (ii) Increased observation and monitoring of the societal consequences of climate change as a basis for planning adaptations to change. Difficulties in pursuing adaptation strategies may be great for those who place strong cultural and social importance on traditional uses of ecosystem resources; therefore, observation is important (Nuttall et al. 2005). (iii) Maximization of adaptive capacity in social systems. Presently, many extractive industries (e.g., commercial forestry) tend to use standard solutions in their activities. A variation of management techniques, tailored for specific needs, and a prioritization of efforts to particularly vulnerable areas, will increase the potential for adaptive responses to surprises (Beier et al. 2008). (iv) Cross-sector, adaptive learning [i.e., sustainability learning (Tàbara and Pahl-Wostl 2007)] about climate change and its effects. Many problems caused by climate change can be overcome by sharing experiences and by developing and sharing technologies. These last two strategies depend particularly on national priorities, for instance, regarding infrastructure development and its interaction with environmental protection. (v) Increased partnerships across the entire region as a means of avoiding conflicts or solving them at an early stage. Coordination across sectors and levels may support early responses to changes and avoid situations where local and indigenous peoples bear the burdens of global change but are unable to reap any benefits.

The global community could benefit from the northern European experiences in developing regional climate adaptation strategies. Warming of this region was documented early and has been stronger than the global average (Intergovernmental Panel on Climate Change 2007), making it a suitable testing ground for climate change adaptation. The future of the Barents region depends on both internal and external factors. Global climate change will lead to increased pressures on its resources, and new transport routes will make the region as a whole more accessible, but will also imply that some of its parts will become more isolated with less sustainable communities. Resource use in the Barents region also has a global responsibility. For example, it is vital that this region, as an important producer and consumer of greenhouse gases, joins global efforts to reduce greenhouse gas concentrations by, for example, using energy-efficient technology and renewable energy sources and by developing environmental management strategies that enhance carbon sequestration. The application of such technology could support both local adaptation and mitigation with larger-scale benefits. Continued warming of the Barents region also has repercussions on global climate through positive feedbacks resulting from a lower reflectance of solar radiation with less ice and snow and release of stored

carbon in melting permafrost and marine deposits (Lenton et al. 2008).

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