Circumpolar Legislation on Pollutants: How Effective is Arctic Governance on Global Environmental Threats?

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The protection of the Arctic environment was one of the main motivations for establishing the Arctic Council. In the past, the Arctic nations have played a pivotal role for several agreements on environmental protection, such as the Stockholm Convention, which can be considered as a positive example of Arctic cooperation and targeted action. However, not all Arctic States have ratified the Convention and its amendments, which regularly add pollutants to the scope of the Convention. Thus, the environmental legislation in the Arctic states does not catch up with the scientific findings and recognition of these threats.

This paper examines the efforts of the Arctic nations towards circumpolar governance and international legislation on pollutants, as well as the consequences and effectiveness of these efforts. A brief comparison of policy initiatives, in particular through a look at U.S. legislation, will serve as an illustration of the development of Arctic environmental governance over time and shed light on differences between Arctic states. An effective governance on Persistent Organic Pollutants (POPs) requires a precautionary approach and the regular adaptation to emerging chemicals of concern. While national initiatives have achieved some success in reducing the production and use of POPs, a more comprehensive approach encompassing a list of pollutants corresponding to state-of-the-art research within a global legislative framework is needed.

Introduction

Persistent Organic Pollutants or 'POPs' are environmentally persistent toxic chemicals, which take a long time to degrade and are transported over long distances. Due to the environmental conditions, they often end up in the Arctic, where different biota can act as sinks and where they can cause considerable damage to the environment and human health. Many of the chemicals classified as POPs were widely used globally in commercial products, in particular as pesticides and industrial applications, until their production and use was limited by national and international regulations, such as the 2001 Stockholm Convention on Persistent Organic Pollutants. Nevertheless, some are still extensively used in some parts of the globe.

In the 1970s, the assessment of POP levels in Arctic indigenous peoples found levels of serious concern. After POPs entered public consciousness in the 1960s thanks to Rachel Carson's celebrated book *Silent Spring,* these results from the Arctic marked the beginning of a long-standing effort on the part of the Arctic states to limit or ban POPs on a global scale.

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Persistent Organic Pollutants (POPs) in the Arctic

What are POPs?

Persistent organic pollutants are chemicals that are highly toxic and very persistent in the environment, which enables their long-range transport to places far from their source. They are transported via atmospheric circulation, ocean currents and to a lesser extent migratory species or formed through the degradation of volatile precursors (Muir & de Wit, 2010). The fastest transport route of POPs is via the atmosphere, through which their reach is expanded globally. The pollutants are atmospherically deposited on land or water, which serve as entry points into the food web (AMAP, 2014; Hung et al., 2016). The 1991 Rovaniemi Declaration on the Protection of the Arctic Environment further lists "releases of large quantities into the environment" as a characteristic and part of the definition of POPs.

POPs are used for a variety of applications, which can be divided into three categories: pesticides used in agriculture or pest control, industrial chemicals, and unintentionally produced POPs resulting from incomplete combustion or chemical reactions (UNEP/AMAP, 2011). Apart from the chemicals found in commercial products, POPs are released by mines, military sites, smelters, power stations and a variety of other sources (Letcher et al., 2010; Hung et al., 2016).

The most well-known POPs are dichlorodiphenyltrichloroethane (DDT), an insecticide used to control vector-borne diseases such as malaria and typhus, and polychlorinated biphenyls (PCBs) used for example as coolant fluids in electrical equipment. A list of the POPs recognized in different agreements can be found in Table 1, below.

Few of the pollutants actually originate in the Arctic, where the special environmental conditions, such as the cold that favors their persistence compared to warmer environments, tend to "trap" the chemicals.

Effects on the Environment

The pernicious effects of POPs were depicted in detail in the 1960s by Rachel Carson's popular book *Silent Spring* and pointed out by ecologists and hobby ornithologists even before that (Carson, 1962). A variety of effects on the environment have been observed, most notably POPs' effect on the health of wildlife. In addition to their toxicity, the pollutants' effects on reproduction disturb the reproduction cycle, for example by interfering with animals' sex hormones and in the case of birds, resulting in thinner eggshells. Their impact on the thymus, which normally produces antibodies, weakens the immune system, making wildlife even more vulnerable to diseases and other stressors. POPs also increase the risk of tumors and their effect on the production of the pigment in red blood cells can lead to an extreme sensitivity of the skin to sunlight and damage to the nervous system. The survival of wildlife populations is therefore seriously endangered in case of high exposure to POPs (NOAA, n.d.).

The pollutants are stored in animals' fatty tissues, which in the Arctic are an important source of energy during long, cold winters. Through the metabolism of fat reserves, the POPs are released and impact the organism. In spring, a critical period for reproduction, the melting of ice and snow releases the accumulated POPs into the environment, where they are ingested by wildlife.

By feeding on smaller animals poisoned by POPs, such as earthworms, the pollutants are ingested by other animals and then passed from one species to another. Along the process, they accumulate over the food web, which is known as biomagnification or bioaccumulation. Predator species higher up in the food chain, such as seals, bears or toothed whales, have potentially very high levels of pollutants. Species such as polar bears, which are a fourth level carnivore, meaning that they feed on other carnivores, are therefore at the top of the food web and likely have very high levels of POPs. However, these animals are also often sources of subsistence food for Arctic indigenous people, which is how POPs make their way into human bodies. The pollutants' potential for bioaccumulation means that the release of even small quantities can lead to their accumulation with significant impacts.

During the period from 2002 to 2009, tissue concentrations measured in several Arctic species exceeded 1 part-per-million (ppm), which is considered a threshold of concern (Letcher et al., 2010). However, other environmental, ecological and physiological stressors might add to the negative repercussions of POPs and make it more difficult to assess their impact. The Arctic species at highest risk include polar bears, killer whales, ringed seals, several species of seabirds, such as gulls, as well as a few populations of Arctic char and Greenland shark (Letcher et al., 2010). It can also be argued that the low biodiversity of the Arctic ecosystem, home to a few key species, makes the region particularly vulnerable to the effects of pollution (Koivurova, 2005; Arctic Council, 2013).

A prominent example of Arctic wildlife affected by POPs are peregrine falcons and other birds of prey. While they nest along Alaska's Yukon River, their migrations south exposed them to DDT, which led to a thinning of the eggshells and substantially harmed the reproduction of the population. Peregrine falcons were classified as endangered under the 1969 U.S. Endangered Species Conservation Act. Soon after DDT was banned, the population recovered and the U.S. Fish and Wildlife Service eventually proposed delisting American peregrine falcons from the federal list of threatened and endangered species in 1998, which was accepted a year later (Florida Fish and Wildlife Conservation Commission, 2009). This example reveals how toxic persistent organic pollutants are and is indicative of the short amount of time needed to critically endanger wildlife or human health. Long-term monitoring to gain a comprehensive understanding of the ramifications of diverse substances on the environment is therefore crucial (Ambrose et al., 2016). It is further important to consider continuously new chemicals for listing. In 2011, flame retardants were detected in peregrine falcon populations in Spain and Canada, whereby the latter exhibited higher levels of 'dechlorane plus' and other chlorinated compounds used on products to inhibit the spread of fire (Guerra et al., 2011).

Another case of highly affected species is the wild reindeer, also known as caribou in North America. Already in 1997, a study by the Arctic Monitoring and Assessment Program (AMAP) indicated the accumulation of PCB over the reindeer's food chain. Compared to the contaminated lichen on which they feed, the reindeer in Canada's Northwest Territories had ten times higher levels of PCB. In turn wolves' PCB levels were 60 times that of the lichen at the bottom of the food chain. In 2010, as the only terrestrial mammal included in the studies on POP levels, Muir and de Wit noted a decline of the levels of "legacy POPs", which were the initial twelve chemicals included in the 2001 Stockholm Convention on POPs (Stockholm Convention b, n.d.), in reindeer from northern Sweden. However, new pollutants of emerging concern were measured in later studies. Last year, Wang et al. (2015) found flame retardants – in this case polybrominated diphenyl ethers or PBDEs - in the feces of wild reindeer on Svalbard and in one of their favorite foods: moss. Brominated flame retardants (BFRs) were recognized as pollutant of emerging concern in the 2004 AMAP Assessment. They were extensively used for several decades in a wide range of commercial and household products, ranging from plastics to textiles and electronic equipment, and can be released into the environment during production, use or dismantling of the products.

Climate Change as Game Changer and the Consequences for Governance

Release, Distribution and Degradation of POPs

The release, distribution and degradation of POPs is highly dependent on environmental factors, which is why climate change is likely to have a great impact on POP contamination through changes in:

- emission sources,
- transport processes and pathways, and
- degradation processes (UNEP/AMAP, 2011).

After initially decreasing trends, higher levels of gexachlorobenzene and PCBs, whose use has been restricted and which are no longer produced, were observed in the Arctic in the mid-2000s. The Arctic Climate Impact Assessment (ACIA) report of 2004 warned that global warming is likely to speed up the transport of pollutants to the Arctic and increased precipitation would lead to more POP deposits in the Arctic. In addition, the melting of snow and ice – and similarly permafrost – releases the contaminants accumulated over decades in the form of melt water, which will then enter the food web. Increased frequencies of forest fires due to climate change could also release increasing amounts of pollutants into the Arctic air (Muir, 2010; Hung et al., 2010).

POPs have low water solubility. As a result, they are harder to dissolve in water and evaporate more easily. They bond strongly to particulate matter in aquatic sediments, which then serve as "sinks" for the pollutants. In the case of global warming, which disturbs the ecosystem, they might be released. Warmer temperatures lead to a heightened volatilization of the pollutants, which can boost their mobilization from primary sources. This is likely the most important effect of climate change on POP releases. By contrast, in colder temperatures, the chemical compounds are less volatile. The degradation of POPs is likewise temperature-dependent. They are thus likely to degrade faster in warmer temperatures due to the higher degradation capacity of microorganisms. Yet this factor is deemed as less influential. Other factors directly linked to climate change include wind fields and speed, whose local or regional growth could amplify airborne transport, precipitation rates, which influence atmospheric deposition patterns, ocean currents, and a higher frequency of extreme weather events (UNEP/AMAP, 2011).

Likewise, emissions from secondary emission sources, i.e. from remaining stocks such as PCBs still present in buildings and electrical equipment or POP stores in natural "sinks", are also likely to increase due to the higher volatility of POPs in warmer temperatures. They hamper estimates of primary emissions (Lamon et al., 2009).

Ecological Effects

Indirect effects of global warming are changes in patterns of Arctic land use and emissions, such as an intensification of activity in the Arctic through mining or shipping (Hung et al., 2016). Migration routes of wildlife could also be affected. The Pacific salmon for instance may move northwards into Arctic rivers. Changes in bird migrations might transport POPs from marine to freshwater environments, where they can concentrate under certain circumstances, as was the case in a specific watershed at Lake Ellasjoen on the Svalbard archipelago (AMAP, 2004).

Seasonal changes of animals' food intake and correlated processes of fattening and emaciation alter the distribution of POPs in animal tissue and their toxic effects. Climate change and rising temperatures do affect these feeding cycles. The earlier break-up of ice for instance can cause temporal and nutritional shifts in the diet of polar bears. The ripples from these changes might go through the entire food web (Letcher et al., 2010).

Diseases and species invasion that are due to climate change can affect the distribution of the pollutants in the ecosystem and individual animals and impede their adaptation capacity (Muir, 2010). Climate-related changes in biodiversity, ecosystem composition, function and vulnerability will further affect the distribution and toxicity of POPs (UNEP/AMAP, 2011).

Human Adaptation as Additional Factor

Certain adaptations by populations affected by the repercussions of climate change could contribute to a surge in POP levels. The greater risk of vector-borne diseases associated with warmer temperatures might promote the demand for certain POPs, whose use is exempted for public health reasons against malaria-transmitting mosquitoes, for instance DDT in India or sub-Saharan Africa (WHO, n.d.).

Climate change mitigation policies that are aimed at reducing carbon dioxide emissions are generally likely to entail a reduction of unintentionally produced POP emissions. However, some measures could worsen emissions of specific POPs. Promoting biomass fuel could for instance lead to an increased release of toxic chemicals due to the fuel's incomplete combustion.

For human populations, the different stressors stemming from climate change, such as migration, and changes in the availability and quality of local or traditional food, could change their exposure to POPs and increase their vulnerability (UNEP/AMAP, 2011).

Climate change may thus reduce the efforts and effectiveness of the Stockholm Convention, but it is currently not possible to reliably estimate the extent of the potential exposure changes for humans and wildlife (UNEP/AMAP, 2011). The AMAP flagship project "Adaptation Actions for a Changing Arctic" (AACA) examines the interaction of several drivers of change, such as climate change, global resource demands, tourism, global transport, fisheries, and economic development. This will also shed light on the interactions between climate change and POP trends (AACA, n.d.).

The Primacy of Health

Similar to the effects on wildlife, POPs also represent a serious threat to human health and well-being. People living in the Arctic are considered to be especially vulnerable to POP emissions and likely will become even more exposed to emissions due to climate change (UNEP/AMAP, 2011). As high levels of POPs were unexpectedly found in the 1970s and 1980s in the Arctic, an area thought to be largely unpolluted, the issue rose to global prominence. The presence of pollutants in the Arctic, far away from the main source or use area of these pollutants, demonstrated that the chemicals must have been transported over great distances and played a substantial role in subsequent international efforts to limit POPs emissions.

The main source of human contamination in the Arctic is the consumption of traditional Arctic subsistence food, especially traditional marine food, which is central to the diets of Arctic indigenous peoples. As many of the animal species consumed are high up in the food chain and rich in fat, they have elevated levels of POPs. Another factor exacerbating the problem are the high food prices in the North, resulting in a greater dependence of the local population on subsistence foods and therefore aggravating their exposure to the harmful effects of persistent pollutants. The pollutants are further transmitted to future generations through the placenta and breast milk (AMAP, 2015). However, there are great regional differences in the threat that POPs pose, due to environmental and socio-economic factors.

The main health issues related to POPs are the following:

- **Neurobehavioral:** damage to the nervous system. Prenatal and postnatal exposure in children can impair brain development, with symptoms like decreased motor function, attention span, verbal abilities and memory.
- **Immunological:** higher general susceptibility to diseases through the damage of the immune system.
- **Reproductive:** lower level of semen quality and lower capacity for testosterone production, birth defects, dysfunctional reproductive systems.
- **Cardiovascular:** elevated blood pressure.
- **Carcinogenic:** certain types of cancers.
- **Endocrine:** mimicking, interfering or blocking of the function of endogenous hormones, which in addition to adverse developmental, reproductive, neurological, cardiovascular, and immune effects, is also associated with metabolic disorders and type 2 diabetes.
- **Others**, such as the alteration of bone metabolism and increase in bone fragility (UNEP/AMAP, 2011; AMAP, 2015; Stockholm Convention, 2001; NOAA, n.d.).

Policy Developments and Governance

National Initiatives

Prior to international and circumpolar efforts to control POPs, their use and production was already restricted in some countries (Arctic Council, 1991). The United States for instance signed a bilateral agreement with Canada for the Virtual Elimination of Persistent Toxic Substances in the Great Lakes and provided ample financial and technical support to countries across the globe supporting the reduction of POPs (EPA, 2009). They signed but did not ratify the regional protocol of the United Nations Economic Commission of Europe (UNECE) on POPs under the Convention on Long-range Transboundary Air Pollution (CLRTAP). The use of the original "Dirty Dozen", the POPs first included in the Stockholm Convention, is banned within the United States, but several substances more recently added to the Stockholm Convention, such as different flame retardants, continue to be used. Some of the chemicals, like chlordane, are still manufactured for export (Morales, 2014).

Circumpolar and Global Initiatives

The Arctic Environmental Protection Strategy (AEPS) and Arctic Monitoring and Assessment Program (AMAP)

The so-called “Rovaniemi Process” – initiated by Finland – started with a conference on the protection of the Arctic environment. Two years later, the eight Arctic nations Canada, Greenland/Denmark, Finland, Iceland, Norway, Russia, Sweden and the United States signed the non-binding Arctic Environmental Protection Strategy (AEPS) in 1991. Among the three main reasons for the agreement was the finding of abnormally high levels of POPs and heavy metals in Arctic indigenous peoples, in particular of PCB in breast milk samples from Inuit women in northern Canada (Arctic Council, 1991).

The states committed themselves among other things to cooperation on scientific research on pollution issues, in particular POPs, to the control of pollutants and the reduction of their effects on the Arctic environment. To this means, five programs were established, among which the Arctic Monitoring and Assessment Program (AMAP) is mandated to watch over pollution and climate change issues in the Arctic, monitor their levels in the Arctic air, water and biota and assess their effects. Besides oil pollution, heavy metals, noise, radioactivity and acidification, persistent organic contaminants were defined as priorities in the 1991 Rovaniemi Declaration on the Protection of the Arctic Environment. As a result, AMAP also has a strong emphasis on POPs (AMAP, n.d.).

Table 1: Inclusion of POPs in International Agreements

AEPS 1991	Aarhus Protocol under CLRTAP 1998	Stockholm Convention 2001: "legacy POPs"	Amendments listing additional chemicals 2009	Amendments listing additional chemicals 2011, 2013, 2015
Chlordane	Aldrin	Aldrin	Alpha hexachlorocyclohexane	Technical endosulfan and its related isomers
Dichlorodi-phenyltrichloro-ethane (DDT)	Chlordane	Chlordane	Beta hexachlorocyclohexane	Hexabromocyclododecane
Polychlorinated biphenyls (PCBs)	Chlordecone	DDT	Chlordecone	Hexachlorobutadiene
Toxaphene	DDT	Dieldrin	Hexabromobiphenyl	Pentachlorophenol and its salts and esters
	Dieldrin	Dioxins	Hexabromodiphenyl ether and heptabromodiphenyl ether	Polychlorinated naphthalenes
	Endrin	Endrin	Lindane	
	Heptachlor	Furans	Pentachlorobenzene	
	Hexabromobi-phenyl	Hexachloro-benzene (HCB)	Perfluorooctane sulfonic acid, its salts and perluorooctane sulfonyl fluoride	
	HCB	Heptachlor	Tetrabromodiphenyl ether and pentabromodiphenyl ether	
	Mirex	Mirex		
	PCBs	PCBs		
	Toxaphene	Toxaphene		

In the AEPS, the combined effort of the Arctic states towards international cooperation on a global level deserves special attention. Recognizing that the control of POPs in the Arctic required cooperation on a wider geographical scale, the Declaration on the Protection of the Arctic Environment associated with AEPS laid down the resolution of the Arctic nations to "pursue together in other international environmental fora those issues affecting the Arctic environment which require broad international cooperation" and support and promote cooperation (Arctic Council, 1991: 3). The support of the process to include POPs into the CLRTAP, which was underway at that time and culminated in the 1998 Aarhus Protocol on POPs (Arctic Council, 1991) is a good example of the Arctic states' encouragement of international cooperation.

Convention on Long-Range Transboundary Air Pollution (CLRTAP)

Before negotiations started on the AEPS, work was already underway within the Geneva Convention on Long-Range Transboundary Air Pollution (CLRTAP) of the United Nations Economic Commission for Europe (UNECE) to integrate the emerging problem of POPs. This first international legally binding agreement was signed in 1979 and entered into force in 1983. In 1998, it was extended by the Aarhus Protocol on Persistent Organic Pollutants (POPs), which comprises 16 substances (UNECE b, c, n.d.). Seven of the Arctic States – Russia being the exception – are signatories of the protocol. The United States, however, did not ratify the Aarhus Protocol (United Nations, n.d.; de Wit & Muir, 2010). Denmark declared that the amendments to Annexes V and VII, which regulate the use of best available technologies (BAT) to control emissions shall not apply to Greenland (United Nations, n.d.).

The Role of the Arctic Council

The Arctic Council has a long history of advocating for the resolution of environmental issues. When the Arctic Council was established in 1996 in Ottawa, Canada, it subsumed the AEPS programs. In the Declaration on the Establishment of the Arctic Council (1996), the Arctic states set as one goal of the Council to promote "cooperation, coordination and interaction among the Arctic States, with the involvement of the Arctic indigenous communities and other Arctic inhabitants on common Arctic issues, in particular issues of sustainable development and environmental protection in the Arctic." Continuing the course of the AEPS, the protection of the environment was assigned a great value among the tasks of the Arctic Council. The importance of environmental issues is underlined by the fact that all the working groups of the Council (ACAP, AMAP, CAFF, EPPR, PAME, SDWG) deal mostly with environmental issues (Koivurova, 2005). Another principle of the AEPS that the Arctic Council consolidated is the active involvement of the indigenous and local population and the recognition of their "special and unique contributions" and "traditional knowledge" (Arctic Council, 1991).

In 1998, the Arctic Council ministers requested an Action Plan to Eliminate Pollution of the Arctic from the Senior Arctic Officials, which resulted in the Arctic Contaminants Action Program (ACAP). The plan re-stated the recommendation to participate in international fora and agreements and the desire to develop stronger links with international bodies, intergovernmental organizations, financial institutions, observers, the private sector and NGOs relevant to pollution reduction and to urge other countries to take measures through these bodies. It further advocated the "integration of environmental concerns in economic, administrative and research sectors" (ACAP, 2000).

The Arctic Council also played an important role in the negotiations of the Stockholm Convention on Persistent Organic Pollutants during Finland's Chairmanship from 2000 to 2002. Later, it was vital for the implementation of the Convention under the Icelandic Chairmanship from 2002 to 2004 (Koivurova, 2005).

Previously, however, the rotating chairmanship and lack of permanent secretariat of the Arctic Council left much room for setting individual priorities and focal points during the chairmanship tenures, which might have worked against a continuous work on specific environmental issues (Koivurova, 2005). A Standing Arctic Council Secretariat was established in Tromsø, Norway, in 2011 and became operational in 2013 (Arctic Council, 2016). This permanent secretariat might contribute to a more consistent approach.

Stockholm Convention on Persistent Organic Pollutants

The Stockholm Convention built on the 1998 Aarhus Protocol (UNECE a, n.d.) is a legally binding international agreement on a global level. It was adopted in 2001, entered into force in 2004 and is managed by the United Nations Environment Program (UNEP). As of today, 179 parties have ratified the Convention, including the Arctic states with the exception of the United States. Denmark ratified, but excluded the territory of Greenland and initially also the Faroe Islands from the provisions. Canada and Russia have ratified the original treaty, but not its subsequent amendments listing additional pollutants, such as endosulfan and HBCD, as POPs (Stockholm Convention a, n.d.).

The Stockholm Convention refers to the vulnerability of Arctic regions and their inhabitants. Paragraph 3 of its preamble states “that the Arctic ecosystems and indigenous communities are particularly at risk because of the biomagnification of persistent organic pollutants and that contamination of their traditional foods is a public health issue.” During the negotiations for the Convention, Sheila Watt-Cloutier, former vice president of the Inuit Circumpolar Council, in particular cemented the awareness of the public health threat stemming from POPs, symbolized by a carving of an Inuit mother and child (Kohler, 2011).

Recognition of Indigenous Peoples and Traditional Knowledge

In the negotiations of various circumpolar agreements, as well as in the global agreements such as the Stockholm Convention, great importance was attached to the involvement of indigenous peoples, their knowledge and their well-being.

During AEPS negotiations, the Arctic indigenous peoples were represented by the Nordic Saami Council, the Inuit Circumpolar Conference (ICC) and the Association of Indigenous Minorities of the North of the Russian Federation as observers (Arctic Council, 1991). Other observers included the United Nations Economic Commission for Europe (UN ECE), the United Nations Environment Program (UNEP) and the International Arctic Science Committee (IASC). The Declaration on the Protection of the Arctic Environment further acknowledges the “special relationship of the indigenous peoples and local populations to the Arctic and their unique contribution to the protection of the Arctic Environment.” It places special emphasis on the respect of the “traditional and cultural needs, values and practices of the indigenous peoples as determined by themselves, related to the protection of the Arctic environment” (Arctic Council, 1991: 9). The AEPS thus aimed at integrating both traditional knowledge and scientific research. Likewise, the Arctic Council Action Plan further re-emphasized the need for involving local and indigenous communities and the recognition and use of traditional knowledge and advised a precautionary approach.

The Arctic Council’s acceptance of indigenous organizations as Permanent Participants set a precedent. Nevertheless, more recently, the five Arctic coastal states issued the 2008 Ilulissat Declaration stating their “unique position” and thus supremacy in Arctic affairs. This challenges the previous implicit agreement on who is a legitimate stakeholder in Arctic issues, which included indigenous peoples. In the Ilulissat Declaration, they were completely left out, just like the three “non-coastal” Arctic states (Young, 2010).

During the negotiations for the CLRTAP, indigenous peoples played an active role raising awareness on the harmful effects of POPs and advocating their limitation. In the last years of the negotiations, indigenous groups established the Northern Aboriginal Peoples Coordinating Committee on POPs to coordinate their presence at the meetings. One year later, in 1998, they were among the 400 advocacy groups that formed the International POPs Elimination Network to support a global response (Fenge & Downie, 2003).

The Arctic as an Indicator Region

Already in the AEPS, the Arctic is presented as an indicator region, which "exerts an important influence on the global environment" (Arctic Council, 1991: 7). In combination with the leading role of POP research in the Arctic, the acknowledgment of the typical characteristics of POPs in the Stockholm Convention, namely their long-range transport and presence in regions far from the emission source, furthered the position of the Arctic as an indicator region (de Wit & Muir, 2010).

With regards to the framing of Arctic issues for purposes of policymaking, Oran Young (2010) refers to the accentuation of the links between Arctic processes and global systems, which was symbolized among others by the 2004 Arctic Climate Impact Assessment (AMAP, 2004). The presence of POPs in the Arctic is a case in point, showing the complex linkages that need to be addressed when thinking about environmental governance of the Arctic. The Arctic Council here played a substantial role in advancing an ecosystem-based management approach, which views the Arctic as a "complex and dynamic socio-ecological system" and gives preference to an integrated approach to address interrelated Arctic issues (Young, 2010: 174). In the case of POPs, evidence of their dispersion and harmful effects in the Arctic were essential in negotiations and the image of the Arctic as an indicator region was readily adopted (Downie & Fenge, 2003; Young, 2010).

Ratification Differences Among the Arctic States

Interestingly, since the Arctic Council has no law-making or enforcement mechanisms, the national environmental laws of the Arctic states – however restricted by international treaties – apply to most of the region, with the exception of the "high sea" areas. These areas beyond the 200 nautical miles Exclusive Economic Zones (EEZ) of the Arctic coastal states are subject to the United Nations Convention on the Law of the Sea (UNCLOS), which obliges the states "to protect and preserve the marine environment" (United Nations, 1982: 100). While playing an important role in developing global environmental regulations, in the circumpolar region, the Council has thus been limited to recommendations and guidelines.

The example of the United States is striking in this regard. While they implemented several measures against POPs, the United States have until now refused to ratify the Stockholm Convention and have signed, but not ratified the CLRTAP. Arctic indigenous communities' efforts to raise awareness of the urgency and the dangerous effects of POPs on their health have had only limited success. In 2015, Vi Waghiyi of the traditional Yup'ik community Savoonga, Alaska, wrote in an open letter to Alaska Dispatch News: "The United States is one of only a handful of nations which have not signed the Stockholm Convention, and so is not bound by this latest ban. The U.S., along with Canada, remains the highest user of this toxic chemical [PCP or pentachlorophenol]." The U.S. Department of State (n.d.) explains the failure to ratify in the "current lack (of) the authority to implement all of its provisions", referring to the required approval by the Senate. However, the "United States participates as an observer in the meetings of the parties and in technical working groups." Not being party to the treaty has drawbacks such as not being able to take part in decisions on the inclusion of additional substances to the Convention, which has been a central issue in debates on the Convention's ratification. The lack of influence worries not only the U.S. Environmental Protection Agency (EPA), but chemical industry groups as well, who do not get the opportunity to act on or block the global listing of new substances (Schor, 2010). What is more, the necessary legislative changes to the Toxic Substances Control Act (TSCA) and the Federal Insecticide, Fungicide, and Rodenticide Act (FIFRA) prove to be extremely challenging despite serious attempts by several governments. In particular, no agreement could be reached on how the government should react to decisions under the Stockholm Convention to add additional chemicals to the list of limited or banned substances (Bang, 2011).

Effectiveness of Measures

POPs Level Trends

The level of POPs is monitored at four sampling stations in the Arctic: Alert in Canada, Pallas in Finland, Stórhöfði in Iceland and Zeppelin in Svalbard, Norway. The legacy POPs have half-lives of 5 to 15 years, which means that after this time, 50% of the chemicals still remain in the environment (AMAP, 2015). Most of the pollutants listed under the Stockholm Convention show a declining trend in the Arctic air and biota, which suggests that the efforts of limiting and banning POPs under the Stockholm Convention and previous regulations did effectively bear fruit (AMAP, 2014, AMAP, 2015). Hung et al. (2016: 9) view these trends as "evidence of progress achieved as a result of national and international control measures". However, most of these POPs have been banned for decades, often 20 to 30 years, in many countries, but can still be observed now, underlining just how persistent the pollutants are. One conclusion we can draw is the importance of a timely and geographically wide-spread ban.

The levels of hexachlorobenzene (HCB) and lighter PCBs increased at some measurement locations. Reasons for this could be continuous primary emissions or the effects of a warming climate, which could lead to increasing secondary emissions. Due to the retreating Arctic sea ice, they might be revolatilized from the open ocean (AMAP, 2014). The case of PBDEs also hints to differences in local conditions, proximity to the key source regions and the potential for long-range atmospheric transport (Hung et al., 2010). Whereas its levels are declining in European Arctic air, this is not the case in the Canadian Arctic. This might be due to previously higher usage in North America (Hung et al., 2016) and its usage at nearby military sites (AMAP, 2014). Another example of regional differences in the trends is DDT, whose levels consistently decline only at the Zeppelin station on the Norwegian archipelago Svalbard, while they have levelled at the other stations (AMAP, 2014). Of the POPs more recently added to the Stockholm Convention, HBCD already shows a decline at the Svalbard sampling station (AMAP, 2014).

Many of the monitoring time-series began decades before the Stockholm Convention, since the early 1990s in the case of the four Arctic stations. Especially the declining trends they show are thus likely to reflect regulations at the national level prior to the Stockholm Convention (AMAP, 2014). The phase-out of toxaphene in the southern USA in the early 1980s, as well as the phase-out of technical HCH in China and Russia have coincided with the decline of their measured levels in Arctic air (Li & Macdonald, 2005).

Another factor that needs to be taken into account when evaluating the effectiveness of agreements and policies is secondary emissions. Warmer temperatures lead to increasing emissions from POP storages, such as water or land masses, which are generated in atmospheric reactions between contaminants. As the primary emissions decrease, secondary emissions might be the reason for the slower declining rates, such as DDTs, aldrin and dieldrin, PCBs and chlordanes. They seem to be approaching a steady state, which in the absence of further primary emissions can be traced back to secondary sources that are becoming more important (AMAP, 2014).

The decline of some POP levels in human tissues could also be a reflection of a change in the diet of indigenous people to a more western diet (AMAP, 2015). What is more, the Convention entered into force only in 2004, so it might be too early to come to scientifically sound conclusions as to the effectiveness of the treaty, Oran Young (2010) indicates that the Stockholm Convention focused on chemicals, the "dirty dozen", that most signatory countries had already banned prior to the Convention, which might suggest that the Convention is or has been of subordinate importance regarding the regulation of POPs. Notwithstanding, it represents one of the most updated and comprehensive regulations of POPs and advocates global action, which is particularly important in the case of pollutants that are transported over long distances.

The data from the second AMAP Assessment Report on POPs published in 2004 pointed to "new" contaminants reaching the Arctic, such as brominated flame retardants (BFRs) (de Wit & Muir, 2010). Of the emerging contaminants of concern, many are chemicals of commerce, such as PFOS (perfluoroctansulfonat), and do have pollution sources in the Arctic, for example in homes or landfills. Some of these chemicals are more volatile than most "legacy POPs", which makes them more difficult to trace as they might pass through conventional samples. As a result, their actual level might not accurately be reflected in monitoring data. The additional challenges and financial and technical constraints of sampling and analyzing an ever increasing list of chemicals of emerging concern have led to reduced sampling frequency and scope and in general less research of legacy POPs (Hung et al., 2016). This is not without consequences as it weakens the ability to detect trends and the scientific basis for political action (AMAP, 2014).

Monitoring Agreements and Scientific Cooperation

The need for international cooperation on research on pollution was already identified in the 1991 Arctic Environmental Protection Strategy. As mentioned above, long-term monitoring of POPs takes place in Canada, Iceland, Svalbard and Finland. In the Russian Arctic, POPs were so far monitored and assessed only on a campaign basis for 1 to 2 years at four locations. It is thus not possible to evaluate temporal trends for these locations and compare the development to other Arctic sites. To address this data gap, two Russian air monitoring stations are currently being established in Amderma (Nenets Autonomous Okrug) and Tiksi (Sakha Republic - Yakutia) (Hung et al., 2016). In addition, AMAP and NOAA (n.d.) point to data gaps in the United States.

Conclusion

The health case against persistent organic pollutants, which surfaced in the Canadian Arctic in the 1970s and 1980s, proved a powerful impetus in the Arctic states' endeavor to ban POPs on a global level. The states' cooperation achieved a ban of POPs on a circumpolar scale and eventually POPs were recognized internationally as a problem in need of urgent attention. This resulted in the 1998 Aarhus Protocol to the Convention on Long-range Transboundary Air Pollution and the 2001 Stockholm Convention of POPs, which currently lists 26 chemicals that have been or are still being phased out.

During the negotiations for these agreements, the Arctic was promoted as an indicator region of the global environmental state, in particular regarding climate change and pollution. In addition, the recognition of the complex linkages between different geographic regions and factors furthered an ecosystem-based management approach.

Research has shown that the ban of certain POPs decades ago contributed to decreasing levels in the Arctic and benefitted wildlife populations and ecosystems, which subsequently did recover from the damages caused by the toxic chemicals. However, the geographic distribution and development of POP levels is still not enough understood to reliably connect the decreasing levels of some POPs at some sites to specific limitations or bans. Much more research is thus needed. The global cooperation on research and monitoring is a good step in the right direction and should be furthered.

Nevertheless, the ratification and implementation of the provisions of the Stockholm Convention, as well as the continuous update of the list of POPs should therefore have a positive effect on the environment, as well as on the public health, in particular of Arctic indigenous people. It can be suggested that the Arctic countries should ratify the Stockholm Convention without exceptions and phase out these extremely harmful pollutants, including pollutants of emerging concern that are regularly added to the Convention. The inclusion of all Arctic territories, such as Greenland, is another missing piece in the puzzle. In addition, due to the long-range character of POPs, the Arctic states should keep up their proactive stance towards international regulation in order to reduce POP levels globally.

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