Widening the Scope of Responses to Environmental Concerns in the High North: Arctic Countries' Policies and the Role of China

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With the progressing exploration of the Arctic as a resource base and trade corridor between the continents, the region is experiencing changes that fundamentally affect the environment, biodiversity, and people. The once established patterns are transforming and bringing new potential risks to the sustainable development of the region. Due to the industrialization in many northern territories, air, water, and soil pollution have been emerging as threats to ecosystems and public health. For those countries that now launch industrial projects in the Arctic, there is a challenge of how to converge the economic benefits with the urgent need for environmental protection. In this chapter, the authors review current policies and potential responses to environmental challenges contained in the national development strategies of Canada, Denmark, Finland, Iceland, Norway, Russia, Sweden, and the USA. Among non-Arctic countries, China has emerged as one of the prominent actors in the region, including in the spheres of industrial development and shipping. Other countries also show ever-deeper environmental concerns, but progressing climate change in the High North is not an issue to be solved by any country acting alone. It is of emerging global concern with the broader community of Arctic and non-Arctic countries having a mutual interest in cooperation to ensure the protection of fragile ecosystems and sustainable development of the region. Using China as an example, the authors discuss how non-Arctic states may contribute to the solution of environmental problems in the High North. The study analyses existing international and national approaches to environmental protection and climate change issues in the Arctic. It discusses how varying interests of Arctic states, from one side, and China, from the other, could be translated into effective international policies for the benefit of sustainable development of the region.

Introduction

The Arctic is changing in many ways with the climate being one of the most dramatic transformations in the past years. According to the Arctic Monitoring and Assessment Programme [AMAP] (2019), the annual average Arctic surface air temperature has increased by 2.7°C since 1971 (AMAP, 2019: 3), while the September average volume of sea ice has declined by 75% since

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1979 (AMAP, 2019: 4). Climate change in the Arctic is largely related to global warming, the latter being triggered by air pollution (Norkina & Van Canegem, 2020). In terms of various anthropogenic emissions, the world's biggest contributor to climate change is China with 27% of global emissions of greenhouse gas (Olivier & Peters, 2018) and about 20-24% of global emissions of black carbon (United Nations Environment Programme [UNEP], 2015).

Although it is difficult to assess the amount of pollution coming to the Arctic specifically from China (Kopra et al., 2020), it is clear that progressing warming may result in a reduction in the area and thickness of sea ice, melting of permafrost, shifting boundaries of the forest zone, transformation of ecosystems, and degradation of landscapes. Due to excessive air pollution, chemicals accumulate intensively in the trophic chains of terrestrial and aquatic Arctic ecosystems and are concentrated in the bodies of long-lived carnivorous mammals, birds, and fish. This creates prerequisites for the long-term effects of chemical pollution in Arctic ecosystems, including the death of offspring, the reduction or extinction of populations, and the depletion of fauna. Currently, the critical pollutants in the trophic chains of the Arctic ecosystems are organochlorine hydrocarbons. They are herbicides, insecticides, fungicides, and industrial chemicals (carbon, chlorine, and other products of transformations occurring in technological processes and side reactions in the environment) that disrupt the hormone balance of animals, birds, and aquatic organisms (Rosińska, 2019; Macías-Zamora, 2011). Bioaccumulation of such contaminants is associated with ocean pollution, long-range transboundary air pollution, aerosol deposition, as well as bird migrations. Arctic ecosystems are highly susceptible to global and regional transport of substances. Global pollution is primarily associated with the Gulf Stream, river flow, and atmospheric transport. Regional ones have their specifics in each country, but in general, they are the consequences of toxicant emissions by industrial enterprises, shipping, military and industrial waste, oil and gas production in coastal areas, as well as the exploration and development of oil and gas fields.

For over a decade by now, China has been actively implementing various domestic policies to reduce the growth of emissions of greenhouse gases and other pollutants. The Greenhouse Gas Emission Reduction Plan (China Briefing, 2012) aimed to reduce the amount of carbon emitted per unit of GDP by 17% by 2015 compared with 2010. China has taken part in a variety of international negotiations and partnerships on climate change, including the United Nations Framework Convention on Climate Change, the Kyoto Protocol, and the Paris Agreement (Koivurova et al., 2019). In 2016, China ratified the Kigali Amendment to the Montreal Protocol aiming to reduce the climate impact of hydrofluorocarbon gases (Science Daily, 2020). In 2018, China introduced an action plan to meet "ultra-low emission" standards in steel production (China Power, 2020). The power grid system has been actively transitioning to the use of natural gas instead of coal. Furthermore, China has made serious efforts to develop its renewable energy sector. As a result of these actions, by 2018, China had managed to reduce carbon intensity by 45% and raise the share of non-fossil fuel energy sources to 15% compared to 2005 levels (China Power, 2020).

Despite the efforts on reducing emissions of greenhouse gases, persistent organic pollutants, and other climate change forcers, Chinese companies have been blamed for negatively affecting Arctic habitats, including in Greenland, Russia, northern Europe, and Canada (Sidorov, 2018; Lajeunesse, 2018; Erokhin et al., 2019; Kopra et al., 2020). The increasing shipping activities of Chinese operators in the Arctic Ocean are also viewed as a threat to marine ecosystems and air quality in the Arctic (Kopra et al., 2020). Among the risks are oil spills, emissions of pollutants into the air and water, oil spills during loading, unloading, bunkering, or as a result of emergencies. In its Arctic policy, China advocates stronger international cooperation in environmental protection, energy conservation, emissions reduction, low-carbon development, and tackling climate change in the Arctic (State Council of the People's Republic of China, 2018: article IV.4). However, the development and implementation of such cooperation should take into account both the global challenges of controlling climate change in the Arctic and individual priorities of Arctic countries (as well as China itself) in concentrating their efforts and resources in certain areas of the environmental agenda. This chapter aims to address major environmental problems in the Arctic across the spheres of climate change, industrial pollution, shipping, living resources, and habitats and populations of various species of flora and fauna. The authors explore how the international community in general and Arctic countries in particular approach to responding to the above-mentioned environmental problems in their strategies, policies, and regulations. The article concludes with an analysis of intersections between China's and Arctic countries' priorities in environmental protection and climate change responses in the Arctic.

Major environmental challenges in the Arctic

According to the United Nations Environment Program (UNEP) (n.d.), the environmental problems of the Arctic are grouped into several main areas: oil pollution of the Arctic seas; climate change leading to ice melting; extensive fishing and seafood production; changes in the habitat of flora and fauna and reduction of animals' populations; and intensive shipping. These five points are detailed in the following sections.

Oil spills and industrial pollution

Arctic territories and offshore waters of the Arctic Ocean seas are increasingly being developed by oil-and-gas and other resource companies (Blaauw, 2013; Batin et al., 2015). In many regions, especially in the Russian sector of the Arctic as the most developed in industrial terms, negative environmental processes lead to the transformation of the natural geochemical background, atmospheric pollution, degradation of vegetation, soil pollution, and introduction of harmful substances in food chains. Industrial pollution in the Arctic affects the safety of the river and marine ecosystems, as well as the health of Indigenous populations. Only with river runoff, several hundred thousand tons of oil products are taken out to the Arctic Ocean annually. This problem is particularly critical in Russia, where intensive resource development projects are being carried out. Air masses from the continent are transported to the High North, bringing nitrogen and sulfur oxides. Acid rains negatively affect the health of people and animals.

In a cold climate, the risk of accidents increases significantly whereas the possibilities for the elimination of consequences decrease (Fadeev, 2012). On the Arctic Ocean shelf, even a small leak of hydrocarbons into ice-covered water areas can lead to significant environmental damage. On May 29, 2020, in Norilsk, Russia, there occurred a spill of over 20,000 tons of diesel fuel, with part of it flowing into the Ambarnaya and Daldykan rivers. According to Greenpeace (2020), this is one of the most massive environmental disasters in the Arctic in the past few decades. It is comparable in scale and consequences with the accident that occurred in 1989 off the coast of Alaska when the wreck of the Exxon Valdez tanker spilled 37,000 tons of fuel into the ocean. In

Norilsk, the pollution covered the total area of 180,000 square meters. The damage is estimated at $86 million, while it is still difficult to assess the long-term impact caused to the soil and air. Diesel fuel is more toxic than oil and contains chemical compounds that are not captured by treatment facilities. According to Knizhnikov (RBC, 2020), Blokov (Greenpeace, 2020), and some Russian environmental experts working at the site of the accident, the diesel will dissolve in the water, remaining there for a long time. In a cold climate, where nature is slower to respond to oil spills, the effects of the latter on the environment may be observed for years, causing permanent losses of fish and other aquatic organisms and thus degrading traditional sources of the food supply in Indigenous communities in the long run.

There is growing evidence of contamination from industrial pollution in the Arctic (Davis, 1996; Macdonald et al., 2000; Kurgankina et al., 2020). The ecosystems are affected by the emissions and effluents from industrial enterprises and public utilities (Arnold et al., 2016; Law et al., 2017; Recio-Garrido et al., 2018), products of hydrocarbon processing (Fang et al., 2018), heavy metals and other wastes from metallurgical production (Caputo et al., 2019; Khan et al., 2019), microplastics and marine litter (Abate et al., 2020; Martinez et al., 2020), certain toxic substances (phenol, ammonia, and others) (Lee et al., 2019; Skaar et al., 2019), numerous pollutants from military sites (Koch et al., 2005; Brown et al., 2014; Hird, 2016), and waste from nuclear-powered vessels (Sarkisov, 2019; Karcher et al., 2017; Huang et al., 2020). In conditions of ultra-low temperatures and the shielding effect of permafrost, pollutants can have a long-term negative impact on peoples, fauna, and flora.

Ice Melting

Climate changes observed in the Arctic in recent decades may lead to the reduction of the ice cover and the expansion of the navigation window. According to the Intergovernmental Panel on Climate Change (IPCC) (2013), the global average temperature increased by 0.85°C during 1880-2012. In the polar regions, however, the increase has been much more noticeable, especially in recent decades, reflecting new prospects for commercial cargo shipping and research due to climate change (Cavalieri & Parkinson, 2012; Stroeve & Notz, 2015; Ng et al., 2018). Observations show significant fluctuations in the ice cover across the Arctic Ocean (Landy et al., 2016; Tschudi et al., 2016). In 1979-2019, the September minimum ice spread decreased significantly – by 87.2 km^2 or 13.3% every decade (National Snow and Ice Data Center [NSIDC], 2016). The record low in September 2012 was 3.41 million km^2, or just 54% of the average low in 1981-2010 (Liu et al., 2016). In addition to the reduction of the spread of ice, Lindsay and Schweiger (2015) report an increase in the proportion of thinner and younger ice in the overall structure of the Arctic Ocean ice cover (Figure 1).

The average annual temperature in the Arctic is increasing, which affects the processes of ice formation, growth, constancy, and movement throughout the year. Side processes are also triggered, which have an equally noticeable and non-linear growing influence on the ice cover. For example, melting ice increases the area of open water, which has a lower coefficient of reflection of sunlight compared to ice. As a result, the absorption of solar heat in open water zones increases, the surface water temperature increases, which causes a cyclical process of ice melting (Parkinson, 2014). This effect of global warming works both in seasonal and long-term perspectives: warming of surface water layers postpones autumn freezing, thereby reducing the period of ice growth. As a result, the next year, the ice layer is thinner and more prone to early splitting (Serreze & Barry, 2011). However, despite the apparent relief of the ice situation occurring in the Arctic, it should not be unambiguously identified with the improvement of conditions for shipping.

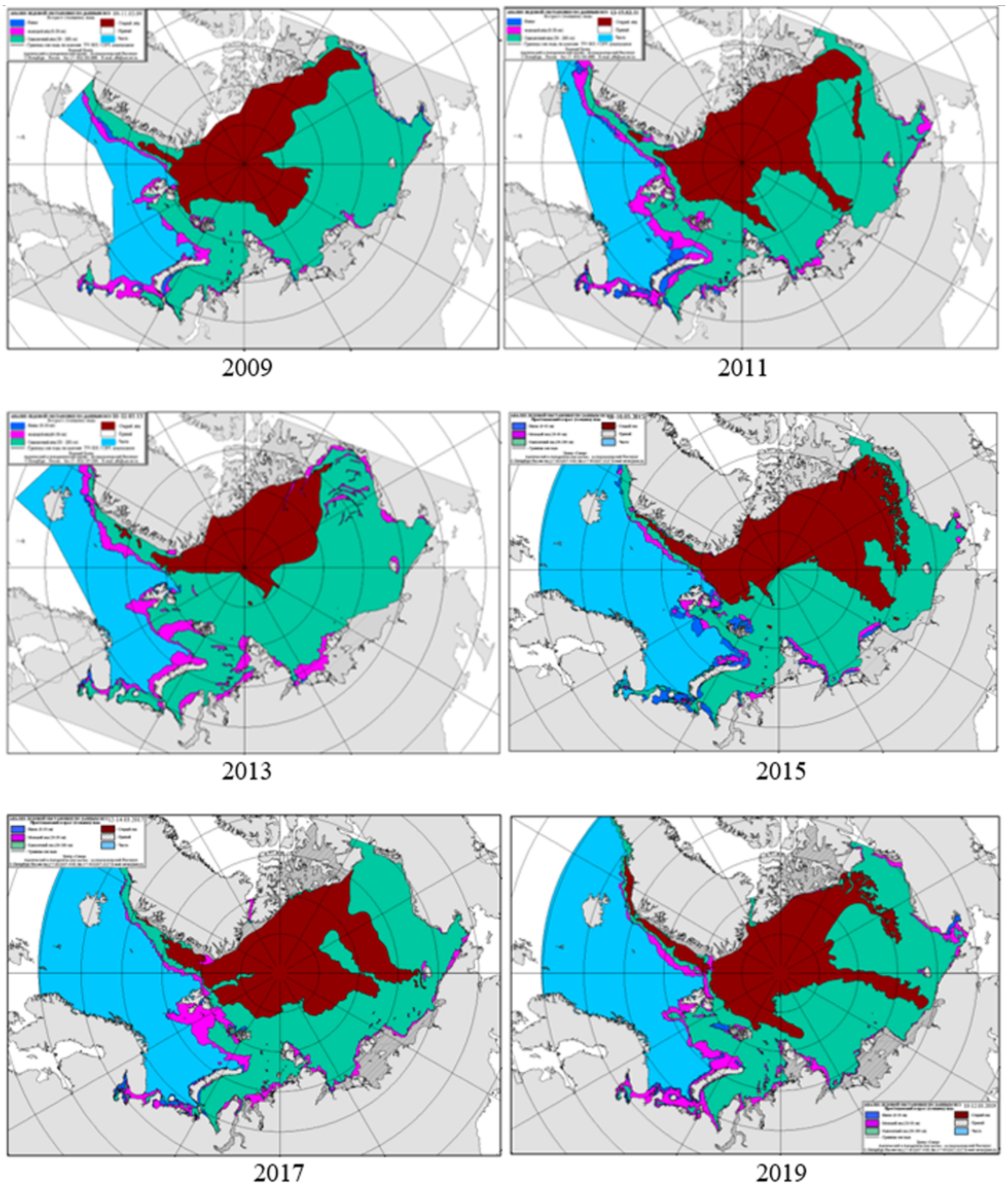

Figure 1. Ice distribution in the central part of the Arctic Ocean during peak periods (March) in 2009-2019
Note: light blue – open water, blue – nilas ice (0-10 cm), purple – newly-formed ice (10-30 cm), green – first-year ice (30-200 cm), brown – multi-year ice, gray – fast ice.
Source: Authors' development based on the Arctic and Antarctic Research Institute [AARI] (n.d.)

Dynamic forces affecting the ice or icebergs breaking off from glaciers pose serious risks to the establishment of stable and secure shipping routes. In some zones of the Arctic Ocean, dynamically deformed annual ice can reach 5-7 meters in thickness (Landy et al., 2016). This complicates or completely blocks the passage of vessels, especially in narrow straits. To the north of Greenland and in the waters of the Canadian Arctic Archipelago, currents press ice, and the thickness of the ice cover reaches the world's maximums (Melling, 2002). Drifting ice is also a danger. Due to the decrease in the thickness of the ice cover and its area, the ice becomes more mobile, the speed of drift increases, and the behavior of the ice becomes more dynamic and less predictable (Rampal et al., 2009).

Increase in marine fisheries

Ice melting frees up a significant part of the Arctic Ocean for fishing. During warmer seasons, fish and other marine populations increase in the Barents, Norwegian, and Greenland seas. This applies primarily to cod, haddock, perch, halibut, herring, whiting, and other species. At the same time, their range is expanding in eastern and northern directions (Zilanov, 2015). Rayfuse (2019) warns that an expansion of unregulated fishing may wipe out particular fish species or entire fish stock. The extensive removal of fish from food chains may harm many species, including marine mammals and birds. Improper monitoring and lack of international research may result in overfishing of harvested species and may undermine the economic integrity of the ecosystem. Diminishing fish stock in the Arctic seas may have a negative consequence for Indigenous peoples, for whom fish and marine mammals are subjects of subsistence harvesting (Muir, 2010).

Regularly, fishing is carried out by Norway, Russia, Iceland, the Faroe Islands, Greenland, and some of the EU countries. The central part of the Arctic Ocean is located outside the exclusive economic zones of the five Arctic states (Canada, Denmark, Norway, Russia, and the USA) and is thus considered as an open sea where any country can fish. In 2015, Canada, Denmark, Norway, Russia, and the USA signed the Agreement to Prevent Unregulated High Seas Fisheries in the Central Arctic Ocean (CAOFA). In 2018, the agreement was extended to include China, Japan, South Korea, Iceland, and EU countries (EUR-Lex, 2018). According to the CAOFA, each signing party allows vessels under its flag to conduct commercial fishing in the Central Arctic only in accordance with measures for sustainable management of fish stocks taken by regional or sub-regional fisheries management organizations. Taking into account the current lack of commercial fishing in the central part of the Arctic Ocean (Schatz et al., 2019), there is no clear indication yet as to the immediate success of the agreement. Moreover, the likelihood of the rapid growth of commercial fisheries in the Central Arctic is low even in 2034 until when the CAOFA is valid. Vylegzhanin et al. (2020) underline the reliance of the CAOFA on a precautionary approach, while Rayfuse (2019) considers the agreement as "an initial framework for environmentally sound decision making regarding the potential for future fisheries". In a few years, it remains to be seen whether the CAOFA is applied correctly by all signing parties and allowed to ensure the conservation and sustainable use of fish stocks.

Habitat change and population decline

Rising sea level as a result of climate warming and ice melting leads to the desalination of surface water and an increase in primary productivity of the Arctic seas. Besides, global warming triggers the invasion of alien species into the northern ecosystems. As a result, the characteristics of the habitats of both marine and land animals change. According to the Organization for Economic Cooperation and Development (OECD) (2016), there are seven critical environmental threats to marine ecosystems in the Arctic (Table 1).

Table 1. Main environmental threats to Arctic marine ecosystems until 2050

Environmental threat	**Impacts on ecosystems and potential economic losses**
Sea level rise as a result of climate change and ice melting	Flooding of low-lying coastal areas and wetlands, erosion of coastal areas, increased flooding in other areas, increased salinity of rivers, bays, and aquifers. The threat of damage to harbors and ports due to rising sea levels. According to the OECD (2016), total economic losses could reach $111.6 billion by 2050 and $367.2 billion by 2100.
Increase in temperature and freshening of surface waters due to glaciers melting	Significant changes in the lower/middle trophic chains and fluctuations of the quantity and quality of food resources at higher trophic levels.
Increase in primary productivity of the Arctic Ocean and the North Atlantic seas	Reduced proportion of stocks of valuable commercial species in the structure of biodiversity, significant modification of technologies for extraction of biological resources.
Invasion of alien species	
Loss of marine biodiversity	Currently, 550 species of fish are endangered. The rate of biodiversity loss will continue to increase.
Marine pollution	Marine ecosystems are under pressure from more than 300 chemicals classified as the most dangerous, as well as plastics and microplastics. They cause changes in the physical, chemical, and biological characteristics of marine and coastal zones that affect the quality, productivity, and sustainability of marine ecosystems. Pollutants can undermine the immune system and reproduction capacity of marine species, their resistance to other anthropogenic stressors, and contribute to the shifts in the ecosystems.
Acidification of the world's ocean waters	The increase in carbon dioxide emissions and climate warming causes an increase in the acidity of ocean waters, a gradual increase in the concentration of inorganic carbon, a decrease in the pH of waters, and their saturation with calcium carbonate.

Source: Authors' development based on OECD (2016)

With the current rates of pollution and climate change remaining constant, the OECD (2016) predicts the increased pressure on Arctic ecosystems from chemical pollution, affecting their health, productivity, and sustainability. Pollution undermines the immune system and reproduction of all Arctic animal species. There are changes in the functioning of ecosystems, the consequences of which are global and long-term (Titova, 2016). One of the major threats is the expected increase in acidification of marine waters, a factor of physical and biological changes in ecosystems. The extinction of entire populations of animals, birds, and fish is also a significant environmental problem. To a certain extent, this is due to a sharp change in climate and habitat conditions. According to the Conservation of Arctic Flora and Fauna (CAFF) (n.d.), mammals, birds, and fish living in the High Arctic experienced an average 26% drop in their populations between 1970 and 2004 due to the loss of sea ice. Arctic grazing species have declined by 20% between 1985 and 2004 (CAFF, n.d.). For many bird species, widespread and accelerating declines in population have been observed by Smith et al. (2020), Fuglei et al. (2020), Goyert et al. (2018), and Amundson et al. (2019). According to Taylor et al. (2020), 57% of bird species in the Arctic had at least one population in decline, while for 21% of species, all populations were declining. In the case of mammals, Cuyler et al. (2020) found that six muskoxen populations had been declining since the

2000s. The two of six with steepest declines used to be the largest endemic populations in the world as recently as two decades ago (Taylor et al., 2020). Lemming populations declined in Russia and outside Fennoscandia at the southern edge of their distribution (Loarie et al., 2009; Ehrich et al., 2020) due to more frequent melt and freeze events in winter caused by climate change (Kausrud et al., 2008; Berteaux et al., 2017). The occurrence of irregular winter conditions is recognized as one of the major reasons for the Peary caribou population decline (Langlois et al., 2017; Kaluskar et al., 2019), as well as habitat shifts in polar bears populations (Watson et al., 2019). Other important factors of habitat change and biodiversity loss in the Arctic are poaching, industrial development, urbanization, and increased shipping (Peck et al., 2018; Yurkowski et al., 2019).

Intensification of shipping

Currently, most ships operating in the Arctic use heavy fuel (up to 75% of all fuel), which is dangerous for the environment (Cariou & Faury, 2015). As a result of its combustion, soot gets into the air and then condensates on ice and snow thus contributing to greater absorption of solar energy and ice melting. As the reflectivity of water and ice surfaces decreases, they absorb more and more energy, which contributes to the strengthening of the greenhouse effect and progressing warming. In the case of Norilsk and other catastrophes, we see that fuel spills cause serious damage to the entire ecosystem, including people. Because of its viscous consistency, fuel oil is practically insoluble in water and has a detrimental effect on birds and marine mammals.

Since the 2010s, there has been a search for ways to restrict and ban the use of heavy fuel in Arctic shipping. The Arctic Council's Working Group on the Protection of Arctic Marine Environment (PAME) conducted a comprehensive assessment of the impact of shipping on Arctic ecosystems and the threat of accidental oil spills in 2009 (Arctic Council, 2009). Further, the comprehensive three-staged PAME study on the use and carriage of heavy fuel in Arctic shipping in 2011-2016 (PAME, 2011, 2013a, 2013b, 2016a, 2016b), has resulted in the IMO's proposal to ban the use of heavy fuel in the Arctic. According to the IMO's Sub-Committee on Pollution Prevention and Response, the ban is expected to be adopted in 2020 and will come into force on July 1, 2024. However, some vessels, especially those with a double hull, will be able to continue using heavy fuel until 2029. Also, for the Arctic littoral states, it will be possible to issue special permits for individual vessels using heavy fuel also until 2029.

Responses to environmental problems in the Arctic

To unify approaches to solving the above-mentioned environmental problems, the issues of conservation and protection of the Arctic ecosystems are addressed at the international, bilateral, and national levels (Khludeneva, 2016).

International legislation in the sphere of environmental protection

At the international level, environmental challenges in the Arctic have been addressed since the 1960s. Since then, a comprehensive framework of multilateral agreements has been established, including:

- International Convention on Civil Liability for Oil Pollution Damage 1969 (International Maritime Organization [IMO], 1969).

- Convention on Wetlands of International Importance Especially as Waterfowl Habitat 1971 (International Union for Conservation of Nature [IUCN], 1971).
- Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter 1972 (IMO, 1972).
- Declaration of the United Nations Conference on the Human Environment 1972 (United Nations [UN], 1972).
- Convention on Long-Range Transboundary Air Pollution 1979 (United Nations Economic Commission for Europe, 1979).
- United Nations Convention on the Law of the Sea 1982 (UN, 1982).
- Convention on Biological Diversity 1992 (UN, 1992a).
- United Nations Framework Convention on Climate Change 1992 (UN, 1992c).
- The Rio Declaration on Environment and Development 1992 (UN, 1992b).
- Kyoto Protocol to the United Nations Framework Convention on Climate Change 1992 (UN, 1997).
- Stockholm Convention on Persistent Organic Pollutants 2001 (UN, 2001).

International conventions set out the general requirements applicable to the protection of Arctic ecosystems. These are, in particular, the measures for the protection of wetlands established by the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (IUCN, 1971), the measures to combat pollution of the marine environment from waste discharges, as set out in the Convention on the Prevention of Marine Pollution by Dumping of Wastes and Other Matter (IMO, 1972), and the measures for the conservation and sustainable use of biological diversity envisaged by the Convention on Biological Diversity (UN 1992a).

The international framework for the protection of the Arctic environment is supplemented by the measures stipulated in legal acts and agreements concluded between the Arctic states, for example:

- The 1973 Agreement on the Conservation of Polar Bears between Canada, Denmark, Norway, the USSR, and the USA (Polar Bear Range States, 1973).
- Arctic Environmental Protection Strategy 1991 (Arctic Council, 1991).
- Declaration on Environment and Development in the Arctic between Arctic Council member countries (Arctic Portal, 1993).
- Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic between Arctic Council member countries (Government of Canada, 2013).

These agreements develop and specify the provisions of universal international treaties to ensure that the natural and other features of the Arctic region are taken into account. As a rule, they are concluded within the framework of the Arctic Council between all member countries, and then implemented under the supervision of the relevant working groups. During its existence, working groups of the Arctic Council have prepared many guidelines and reports on such areas as biodiversity, development of offshore oil and gas fields, safe transportation of oil in Arctic waters, and spills of oil and other dangerous and toxic substances.

Environment-related policies and strategies of Arctic states

The recommendations made by the Arctic Council are not binding. Therefore, the key role in shaping responses to environmental concerns in the Arctic is played by national environmental policies. They address various aspects of both international and country-specific activities, including prevention of pollution of the Arctic marine environment from various sources, creation of Arctic marine and coastal specially protected natural territories, prevention of negative impact on Arctic natural resources, and promotion of effective participation of indigenous people in the rational use and protection of the Arctic environment. Given the above outlined five major environmental concerns, the following sections discuss policies and responses to current environmental challenges contained in the Arctic-related development strategies and documents of eight Arctic Council states.

Canada

Canada's Arctic legislation has changed significantly over the past decades. In 1985, the approval of the Arctic Water Pollution Prevention Act (Government of Canada, 1985) meant to create a legal framework for regulating shipping, economic activities, and marine pollution and for protecting the Arctic marine environment. The Act provides for administrative and civil liability, and economic sanctions against entities that pollute the marine environment. The Act also contains a clause that regulates and controls activities in all Arctic territories of the country. Canada's Arctic strategy has been updated since the early 2000s. In 2019, Canada's Arctic and Northern Policy Framework (ANPF) (Government of Canada, 2019) was approved. Similar to previous Arctic-related documents, it emphasizes the importance of climate change responses, environmental protection, environmental management, and biodiversity conservation in the vast northern territories of the country. In the Canadian Arctic, the annual temperature is rising 2-3 times faster compared to the global average (Bush & Lemmen, 2019), which poses a significant threat to the population, infrastructure, and ecosystems (Government of Canada, 2019). Najafi et al. (2015) and Zhang et al. (2019b) attribute at least half of the observed warming to the anthropogenic activity, particularly, to human-caused emissions of greenhouse gases. Climate change is projected to affect northern parts of Canada more than southern ones, thus increasing the likelihood of extreme events in the Canadian Arctic such as wildfires, droughts, and floods (Zhang et al., 2019b). Future warming may have adverse effects on terrestrial and marine ecosystems, as well as on the economy. These include risks to freshwater supply (Sturm et al., 2017), unpredictable seasonal and spatial variations in ice situation for marine shipping (Laliberté et al., 2016; Pizzolato et al., 2016), interruption of overland transportation due to the unstable lake and river ice conditions (Furgal & Prowse, 2008), and the impacts of thawing permafrost on greenhouse gases release (Olefeldt et al., 2016) and degradation of northern infrastructure (Prowse et al., 2009).

Increasing the resilience and ensuring a healthy state of the northern ecosystems are among the strategic goals of Canada. To achieve this goal, the following tasks are provided (Government of Canada, 2019):

- "accelerate and intensify national and international reductions of greenhouse gas emissions and short-lived climate pollutants;

- ensure the conservation, restoration, and sustainable use of ecosystems and species;
- support sustainable use of species by Indigenous peoples;
- approach the planning, management, and development of Arctic and northern environments in a holistic and integrated manner;
- partner with territories, provinces, and Indigenous peoples to recognize, manage and conserve culturally and environmentally significant areas;
- facilitate greater understanding of climate change impacts and adaptation options through monitoring and research, including Indigenous-led and community-based approaches;
- enhance support for climate adaptation and resilience efforts;
- enhance understanding of the vulnerabilities of ecosystems and biodiversity and the effects of environmental change;
- ensure safe and environmentally-responsible shipping;
- decommission or remediate all contaminated sites;
- strengthen pollution prevention and mitigation regionally, nationally and internationally".

The ANPF specifies no tools adjusted individually to the achievement of the environmental tasks, but it outlines government mechanisms that will be developed to accomplish Canada's overall goals in the Arctic. These include renewed federal-provincial-territorial-Indigenous relationships, involvement of the Inuit Crown Partnership Committee, the Yukon Forum, and the Intergovernmental Council of the Northwest Territories, investment plan to define and attract new investments to the region, and economic and regulatory levers to align funding initiatives with the objectives of the Framework (Government of Canada, 2019). The ANPF declares Canada's commitment to international efforts to reduce the negative impact of environmental issues on the population and Arctic ecosystems. Again, no specific environment-related agreements are mentioned, but among the institutions and international formats, the ANPF underscores the Arctic Council, the Arctic Coast Guard Forum, the Arctic Economic Council, the International Maritime Organization (IMO), and the United Nations Convention on the Law of the Sea (UNCLOS) (Government of Canada, 2019).

Denmark (Greenland and the Faroe Islands)

Denmark has a common strategy for the development of its circumpolar territories taking into account the interests of Greenland and the Faroe Islands (Government of Denmark, Government of the Faroes, & Government of Greenland [Kingdom of Denmark Strategy], 2011). The 2011 Arctic strategy is expected to be revised before it expires at the end of 2020 (McGwin, 2020). Since the new text was unavailable at the time of writing, we analyze the 2011 version.

Both Greenland and the Faroe Islands are important migration routes for birds, whales, polar bears, and other polar animals, as well as the conventional habitats of various species of flora and fauna (Lyngs, 2003; Boertmann et al., 2006; Merkel et al., 2019). Over the past years, the evidence that migratory species have declined in the North Atlantic has accumulated (Ganter & Gaston, 2013; CAFF, 2017). Adverse effects of climate change on the terrestrial and marine ecosystems across Arctic territories of Denmark were found by many scholars, including Irons et al. (2008), Canini et al. (2019), Fortune et al. (2020), and Burgos et al. (2020). The 2011 Strategy recognizes that a negative impact on the environment is caused by economic activities in Denmark, Greenland, and the Faroe Islands, including the extractive and energy industries (Kingdom of Denmark Strategy, 2011: 26). Intensive shipping is attributed to becoming a threat to marine ecosystems as a source of pollution and a potential transfer route for invasive alien species (Kingdom of Denmark Strategy, 2011: 45). In light of the increased maritime activities, oil exploration, marine studies, fishing, and passenger transport, both Greenland and the Faroe Islands "have entirely or in part been responsible for the monitoring of the marine environment and pollution control in territorial waters" (Kingdom of Denmark Strategy, 2011: 18). Denmark supports the surveying of territorial waters and promotes maritime safety and marine protection. The Strategy claims that although a certain amount of pollutants is generated domestically, the majority of greenhouse gases, heavy metals, persistent organic pollutants, petroleum products, and mercury still comes from outside (Kingdom of Denmark Strategy, 2011: 45). Such influx of transboundary pollutants negatively affects the health of the population and food chains (Snodgrass, 2020; Foguth et al., 2020), as well as triggers Greenland Ice Sheet melt (Lamarche-Gagnon et al., 2018; Williamson et al., 2020).

Due to the impacts of rapid global warming and greater pressure of anthropogenic activities on fragile biodiversity, Danish Arctic policy expresses particular concern for protecting the environment through improved understanding of climate change in the Arctic (Kingdom of Denmark Strategy, 2011: 43), monitoring of the Greenland ice sheet (Kingdom of Denmark Strategy, 2011: 45), monitoring and study of migratory species and migration routes, and tracking of transboundary pollutants and understanding of their effects on the health of the people and the biodiversity loss (Kingdom of Denmark Strategy, 2011: 46). The country plans to reduce greenhouse gas emissions by 50% by 2050 in accordance with the EU guideline, increase the share of renewable energy sources to 30% by 2020, and achieve full independence from hydrocarbon fuels by 2050 (Kingdom of Denmark Strategy, 2011: 46).

Environmental protection efforts are focused on the national implementation of international agreements (Kingdom of Denmark Strategy, 2011: 46) and are made in accordance with international obligations based on the best international experience and scientific knowledge to ensure the health, productivity, and sustainability of northern communities (Kingdom of Denmark Strategy, 2011: 10). The two treaties that Denmark focuses on in its environmental policy in the Arctic are the Convention on Wetlands of International Importance Especially as Waterfowl Habitat (IUCN, 1971) and the Convention on Biological Diversity (UN, 1992a). In the sphere of pollutants control, Denmark calls for a proactive application of the UNEP's global mercury convention (today, it is the Minamata Convention on Mercury signed in 2013 (UNEP, 2013)) and the Stockholm Convention on Persistent Organic Pollutants (UN, 2001) (Kingdom of Denmark Strategy, 2011: 46). In the sphere of marine environment protection, Denmark participates in the International Convention on Liability and Compensation for Damage in Connection with the Carriage of Hazardous and Noxious Substances by Sea (IMO, 2010) and the International Convention for the Control and Management of Ships' Ballast Water and Sediments (IMO, 2004) (Kingdom of Denmark Strategy, 2011: 46). Under a bilateral agreement with Canada, Denmark and Greenland share information on oil spills and other marine pollution. Denmark also collaborates with the IMO in the field of environmental regulation of shipping and oil spills.

Finland

Finland's Strategy for the Arctic Region 2013 (Government of Finland, 2013) is largely focused on environmental protection and climate issues. It states that the efforts are focused on the following areas (Government of Finland, 2013: 38):

- developing an understanding of the impact of climate change and transboundary transport of pollutants;
- sustainable use of natural resources in the Arctic;
- identification of environmental limitations of Arctic development;
- implementation of environmental protection measures in all spheres of activity in the Arctic.

To some extent, this vision conflicts with the economic interests in the northern territories of the country. Finnish legislation, particularly, the Environmental Protection Act (Ministry of the Environment of Finland, 2014), the Waste Act (Finlex, 2011a), and the Water Act (Finlex, 2011b) require the use of best available sustainable economic practices to reduce harmful impacts of exploration of natural and mineral resources. The 2013 Strategy emphasizes that an environmentally-oriented approach allows taking into account the impact of the use of natural resources in a broad perspective. Environmental objectives are "the key considerations in the efforts to promote economic activity and cooperation, while at the same time ensuring sustainable use of natural resources" (Government of Finland, 2013: 7).

The fundamental parts of Finland's environmental program in the Arctic are the creation of conservation zones and the conservation of biodiversity (Heininen et al., 2020). One of the Strategy's objectives related to the Arctic environment is "the development of the network of nature conservation areas … in order to improve the standard of environmental protection and clarify the framework for economic activity" (Government of Finland, 2013: 57). The expansion of a network of nature reserves and protected areas in the north of Finland is seen as a pragmatic way to improve environmental protection and to facilitate economic activity. In terms of biodiversity, the main focus is on the conservation of various species of flora and fauna, especially migrating birds. Since the development of economic development can negatively affect the conservation of biodiversity, there is a need for careful planning of those activities that involve the use of resources or land.

Finland recognizes pollution from various types of domestic and outer sources as one of the main environmental threats (Government of Finland, 2013: 39). The main pollutants are greenhouse gases, black carbon, methane, carbon dioxide, oil, waste from military production and military bases, radioactive waste, waste from the mining industry, household garbage from settlements, as well as pollution from the shipbuilding industry and shipping. To address the existing pollution problems, Finland relies on the Arctic Council countries' compliance with the regulations of the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic (Government of Finland, 2013: 58). Finland also calls on all Arctic states to responsibly reduce emissions of greenhouse gases and non-persistent pollutants (Government of Finland, 2013: 13, 39).

Iceland

Iceland has long been known to be one of the critical regions in the Arctic for preserving biodiversity (primarily, in marine ecosystems) and global circulation of air and water masses (Meissner et al., 2018). An increasing number of studies have been reporting a human-driven climate change in Iceland in recent decades due to deep-sea resource extraction, mining operations, fishing, shipping, and other anthropogenic activities (Halfar & Fujita 2007; Mengerink et al., 2014; Van Jochumsen et al., 2016). Many of these concerns are addressed in the Parliamentary Resolution on Iceland's Arctic Policy (Ministry for Foreign Affairs of Iceland, 2011), which, as noted by Heininen et al. (2020), has the most pronounced focus on climate change and environment among the policies of other Arctic countries. The Resolution states that "Iceland will concentrate its efforts fully on ensuring that increased economic activity in the Arctic region will contribute to sustainable utilisation of resources and observe responsible handling of the fragile ecosystem and the conservation of biota" (Ministry for Foreign Affairs of Iceland, 2011: 2).

An intensification of shipping activities in the waters around Iceland is considered to be one of the major sources of increased greenhouse gases emission. Heininen et al. (2020) note that although the Resolution hardly identifies other sources and types of pollution, it nevertheless suggests measures to reduce the negative impact of pollutants on the environment. First, it calls for the compliance with the provisions of such international agreements as the United Nations Convention on the Law of the Sea (UN, 1982) and the United Nations Framework Convention on Climate Change (UN, 1992c), as well as with the regulations established by the IMO. Second, environmental pollution is considered a national security issue in terms of the establishment of adequate capacity for response to "environmental accidents, accidents at sea and maritime activity in connection with oil extraction and other resource utilization" (Ministry for Foreign Affairs of Iceland, 2011: 10).

Various approaches are being implemented concerning climate change adaptation, including research activities. Many states and their associations, including China, Japan, and the EU, are invited to participate in the activities related to inter-state aspects of climate change. Iceland also proclaims its collaboration with the UN in implementing the provisions of the Framework Convention on Climate Change (UN, 1992c) and its commitment to the principles of sustainable development, including reducing greenhouse gas emissions and developing renewable energy opportunities.

Norway

The updated version of Norway's Arctic Strategy has been in effect since 2017 (Norwegian Ministries, 2017). It names environmental protection and preparedness for natural and man-made emergencies among priority areas of the country in the Arctic, along with international cooperation, business development, knowledge, and infrastructure development (Norwegian Ministries, 2017: 15). In the sphere of environmental protection, Norway aims to "safeguard threatened and valuable species and habitats and achieve good ecological status in ecosystems; ensure sustainable use and the conservation of a representative selection of Norwegian nature covering the whole range of habitats and ecosystems; reduce greenhouse gas emissions and pollution in line with national targets and international commitments; and strengthen emergency preparedness and response related to increased activity in the north" (Norwegian Ministries, 2017: 35).

As pointed by Heininen et al. (2020), the Norwegian Arctic Strategy is particularly focused on establishing a balance between environmental and economic activities. The Strategy underscores that "all business activity in the Arctic is to be economically, environmentally and socially sustainable" (Norwegian Ministries, 2017: 23), while main industries (fishing, mining, marine biotechnology, energy, shipping, and tourism) have to be based on "even better utilisation of the region's natural and human resources" (Norwegian Ministries, 2017: 23-24).

Among the main pollutants in the Norwegian Arctic, the Strategy recognizes greenhouse gases emissions, primarily, from the transport sector (Norwegian Ministries, 2017: 10, 32) and articulates a goal to reduce the emissions by at least 40% by 2030 and to becoming a low-carbon society by 2050 (Norwegian Ministries, 2017: 12). Apart from road transport, other sources of pollution include shipping and infrastructure development. The Government aims "to reduce the environmental and climate impacts of ferry traffic and domestic shipping", as well as "to ensure that adequate attention continues to be given to climate change and environmental considerations in connection with land-use decisions concerning infrastructure development" (Norwegian Ministries, 2017: 33).

In the sphere of environmental protection, Norway announced several ambitious projects. The Strategy mentions the creation of a center for oil spill preparedness and response, as well as the collection of plastic debris (Norwegian Ministries, 2017: 37). Norway has high hopes for the contribution of the Arctic Council states to the development of the seed storage facility in Svalbard to preserve genetic diversity and promote global food security. The Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic is seen as one of the principal tools for combating pollution (Norwegian Ministries, 2017: 36).

Climate change impacts on the environment are one of the greatest challenges for the Norwegian Arctic recognized by the 2017 Strategy (Norwegian Ministries, 2017: 3), ministerial reports (Norwegian Ministry of Climate and Environment, 2015; The Research Council of Norway, 2012), and individual scholars (Benestad & Haugen, 2007; Pall et al., 2019; Poschlod et al., 2020; Ward, 2020). The climate in Norway has become warmer and precipitation has increased by about 20% since 1900. The Norwegian Ministry of Climate and Environment (2015) forecasts the annual mean temperature in Norway to rise by between 2.3°C and 4.6°C by 2100. According to Heininen et al. (2020), the Norwegian Arctic Strategy views global warming from two sides. Norway expects that ice melting may soon have a positive impact on the development of economic activity in the Arctic in terms of the emergence of new opportunities for shipping and resource extraction (Norwegian Ministries, 2017: 3). On the other side, climate change is considered as a threat to Arctic species and ecosystems (Norwegian Ministries, 2017: 35). For instance, rising temperatures can lead to a northward shift in the distribution of habitats of terrestrial animals and plants, while changing ocean currents along with the retreat of the sea ice can allow more southerly fish species to move into Arctic sea areas. When such shifts happen, purely Arctic species of flora and fauna will meet growing competition, greater predation pressure, and a higher risk of an influx of diseases and parasites into the region (Norwegian Ministry of Climate and Environment, 2015). Establishing a balance between economic opportunities and environmental considerations could be a challenging task for the Norwegian Government. Among the prospective tools to achieve a balance, the Strategy outlines integrated management that pulls local, regional, and international policies in the same direction.

Russia

In Russian legislation, the issues of environmental protection and rational use of natural resources are covered at various levels. In the Foundations of the State Policy of the Russian Federation in the Arctic till 2035 (President of the Russian Federation, 2020), environmental protection and environmental security are mentioned among the main directions of the national policy in the region. The lack of preparedness of the environmental monitoring system to contemporary ecological challenges is recognized among the threats to national security in the Arctic. Following this vision, the 2020 Policy identifies the tasks in the field of environmental protection and environmental safety (President of the Russian Federation, 2020: article 15):

- development of a network of specially protected natural territories and water areas to preserve ecosystems and to adapt them to climate change;
- ensurance of conservation of Arctic fauna and flora, protection of rare and endangered plants, animals, and other organisms;
- permanent work on the elimination of accumulated environmental damage;
- improvement of the environmental monitoring system, usage of modern information and communication technologies and communication systems for satellite monitoring, development of sea and ice platforms, research vessels, and observatories;
- introduction of the best available technologies, ensuring minimization of air emissions, discharges of pollutants into water bodies, and reduction of other types of negative impact on the environment in the course of economic and other activities;
- ensurance of the rational use of natural resources, including in locations of traditional residence and economic activities of indigenous peoples;
- development of a comprehensive waste management system of all hazard classes, construction of modern environmentally friendly waste processing complexes;
- implementation of a set of measures to prevent toxic substances, infectious agents, and radioactive substances from entering Russia's Arctic zone.

The 2020 Policy's vision of environmental protection tasks in the Russian Arctic is detailed in the Strategy of Development of the Arctic Zone of the Russian Federation and Ensurance of National Security till 2020 (Government of the Russian Federation, 2013). The update of the 2013 Strategy is expected by the end of 2020 until when it is currently valid. The 2013 Strategy points out the increase of technological and man-made burdens on the environment in some of Russia's northern coastal territories (Government of the Russian Federation, 2013: 3). It also emphasizes risks of radioactive contamination along with a high level of accumulated environmental damage in many inland areas of the Arctic zone (Government of the Russian Federation, 2013: 3). Therefore, the 2013 Strategy prioritizes the improvement of environmental security as a means of development of the Arctic and the ensurance of national security (Government of the Russian Federation, 2013:

3). Rational use of natural resources is recognized as a key to improving the quality of life of the population in the Arctic, as well as ensuring positive demographic processes and socioeconomic conditions in the region (Government of the Russian Federation, 2013: 7, 11, 13, 19).

To protect the environment and ensure environmental safety in the Arctic zone of Russia, the 2013 Strategy provides for (Government of the Russian Federation, 2013: 12-13).

- ensuring the conservation of the biological diversity of Arctic flora and fauna in the context of expanding economic activity and global climate change;
- development and expansion of the network of specially protected natural territories and water areas at both federal and regional levels;
- elimination of environmental damage caused as a result of past economic, military, and other activities, including assessment of the environmental damage and implementation of measures to clean up land and water areas from pollution;
- development, justification, and implementation of measures to reduce environmental threats caused by the expansion of economic activity in the Arctic, including on the continental shelf;
- increasing the responsibility of enterprises for environmental pollution, encouraging the development and implementation of new technologies that reduce a negative impact on the environment, reduce the risks of occurrence and minimize the consequences of man-made emergencies;
- improving the system of state environmental monitoring to assess environmental parameters, the establishment of a system to monitor environmental pollution, air, and space-based observations of ecosystems and climate;
- development and implementation of economic mechanisms that stimulate the reproduction and rational use of mineral and biological resources, energy and resource conservation, and utilization of fossil gas in oil production areas.

Along with the fundamental principles set out in the strategic documents, environmental protection activities are regulated by industry-specific legislation. Within the Arctic zone of Russia, continental shelf, and exclusive economic zone, it covers environmental requirements for any activity that has or may harm the environment. The 2013 Strategy also defines the tools of environmental regulation, environmental expertise, environmental impact assessment, payment for negative impact on the environment, environmental insurance, state environmental monitoring, state environmental supervision, industrial and public control in the field of environmental protection (Government of the Russian Federation, 2013: 12-13).

Sweden

Among Arctic Council countries, Sweden was the first to elaborate comprehensive environmental legislation by adopting the Environmental Protection Act in 1969 (Lidskog & Elander, 2000). Since that time, environmental issues have always stood high in the national political agenda (Granberg & Elander, 2007). Sweden's Strategy for the Arctic Region addresses climate change and the environment among major concerns of the country in the Arctic (Government Offices of Sweden, 2011: 23). There is also the Environmental Policy for the Arctic (Government Offices of Sweden,

2016) which particularly emphasizes the focus on environmental and ecological activities in the High North. As the 2016 Policy directly addresses Sweden's priorities in the sphere of the Arctic environment, we consider this document in our study.

The 2016 Policy declares three priorities for protecting the environment in its northern territories: strengthening measures to prevent the negative effects of climate change, improving the protection of biodiversity and ecosystems, and sustainable use of resources (Government Offices of Sweden, 2016: 2).

According to the first priority, international cooperation to prevent global warming above 2°C is considered a fundamental element of curbing climate change in the Arctic (Government Offices of Sweden, 2016: 2). Sweden's approach to this task is expressed in the climate strategy developed in the run-up to the Paris agreement in 2015. Sweden aims "to strengthen the Arctic Council's climate and renewable energy measures" (Government Offices of Sweden, 2016: 2). One of the main goals is to reduce "emissions of emissions of short-lived climate forcers such as soot and methane" (Government Offices of Sweden, 2016: 2). In this area, Sweden operates within the framework of the agreement on reducing harmful emissions concluded in 2015 between Arctic countries, which involves improving national measures and joint actions to reduce soot and methane emissions (Government Offices of Sweden, 2016: 2).

The second priority also highlights the need for international efforts to protect valuable natural habitats of animals and plants. In its 2016 Policy, Sweden "supports the process under way in the Arctic Council to implement the recommendations of the Arctic Biodiversity Assessment, including efforts to establish networks of protected areas" (Government Offices of Sweden, 2016: 3). Protection of habitats in the Arctic meets the guidelines of the Convention on Biological Diversity (UN, 1992a) on the conservation of at least 10% of inland territories and water areas and up to 17% of inland water reservoirs by 2020 (Government Offices of Sweden, 2016: 3). The UNCLOS (UN, 1982) is considered as an instrument for the protection and conservation of marine biodiversity in the areas beyond national jurisdiction (Government Offices of Sweden, 2016: 3). However, Sweden recognizes that it takes "many years before such an implementing agreement can enter into force" (Government Offices of Sweden, 2016: 3). In the meantime, operational environmental measures can be implemented based on the Convention for the Protection of the Marine Environment of the North-East Atlantic (OSPAR Commission, 1992).

Concerning the sustainable use of resources, the 2016 Policy recognizes the role of the UNCLOS (United Nations, 1982) as the main international instrument for regulating the rights of littoral states to explore mineral and other resources on the continental shelf (Government Offices of Sweden, 2016: 4). At the same time, the extraction of oil and gas from the subsurface for combustion and energy production must be limited to achieve the internationally approved target of containing global warming within 2°C (Government Offices of Sweden, 2016: 4). Sweden is committed to strict regulatory measures, particularly, in the areas with permanent or seasonal ice cover, where the risks of oil spills and other pollutions to fragile Arctic ecosystems are higher (Government Offices of Sweden, 2016: 4). Among the major sources of environmental risk, the 2016 Policy recognizes increased shipping activities (Government Offices of Sweden, 2016: 4). To mitigate potential risks, Sweden follows the provisions of the Polar Code, which includes both environmental regulations and technical requirements for marine and river vessels used in the Arctic (Government Offices of Sweden, 2016: 4).

USA

Similar to those in other Arctic territories, adverse impacts of climate change and environmental disruptions on terrestrial and marine ecosystems in Alaska have been increasing in the previous decades. The average temperature in Alaska has risen at twice the rate of the global average (Allen, 2020), while the Gulf of Alaska experienced extreme temperatures during 2014-2019, including the four warmest years ever observed (Litzow et al., 2020). In response to warming and sea ice reduction, Alaskan ecosystems are reacting by a decline and lower productivity in fish populations (Jones et al., 2020), change of habitats of Arctic animals and birds (CAFF, 2017; Larson et al., 2020), and decomposition of previously frozen carbon from tundra soils (Tao et al., 2020).

Many studies suggest that increasing and more fluctuant variabilities in the Alaskan climate, as well as environmental pollution in the region, could be associated with more intensive anthropogenic activities, including exploration of natural resources and development of industrial infrastructure (Skjærseth & Skodvin, 2003; Jezierski et al., 2010a, 2010b; Litzow et al., 2020). An emerging environmental problem in Alaska is the metal contamination of food and water resources due to the emergence of mining and drilling activities (Perryman et al., 2020). The United States has significantly developed its legislation related to the exploration of the continental shelf and territorial waters. Outer Continental Shelf Lands Act (Cornell Law School, n.d.) is one of the principal documents to regulate the activities of oil and gas companies on the Alaska shelf. The Act states that the operations on the outer continental shelf should be concluded in a safe manner to prevent or minimize the occurrence of damage to the environment (Cornell Law School, n.d.: §1332). It also establishes liability for all types of environmental and economic damage is established. There is a multi-stage system for planning of subsurface use, issuing licenses for exploration, development of deposits, and production of minerals (Gladun, 2015).

The National Strategy for the Arctic Region states that the USA "will continue to protect the Arctic environment and conserve its resources" (President of the United States, 2013: 2). Specific objectives of the U.S. environmental efforts in the Arctic include conservation of natural resources, assessment and monitoring of ecosystems and the risks of climate change, implementation of integrated management practices to balance economic development and environmental protection, studies on environment changes, and charting and mapping the ocean and waterways (President of the United States, 2013: 9-10). Among critical concerns, the 2013 Strategy underscores "land ice and its role in changing sea level; sea-ice and its role in global climate, fostering biodiversity, and supporting Arctic peoples; and, the warming permafrost and its effects on infrastructure and climate" (President of the United States, 2013: 9-10).

While the 2013 Strategy calls for a strengthening of international cooperation for "collaborative efforts by nations seeking to explore emerging opportunities while emphasizing ecological awareness and preservation" (President of the United States, 2013: 8), in recent years, the Arctic has been turning into "an arena of global power and competition" (Pompeo, 2019). Two documents released in 2019 articulate this new vision of the Arctic by the U.S. Coast Guard and the U.S. Department of Defence. While the latter one, the DoD's Arctic Strategy views environmental changes in the High North as "specific operational challenges that limit communications, including the harsh climate, vast distances, and atmospheric phenomena" (United States Department of Defence, 2019: 10), the Coast Guard Arctic Strategic Outlook calls for a deeper understanding of environmental processes through the development of pollution detection and tracking capabilities, weather and environmental observations, and assessment of living marine resources activity (United States Coast Guard, 2019: 27).

Environmental focus of China's Arctic policy

Since the contemporary environmental challenges faced by the Arctic countries are rapidly becoming global, a broader international community has been attempting to contribute to their solution. Among the non-Arctic states, China has become one of the most prominent and important actors in the Arctic in recent years.

China's active involvement in environmental studies in the Arctic dates back to 1996 when the country entered the International Arctic Science Committee (IASC). In 1999, China organized its first scientific expedition to the Arctic to study climate change and its impact on the country. Since then, Chinese researchers have carried out eleven expeditions to various parts of the Arctic Ocean to study the biological diversity of Arctic ecosystems and atmospheric, marine, and oceanic processes associated with ice melt (Chistyakova, 2018; Filippova, 2019; Staalesen, 2020). Having analyzed the results of China's expeditions to the Arctic, Wang (2015) and Wei et al. (2020) identified priority spheres in Arctic studies for China, i.e. environment, climate change, water and ice, maritime routes, and sustainable development. Pan and Zhou (2010), Wu et al. (2013), and Zhang et al. (2019a) emphasized environmental security and the need for scientific knowledge on climate change as the premier interests explaining China's research activities in the High North.

In 2017, China's President Xi Jinping underscored the commitment of the country to "the principles of prioritizing resource conservation and environmental protection" (Xi, 2017: 45) by promoting low-carbon development, preventing and controlling pollution of air, water, and soils, restoring ecosystems, and developing biodiversity protection networks (Xi, 2017: 45-46). Such a vision of China's role in building an "ecological civilization" (Xi, 2017: 47) is very much enshrined in China's Arctic Policy 2018 which states that "the Arctic situation now goes beyond its … regional nature, having a vital bearing on … the survival, the development, and the shared future for mankind" (State Council of the People's Republic of China, 2018: Foreword).

The 2018 Policy emphasizes that ice melting is associated with significant climate changes throughout the planet and alerts the fact that progressing climate change in the Arctic can cause a rise in the level of the Arctic Ocean and trigger natural disasters (State Council of the People's Republic of China, 2018: article I). Despite such threats to polar ecosystems, China acknowledges the opportunities climate change could bring for the research and development of the Arctic, for commercial use of maritime routes, and the exploration of natural and other resources in the region (State Council of the People's Republic of China, 2018: article I). A balance between economic opportunities and environmental concerns may be established by integrating environmental protection efforts and rational utilization of all kinds of natural resources – the key areas of China's activities in the Arctic both prioritized in the 2018 Policy (State Council of the People's Republic of China, 2018: article IV). China recognizes the direct impact of the natural conditions of the Arctic on China's climate system (State Council of the People's Republic of China, 2018: article II) and calls for the enhancement of the environmental background investigation of Arctic activities, evaluation of the interaction between the Arctic and global climate change, and forecasting of potential risks posed by future climate change to the Arctic's natural resources and ecological environment (State Council of the People's Republic of China, 2018: article IV.2). The

2018 Policy states that "to protect the Arctic, China will actively respond to climate change in the Arctic, protect its unique natural environment and ecological system, promote its own climatic, environmental and ecological resilience" (State Council of the People's Republic of China, 2018: article III).

China's role in shaping the common response to future environmental challenges in the Arctic

Being a non-regional actor, China is particularly concerned with global implications and international impacts of environmental management in the Arctic. To contribute to the protection of the natural environment and Arctic ecosystems, China follows international law (the UN Framework Convention on Climate Change, the Kyoto Protocol, the Paris Agreement, the Agreement on Cooperation on Marine Oil Pollution Preparedness and Response in the Arctic, and the IMO's regulations) and participates in Arctic governance and international cooperation in the sphere of environmental protection (Arctic Council, Arctic Science Ministerial Meeting, China-US and China-Russia dialogues on polar issues, China-Iceland Framework Agreement on Arctic Cooperation) (State Council of the People's Republic of China, 2018: article IV.4). The country takes an active part in addressing the challenges of environmental and climate change in several ways, including environment protection, sustainable development and biodiversity protection, emission reduction, utilization of Arctic resources in a rational manner, conservation and utilization of living resources (State Council of the People's Republic of China, 2018: article IV.3).

Such involvement of China in the Arctic environmental agenda provides a number of opportunities for reshaping the existing approaches to addressing climate change and other global ecological challenges in the region. To find potential areas for China and Arctic countries to collaborate in the sphere of environmental protection in the High North, we viewed previously discussed five environmental challenges through the lens of China's priorities outlined in the 2018 Policy (State Council of the People's Republic of China, 2018: articles IV.2, IV.3). These priorities (namely, more efficient environmental protection, more resilient ecosystems, addressing climate change, and conservation and utilization of fisheries and other living resources) were detailed in 24 activities derived from the text of articles IV.2 and IV.3 of the 2018 Policy. The activities were then attributed to specific environmental challenges thus establishing five groups. For each activity, we scanned the Arctic-related documents previously discussed in the Environment-Related Policies section of the paper to identify intersections between China's priorities and those of Arctic countries.

As regards industrial pollution, oil spills, and intensification of shipping in the Arctic, China's interests correspond with those of Arctic countries in many areas, particularly, an assessment of the environmental impact of Arctic activities, reduction of pollutants in the Arctic waters from land-based sources, and control of the sources of marine pollution, including ship discharge, offshore dumping, and air pollution (Table 2). China requires its enterprises to conduct comprehensive risk assessments for resource exploration and encourages them to participate in the exploitation of resources in the Arctic on the condition of properly protecting the environment (State Council of the People's Republic of China, 2018). To establish the foundations of stronger cooperation, Chinese research institutions could also be engaged in enhancing the environmental background investigation of economic, transport, resource extraction, and other activities.

Table 2. Intersections between China's and Arctic countries' priorities in environmental protection and climate change responses in the Arctic (challenges 1-3)

Activity	CAN	DEN	FIN	ICE	NOR	RUS1	RUS2	SWE1	SWE2	US1	US2
Challenge 1: Industrial pollution and oil spills											
Environmental background investigation of Arctic activities	–	+	–	–	–	+	–	–	–	–	+
Assessment of the environmental impact of Arctic activities	+	+	+	+	+	+	+	+	+	+	+
Reduction of pollutants in the Arctic waters from land-based sources	–	+	+	–	+	+	+	+	–	–	–
Environmental responsibility awareness of citizens and enterprises	+	–	+	+	+	–	–	–	–	+	+
Challenge 2: Intensification of shipping											
Control of ship discharge, offshore dumping, air pollution	+	+	+	+	+	+	+	+	+	+	+
Challenge 3: Ice melting											
Energy exchange processes in the Arctic	–	+	+	–	–	+	–	+	+	+	–
Evaluation of the impact on ecosystems caused by climate and human activities	+	+	+	+	+	+	–	+	–	+	–
Interaction between the Arctic and global climate change	+	+	+	–	+	+	–	+	+	+	–
Risks posed by climate change to natural resources and ecosystems	+	+	+	+	+	+	+	+	+	+	+
Arctic cryospheric sciences	–	+	+	–	–	–	–	+	–	+	–
Public awareness of climate change	+	+	+	+	–	–	–	+	–	–	–
International projects to address climate change	+	+	+	+	+	+	+	+	+	+	+

Note: CAN = Canada's Arctic and Northern Policy Framework (Government of Canada, 2019); DEN = Denmark, Greenland, and the Faroe Islands: Kingdom of Denmark Strategy for the Arctic 2011-2020 (Kingdom of Denmark Strategy, 2011); FIN = Finland's Strategy for the Arctic Region 2013 (Government of Finland, 2013); ICE = A Parliamentary Resolution on Iceland's Arctic Policy (Ministry for Foreign Affairs of Iceland, 2011); NOR = Norway's Arctic Strategy – between Geopolitics and Social Development (Norwegian Ministries, 2017); RUS1 = Strategy of Development of the Arctic Zone of the Russian Federation and Ensurance of National Security till 2020 (Government of the Russian Federation, 2013); RUS2 = Foundations of the State Policy of the Russian Federation in the Arctic till 2035 (President of the Russian Federation, 2020); SWE1 = Sweden's Strategy for the Arctic Region (Government Offices of Sweden, 2011); SWE2 = New Swedish Environmental Policy for the Arctic (Government Offices of Sweden, 2016); US1 = National Strategy for the Arctic Region (President of the United States, 2013); US2 = Arctic Strategic Outlook (United States Coast Guard, 2019); "+" = intersection with China's Arctic Policy; "-" = no intersection with China's Arctic Policy.

Source: Authors' development

Water areas out of the national jurisdiction, where Chinese expeditions may carry out their research activities without permission of the Arctic states, are considered as key areas for Arctic environmental protection (Pilyasov, 2018). China proclaims the principle of unrestricted navigation in the Arctic Ocean for all countries and recognizes the Polar Code to a greater extent than national regulations of the Arctic countries (Erokhin et al., 2018). Nevertheless, China is committed to collaborating with other countries in the Arctic to enhance control of the sources of marine pollution such as ship discharge. Many Arctic states recognize shipping as one of the sources of pollution. Because of the increasing activity of Chinese research and cargo vessels in the Arctic Ocean, the reduction of ship discharge is one of the critical areas to collaborate. Due to the ban on the use of heavy fuel in the Arctic, it will be necessary to ensure the transition to the use of other types of fuel for cargo ships and tankers after 2024 and in some cases after 2029 (due to the IMO's ban of heavy fuel which will come into force in 2024 with specific extensions until 2029). It may have a major impact not only on Chinese vessels but also on resource-extraction projects. China is one of the major consumers of liquefied natural gas (LNG) from Yamal LNG and other facilities located in Russia's Arctic sector. Knizhnikov and Klimentyev (2019) expect that the use of LNG as an alternative to heavy fuel could become a solution for Chinese and other vessels used in the Arctic. For Finnish and Norwegian companies, there is an opportunity to work with China on the development of LNG technologies (Gao & Erokhin, 2019). In cooperation with Russian oil-and-gas companies, Chinese research institutes and enterprises could be engaged in the hydrographic surveys in the Northern Sea Route to improve the security of navigation and reduce ship accidents (Erokhin & Gao, 2018; Gao & Erokhin, 2020b). The transition to the use of LNG instead of heavy fuel can reduce air pollution, including carbon dioxide emissions.

The 2018 Policy underscores China's commitment to "studying the substance and energy exchange process and mechanisms of the Arctic" in relation to climate change (State Council of the People's Republic of China, 2018: article IV.2). Although none of the eleven documents contains this exact term "energy exchange", a need to study the impacts of melting ice sheet mass and permafrost on elevated carbon dioxide levels in the atmosphere is prioritized by Denmark, Finland, Russia, Sweden, and the USA. Denmark calls for the development of a model system "to study the inland ice and its interaction with the surrounding seas, … the knowledge of permafrost conditions, and the interplay between weather, sea and ice more generally" (Kingdom of Denmark Strategy, 2011: 45). Finland stands for deeper cooperation between countries which "must shoulder their responsibility for reducing emissions of greenhouse gases and short-lived climate pollutants" (Government of Finland, 2013: 41) in view that "the melting of the polar ice cover and permafrost will further accelerate global warming" (Government of Finland, 2013: 15). Russia directly links energy and climate and advocates the development of an international dialogue "for the exchange of experience in the development of climate and energy policies" (Government of the Russian Federation, 2013: article 15).

There are several areas for collaboration in the sphere of protection of Arctic ecosystems, including habitat changes, declines of populations of mammals, fish, and birds, and rational use of fishery resources (challenges 4 and 5). Such activities as biodiversity protection, ensurance of adaptability and resilience of ecosystems, international cooperation in the sphere of protection of Arctic flora and fauna, and environmental and ecosystem-based management are prioritized by most Arctic countries (Table 3).

Table 3. Intersections between China's and Arctic countries' priorities in environmental protection and climate change responses in the Arctic (challenges 4 and 5)

Activity	**CAN**	**DEN**	**FIN**	**ICE**	**NOR**	**RUS1**	**RUS2**	**SWE1**	**SWE2**	**US1**	**US2**
Challenge 4: Increase in fisheries											
Conservation and rational use of fishery resources	–	+	+	+	+	+	–	+	+	–	–
Survey on the fishery resources and exploratory fishing	+	+	–	–	+	–	–	–	+	–	+
International management of fisheries	–	+	–	+	+	–	–	+	+	–	+
Cooperation on conservation and utilization of fishery resources	–	+	–	+	+	–	–	+	+	–	–
Challenge 5: Habitat change and population decline											
Biodiversity protection	+	+	+	+	+	+	+	+	+	+	–
Protection of migratory birds and their habitats	–	–	+	–	–	–	–	–	–	–	+
Study of migration patterns of Arctic migratory birds	–	+	+	–	–	–	–	–	–	–	–
Adaptability and resilience of ecosystems	+	+	+	–	–	+	–	+	+	+	–
International projects to protect flora and fauna	+	+	+	+	+	+	+	+	+	+	–
Transparent exploration and utilization of Arctic genetic resources	–	+	–	–	+	–	–	–	–	–	–
Equitable sharing and use of the benefits generated by the exploitation of living resources	–	+	–	–	–	–	–	–	–	–	–
Environmental and ecosystem-based management	+	+	+	–	+	–	–	+	+	+	–

Note: CAN = Canada's Arctic and Northern Policy Framework (Government of Canada, 2019); DEN = Denmark, Greenland, and the Faroe Islands: Kingdom of Denmark Strategy for the Arctic 2011-2020 (Kingdom of Denmark Strategy, 2011); FIN = Finland's Strategy for the Arctic Region 2013 (Government of Finland, 2013); ICE = A Parliamentary Resolution on Iceland's Arctic Policy (Ministry for Foreign Affairs of Iceland, 2011); NOR = Norway's Arctic Strategy – between Geopolitics and Social Development (Norwegian Ministries, 2017); RUS1 = Strategy of Development of the Arctic Zone of the Russian Federation and Ensurance of National Security till 2020 (Government of the Russian Federation, 2013); RUS2 = Foundations of the State Policy of the Russian Federation in the Arctic till 2035 (President of the Russian Federation, 2020); SWE1 = Sweden's Strategy for the Arctic Region (Government Offices of Sweden, 2011); SWE2 = New Swedish Environmental Policy for the Arctic (Government Offices of Sweden, 2016); US1 = National Strategy for the Arctic Region (President of the United States, 2013); US2 = Arctic Strategic Outlook (United States Coast Guard, 2019); "+" = intersection with China's Arctic Policy; "-" = no intersection with China's Arctic Policy.

Source: Authors' development

In its Arctic Policy, China underlines the importance of sustainable development and protection of biodiversity in the Arctic (State Council of the People's Republic of China, 2018: article IV.2). In the coming years, the international collaboration agenda in the Arctic will be dominated by the establishment of a special regime for the use of natural resources, monitoring the state of ecosystem pollution, landscape restoration, creation of natural reserves, waste management, conservation measures, increasing animal and bird populations, control of industrial fishing, and fighting against poaching (Pilyasov, 2018; Heininen et al., 2020; Gao & Erokhin, 2020a; Titova, 2016). In contrast to China, few Arctic countries specify the protection of migratory birds and the study of their flyways. In these areas, Chinese scholars could contribute to the Arctic research agenda with their studies on the migration patterns of birds (for instance, in Finland and Greenland which both prioritize studies of migratory birds), evaluation of the impact on the ecosystem caused by the resource-extraction and other projects where Chinese companies participate (Russia, Nordic countries), as well as with research on the adaptability and resilience of the ecosystems across the Arctic. Most relevant topics: how to avoid a situation where ecosystem approaches and ecosystem management do not create ecological borders in the Arctic in addition to the existing borders of national jurisdiction; how to gradually transform the convention regime and adapt it to the new international political and economic conditions; how to integrate the responses to these problems in the national policies of the Arctic Council, China, and other observer states.

Conclusion

Taking into account progressing climatic and environmental changes in the Arctic along with the growing influence of anthropogenic factors, risks to Arctic ecosystems are emerging due to industrial pollution from land-based and offshore facilities, intensive shipping, and exploratory use of living resources. In Arctic countries, the environmental component has long been an extremely important part of development strategies. With the entry of non-Arctic actors into economic, transport, and research activities in the High North, certain adjustments in the environmental protection agenda are needed to efficiently integrate global responses to climate change with individual priorities of the Arctic and non-Arctic countries in the region. The responses to the existing environmental challenges with stronger involvement of China in international formats like Arctic Council, Arctic Science Ministerial Meeting, and bilateral dialogue frameworks with Arctic countries will depend on the integration of the environmental agenda in the international legal framework. China is exactly committed to the existing framework of international law including the UN Charter, UNCLOS, rules of the IMO, the Spitsbergen Treaty, and other treaties on climate change and the environment that govern Arctic affairs (State Council of the People's Republic of China, 2018). Arguably, a comprehensive international treaty is needed to stress the importance of environmental protection in the Arctic in the international legal context. The elaboration of an umbrella environmentally-oriented agreement between the Arctic Council members, China, and other non-Arctic countries is hardly likely shortly, especially when it comes to the exploration of resources, exploitation of shipping routes, and benefiting from other economic opportunities in the region. Nevertheless, the intersections of China's and Arctic countries' priorities demonstrate the potential for establishing workable multilateral and bilateral cooperation frameworks in the spheres of climate change, conservation and utilization of living resources, clean energy solutions, and environmentally-friendly operation of the Arctic routes.

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