



# Summary for Policy-makers

## Arctic Pollution Issues 2015

Persistent Organic Pollutants; Radioactivity  
in the Arctic; Human Health in the Arctic

## 2 Why is pollution a concern in the Arctic?

The Arctic remains one of the least polluted areas of wilderness on the planet. Limited human development in the region means that local sources of anthropogenic pollution are also limited. Nonetheless, its unique geographical, climatic and biological characteristics mean that the Arctic is a 'sink' for certain pollutants transported into the region from distant sources, and pollutants from local sources with similar properties also tend to persist in the environment for long periods due to low temperatures and low biological activity.

The region is a focus for major atmospheric, riverine and marine pathways that carry contaminants over long distances. These forms of long-range transport include strong south-to-north airflows, northward-flowing Arctic rivers which can lead to local and regional dispersal of contaminants, and ice and ocean currents that can store and transport pollution.

It was to monitor such pollution that the Arctic Monitoring and Assessment Programme (AMAP) was established in 1991. Since then, AMAP has carried out a number of assessments of the extent and effects of pollution in the region.

The 2014 round of AMAP assessments<sup>1</sup> examines four classes of pollutant:

### Persistent Organic Pollutants (POPs)

POPs are long-lasting chemicals that pose health risks to ecosystems and humans. They can be transported long distances and deposited far from their sources of release. They tend to accumulate in the fatty tissues, milk and blood of living organisms, and can have effects on health, including disruptions to immune, hormone and reproductive systems.

A growing number of national and international controls have been introduced on POPs. The globally legally binding 2004 Stockholm Convention targeted an initial 12 chemicals (see figure), with a further 11 controlled since 2009, and three more proposed to be added to the convention in 2015. Many of the currently listed 23 chemicals are often referred to as 'Legacy POPs', as their environmental contamination is mainly a legacy of past use.

### Chemicals of emerging concern

In addition to these internationally controlled compounds, many hazardous chemicals currently in commercial use have the potential to be transported to and accumulate in the Arctic environment, but are not yet regulated by international agreement nor, in most cases, at national level. These compounds include some flame retardants, including brominated flame retardants (BFRs), perfluorinated compounds, siloxanes and some current-use pesticides.

### Heavy metals

Heavy metals such as mercury accumulate in higher predators at the top of Arctic food chains, posing a dietary risk to humans. Methylmercury, an organic form of mercury, poses the main risk to human and ecosystem health. As with POPs, methylmercury can be transferred to the fetus and to breast-fed children. New studies of children exposed to methylmercury during fetal development show adverse and apparently permanent effects on their neurodevelopment.

Major sources of atmospheric mercury are the burning of coal and the chemical's use in artisanal and small-scale gold mining, both of which have been rising in recent years. The Minamata Convention, which was agreed in 2013, aims to reduce emissions from these and other sources.

### Radioactivity

The Arctic is vulnerable to radioactive pollution transported from distant sources, whether by ocean currents or via the atmosphere. These sources include the atmospheric nuclear tests conducted in the 1950s and 1960s, nuclear fuel reprocessing, historical dumping and, more recently, accidents such as those at nuclear power plants in Chernobyl in 1986 and Fukushima in 2011.

Transfer pathways for certain radionuclides in the Arctic terrestrial environment can also lead to elevated human exposures. Moreover, the Arctic has a high density of sources of radioactive material, due to historical dumping of radioactive waste in some areas of the Russian Arctic, incomplete decommissioning of nuclear equipment and the inadequate storage of waste.

<sup>1</sup> AMAP Assessment 2015: Human Health in the Arctic; AMAP Assessment 2015: Radioactivity in the Arctic; Trends in Stockholm Convention Persistent Organic Pollutants (POPs) in Arctic Air, Human media and Biota. AMAP Technical Report No. 7 (2014).

## Impacts on human health

These contaminants threaten Arctic ecosystems and the people who live in the region. Specifically, indigenous Arctic peoples tend to have traditional diets that depend heavily on harvesting local wildlife. These diets are important for social, economic and cultural reasons, and have health and economic advantages over diets that rely on expensive store-bought foods shipped from the south. However, because contaminants can accumulate in animals used as traditional foods, Arctic populations who consume them are among the most exposed in the world to certain toxic chemicals.

The level of concern to humans that these four groups of contaminant raise varies depending largely on levels and trends of environmental contamination and the extent to which traditional foods are consumed.



# What are the trends in terms of pollution levels?

Time-trend monitoring assessed by AMAP since the early 1990s shows how contaminant levels are changing. The monitoring results also indicate how national and international controls on long-range pollutants, shifts in indigenous peoples' diets, and risk communication interventions by public health officials may have affected Arctic residents' exposure.

Environmental pollution trends present a complex picture. While concentrations of many contaminants have substantially declined in some parts of the Arctic, others are influenced by multiple factors and do not show clear trends.

Generally speaking, those pollutants that have been regulated or banned are posing less of a threat to human and ecosystem health in the Arctic than in the recent past. However, levels of exposure in some cases continue to cause concern.

## POPs

In October 2014, AMAP published its latest analysis of trend monitoring studies tracking levels of POPs covered by the Stockholm Convention. These studies track POPs pollution in air, biota and humans in the Arctic. As well as showing generally decreasing trends in air and biota for most POPs considered, levels of POPs in the blood of Arctic residents have also generally declined over the past 20 to 30 years. This includes significant falls in DDT, its most common metabolite DDE, and most polychlorinated biphenyls (PCBs).

However, levels of some POPs, such as PCBs, in human blood remain higher in some Arctic regions than in most general populations in North America and Europe. Others, such as HCB, may be increasing.

## Chemicals of emerging concern

The 2009 AMAP POPs assessment documented the occurrence in the Arctic of chemicals, in addition to those studied in earlier assessments, that could pose a risk to human health and Arctic ecosystems.

Some of these, such as some polybrominated diphenyl ethers (a class of BFRs), hexabromocyclododecane (HBCD), endosulfan and perfluorooctane sulfonate (PFOS), have since been added to the Stockholm Convention's list of globally controlled substances. It is proposed that three more chemicals, pentachlorophenol, chlorinated naphthalenes and hexachlorobutadiene, will be added in May 2015. Others, such as newer BFRs and some current-use pesticides, remain unregulated at the global level.

Sufficient data now exist to analyse time trends for two categories of these additional chemicals: BFRs, in particular brominated diphenyl ethers (BDEs) and HBCD; and per- and polyfluoroalkyl substances (PFASs), including PFOS and perfluorooctonate (PFOA). Evidence of increasing levels of BFRs and PFASs in some datasets is a cause for concern.

## Heavy metals

Levels of mercury in human blood in Arctic populations in Norway and Sweden have now fallen to similar levels to those found in non-Arctic populations in these countries. Mercury levels remain elevated, and in some cases exceed guidelines, in parts of Greenland and Canada.

Levels of lead in humans have fallen in most Arctic countries, although they remain elevated in some parts of Russia and Arctic Canada.

## Radioactivity

The levels of anthropogenic radioactivity measured in the Arctic that are attributable to already identified sources are generally very low and declining. However, elevated levels of both naturally occurring and anthropogenic sources of radioactivity remain a concern.

# Why are trends moving the way they are?

There are several factors that help explain both the declines in concentration of some contaminants in the Arctic, and the increases in others.

## National and global controls are reducing pollution at source

The Arctic states, the Arctic Council and AMAP have played a leading role in focusing the attention of the global community on the need to take action to control pollutants of particular concern to Arctic peoples and the Arctic environment.

Specifically, in 1998, protocols on POPs and heavy metals (the latter addressing cadmium, lead and mercury) were added to the 1979 Convention on Long-range Transboundary Air Pollution (LRTAP). In 2004 the Stockholm Convention on Persistent Organic Pollutants entered into force, and as of January 2015 it addresses 23 chemicals. In both cases, these international agreements followed regulations at the national level that sought to reduce or eliminate many of these pollutants, as well as advocacy from Arctic Council members.

The rates of decline in Arctic air and Arctic wildlife of levels of POPs that have been regulated or banned for more than 25 years in developed countries – such as DDTs, aldrin, dieldrin, PCBs and chlordanes – are now slowing after substantial declines in the last decades of the 20th century. This indicates that there is little new additional transport of these POPs into the Arctic; they are approaching stable and generally low levels within the Arctic environment.

## Effective communication with Arctic communities can reduce exposure

Changes in diet associated with local dietary advice can help to reduce exposure to contaminants. For example, dietary advice in the Faroe Islands regarding consumption of pilot whale meat and blubber from 1986 to 2009 has been associated with reduced mercury exposure in women of child-bearing age and thus much lower mercury levels in their children's

blood. However, this advice had a considerable impact on Faroese cultural identity. There are other examples of effective communications in Canada and Greenland that have also contributed to reduced exposures. That said, assessing the effectiveness of risk communications continues to be a challenge, given the multiple factors influencing dietary advice.

## Risks from radioactivity are abating, or have been mitigated

The risks posed to health by radioactivity in the Arctic are falling, partly due to the natural decay of radionuclides previously released into the environment.

Also, earlier work by AMAP dating back to the mid-1990s has been instrumental in drawing attention to the risks posed by radionuclide sources in Arctic Russia. Since the last AMAP radioactivity assessment in 2009, progress has been made in addressing poorly stored nuclear waste, removing and decommissioning radioisotope thermal generators (RTGs), dismantling nuclear submarines and handling their spent nuclear fuel, and cleaning up the temporary storage sites at Gremhika and Andreeva Bay.

In this regard, the AMAP approach of actions based on scientific study and assessment can be seen as being very effective in reducing radiation risks in the Arctic region.

## But new potential sources of radioactivity have been identified

New potential sources of radioactive contamination in the Arctic include the decommissioning of nuclear power plants in Europe, which may lead to temporary increases in radioactive discharges that could eventually reach the Arctic. New nuclear power plants are also planned in areas where a nuclear accident could potentially affect the Arctic region, and many older plants have been granted extensions to their operating licenses.

# 6 What we don't know about pollution in the Arctic

Research on pollution in the Arctic has focused to date on a subset of risks and exposures, given that the resources available for pollution monitoring are limited. Pollution threats to the Arctic are continuing to evolve, exposing gaps in scientific understanding that are likely to become increasingly important. There is particularly limited knowledge about the cumulative effects on humans and Arctic wildlife of multiple stressors.

## There is growing concern about new, largely unmonitored chemicals

According to the European Chemicals Agency, the number of chemicals in use in the EU alone is greater than 30,000 and is growing by around 300 each year. Some of these chemicals are persistent and pose threats to human and environmental health. There is often limited information about the likely effects of these chemicals, and methods may not exist to monitor their presence in the environment or biota. These subjects will be addressed by a new POPs assessment that AMAP is currently undertaking.

## Limited understanding of effects

Whether the new contaminants that are being detected in the Arctic environment will have adverse effects is not known. Very few have been studied in the Arctic. The extent and degree of contamination is also poorly understood.

## Uncertain effects of climate change

Climate change is already affecting how contaminants cycle within the Arctic, for example by releasing contaminants stored in permafrost, sea ice and glaciers. Increases of HCB and PCBs in air at some Arctic sites have been attributed to their enhanced release from the open ocean following the decline of sea ice, and by glacier and permafrost melt.

The effects of climate change on Arctic food webs, and therefore on feeding habits and diets, can also affect the concentrations of pollutants in Arctic fauna and humans. These effects need to be understood and taken into account to interpret trends and to provide reliable information to policymakers.

Furthermore, there is limited knowledge about the effects of multiple stresses presented by climate change. Certain species under stress from climate change – for example from seasonal malnourishment – are likely to be more vulnerable to contaminant toxicity.

## Multiple cumulative exposures, endocrine effects

Arctic communities are exposed to multiple contaminants, to varying degrees depending on location and diet. However, our knowledge of toxic effects is to a large extent based upon laboratory studies of the effects of individual substances on



a small number of animal species. Studies of the complex interactions of mixes of contaminants on animal and human health are only in their infancy.

Many POPs affect hormone systems. Outside of the Arctic, adverse effects have been observed in some species of wildlife, for example seals in the Baltic, terns in Belgium and the Netherlands, and fish in the UK. There is emerging evidence of effects on humans, but these can be subtle and different chemicals can have counteracting effects, with a large number of chemicals involved. Also, for many such substances, it is not possible to establish safe levels of exposure.

## Implications of waste management of existing chemical stocks

The end-of-life waste management of products containing such chemicals will be an important factor affecting future levels of pollution in the Arctic. For example, many thousands of transformers that may contain PCBs remain in use, particularly in Russia and in China. Equally, PBDEs and HBCD flame retardants in electronics, building insulation, and vehicles could eventually become a significant source of Arctic pollution, as could new types of mercury-containing products such as compact fluorescent lightbulbs. There are also large stocks of obsolete pesticides that may yet pose a threat. These potential releases underline the need for continued monitoring of regulated chemicals.

## Pollution risks from increased exploitation of Arctic resources

The development of extractive industries in the Arctic will lead to increased pollution. Oil and gas extraction, particularly, raises the risk of major pollution incidents such as oil spills.

The waste streams produced in the extraction of hydrocarbons and minerals – such as uranium – contain naturally occurring radioactive substances found in bedrock. As climate change increases the accessibility of the Arctic, the likely increase in oil, gas and uranium extraction would lead to enhanced releases and mobilisation of naturally occurring radionuclides.

More generally, increased economic activity in the Arctic will lead to higher levels of locally occurring pollution, such as from flame retardants, pharmaceuticals, detergents, solvents and lubricants.



# What are the policy lessons?

The data generated by monitoring programmes become more valuable the longer the programmes run. With more than two decades of monitoring data, AMAP is now in a good position to assess the relative success of the various policies aimed at reducing Arctic pollution.

## Controls on pollutants have proven effective

The ideal situation is one where pollutants are not introduced into the environment in the first place. And the evidence is increasingly clear from monitoring data: national and international controls on pollutants have led to lower levels of regulated contaminants in the Arctic, and have proved effective in improving the health of people and wildlife.

Of particular note are the bans introduced on DDT and other POPs by a number of Arctic countries in the 1970s and 1980s, the 1989 Basel Convention on the Transboundary Movement of Hazardous Waste, and the 1998 Heavy Metal Protocol of the Convention on Long-range Transboundary Air Pollution.

The Stockholm Convention, which controls POPs and which entered into force in 2004, has prohibited or severely restricted many POPs found in the Arctic, significantly contributing to their decreasing levels in the region. The 2013 Minamata Convention on Mercury, which has yet to enter into force, is also anticipated to have a significant effect on Arctic mercury levels over the longer term. To reduce pollutants in the Arctic region, global measures such as these are needed in addition to actions by Arctic states.

Monitoring data provided by AMAP have helped build the case for global action, and have been effectively used by Arctic Council nations and by Arctic indigenous peoples groups to ensure that international agreement was ultimately reached.

## There is a need for more timely controls on chemicals of emerging concern

A large number of new chemicals are being developed and put onto the market each year, often with limited documentation and testing. Several decades can pass between the beginning of commercial use of a new chemical, understanding and awareness of any harmful effects, and agreement to ban or restrict its use. Taking into account

the substantial time lag between reduced emissions in the source regions and observed declines in the Arctic environment, rapid analysis and action by the international community is essential.

## Risk communication can help to reduce exposure

Targeted dietary advice in some areas of the Arctic has been associated with decreased levels of contaminant exposure. However, poor risk communication can lead to fear, confusion and undesirable changes in dietary behavior, with negative impacts on health and social and economic well-being in indigenous communities.

Cultural considerations, both in terms of how information is communicated and understood, and indigenous communities' relationships with traditional foods, must be taken into account in risk communication. A balance must be struck to address the 'Arctic dilemma' – warning of contaminant risks while emphasising the benefits of traditional diets.

However, risk communication can only provide short-term mitigation of the effects of Arctic contamination on human health. Continued efforts are required globally to reduce sources of contaminants affecting the region.

## Fukushima is a reminder of the risks of long-range radioactivity

The accident at the Fukushima Daiichi nuclear power plant underlined the importance of environmental monitoring in the region. It was thanks to the long-term radioactivity monitoring carried out by the national monitoring networks that contribute to AMAP that radioactive isotopes from Fukushima could be detected and the associated impacts assessed.

Such monitoring is invaluable in helping scientists understand the pathways for radionuclide transport to, within and from the Arctic, and the long-term effects of radioactive contamination within different environments and foodwebs.

Fortunately, the radioactive impact on the Arctic from Fukushima has so far proved minimal and of no concern to human health. But the accident serves as a reminder that the Arctic is not isolated from the rest of the world – and that a nuclear accident thousands of miles away can pose a risk to the region.

# What are the next steps?

The body of monitoring data accumulated by AMAP has proved invaluable in alerting the international community to risks posed to the Arctic by pollution, and providing the evidence to support international pollution-control agreements. The Arctic faces continuing threats from global and regional pollution, which are only likely to become more intense under the related pressures of climate change and increasing economic development.

## **AMAP therefore recommends that:**

### **The Arctic states and the Arctic Council continue to show leadership on international pollution control**

Long-range transport is the most significant source of Arctic contamination. International agreements to control pollution offer the most effective means of reducing contamination in the region. Arctic Council members should continue to promote the international pollution control agenda.

However, not all Arctic Council members have ratified the Stockholm Convention, and none have adopted all of its provisions as they relate to newly controlled substances. Most Arctic countries have yet to ratify the Minamata Convention – only the United States has done so – and they should be encouraged to do so as quickly as possible.

### **Additional unilateral, regional and global actions to control pollutants be considered**

Both the LRTAP and Stockholm conventions include mechanisms to increase the number of substances that they regulate. However, as noted, there can be a significant time lag between the emergence of concern about the effects of new chemicals, and their control by international conventions. Furthermore, the process of controlling new chemicals through international conventions is not adequate in light of the large numbers of potentially dangerous chemicals being introduced. Moreover, some types of chemicals of emerging concern may fall outside the scope of the existing conventions altogether.

The action taken by many Arctic countries in moving first with national and regional controls on harmful substances will be essential for responding quickly to future threats that are only now becoming apparent. These controls will need to be supplemented with international measures.

### **Monitoring programmes and research be continued, with increased capacity for new pollutants**

AMAP plays an important role in compiling the data to evaluate the effectiveness of international agreements to control pollutants, and in providing information in support of adding new contaminants to existing conventions. Effective time trend monitoring requires a well-defined strategy, consistently applied over many years. It can take 10-15 years before statistically significant time trends can be observed. Monitoring studies that screen for new contaminants are becoming increasingly important in addressing emerging chemical concerns.

The proliferation of new chemicals of concern will place additional pressures on monitoring programmes and AMAP's work. Additional resources will be required to ensure they are monitored effectively. To the extent that some contaminants are declining to levels that are no longer a concern, their monitoring frequency could be reduced to provide greater scope for monitoring chemicals of emerging concern. In addition, the archiving of samples in specimen banks is critical for assessing risks of new and emerging chemicals of concern.

AMAP should continue to build a comprehensive picture of the effects of Arctic contamination and other stressors on human health and ecosystems, using both science and traditional and local knowledge. Risk communication remains an important short-term mitigation strategy, but its effectiveness needs to be evaluated.



## Policy-makers Summary: Arctic Pollution Issues 2015

### Persistent Organic Pollutants; Radioactivity in the Arctic; Human Health in the Arctic

This document presents the Policy-makers Summary of the 2015 AMAP Assessments of Pollution Issues (POPs Trends; Radioactivity in the Arctic; Human Health in the Arctic). More detailed information on the results of the assessments can be found in the related Scientific Assessment Reports. For more information, please contact the AMAP Secretariat.

This document was prepared by the Arctic Monitoring and Assessment Programme (AMAP) Working Group and does not necessarily represent the views of the Arctic Council, its members or its observers.



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