THE ARCTIC MONITORING AND ASSESSMENT PROGRAMME (AMAP) CONTRIBUTION TO TEN YEARS OF GLOBAL MONITORING UNDER THE STOCKHOLM CONVENTION

Wilson SJ[1]*, Reiersen L-O[1]

[1]Arctic Monitoring and Assessment Programme (AMAP), Gaustadalléen 21, N-0349 Oslo, Norway

Introduction

The history of the Stockholm Convention is in many respects inextricably linked to the development of contaminants monitoring and research in the Arctic. It is therefore not surprising that the work carried out under the auspices of the Arctic Monitoring and Assessment Programme played, and continues to play, an important role in both the establishment of the Stockholm Convention and its continuing development.

AMAP was established in 1991 to fulfill parts of the Arctic Environmental Protections Strategy concerned with monitoring and assessment of a number of identified priority 'pollution issues of concern'. From the outset, one of these priority issues concerned persistent organic pollutants POPs. Studies during the late-1970 and 1980s had, at the time to the surprise of many, found POPs to be present in the Arctic environment, and at relatively high levels in some biota. With little use of POPs within the Arctic and the remoteness of the region from main source/use areas, long-range transport was the only possible explanation. One of the first major activities of AMAP was to establish a coordinated Arctic monitoring programme, based as far as possible on the ongoing national monitoring and research activities of the Arctic countries, harmonizing and extending these where necessary.

AMAPs initial assessment of Arctic Pollution Issues (published in 1998[1,2]) was designed to establish a baseline for further work and included a strong POPs component. The outcome of the 1998 AMAP assessment was a vast increase in information available concerning the presence of POPs in the Arctic. This information provided the documentation necessary to substantiate calls for political action to address, in particular, the high exposures to PCBs, DDTs and other POPs that were found in some Arctic biota and (Arctic indigenous) human populations. Subsequent AMAP assessments of POPs (and human health) in the Arctic[3,4,6,7,8,9], including a first assessment of possible influence of climate change on POPs transport[5], only strengthened these calls for action. The most recent AMAP assessments, including one currently underway, document the progress that has been achieved through efforts in recent decades, but also demonstrate the need to continue to monitor POPs as new chemicals enter use.

The value of Arctic (background) monitoring data in documenting, especially the environmental persistence of a number of chemicals, along with the active role played by Arctic indigenous people's representatives was critical to the negotiations that resulted firstly in the agreement of the POPs Protocol to the UN ECE Convention on Long-range transported pollutants and shortly thereafter the global agreement to tackle the 'dirty dozen' – the Stockholm Convention on Persistent Organic Pollutants. Lessons learned during the establishment of the AMAP programme also proved of considerable valuable in the development of the Stockholm Convention Global Monitoring Program for POPs.

This presentation provides a short review of this history, but focusses more on developments since 2004, and the way that AMAP work has been adapted to support the further development of the Stockholm Convention through expanding the monitoring of POPs in the Arctic region, compiling data and making this available, delivering results that support the Stockholm Convention Article 16 effectiveness and sufficiency reviews, and work to identify new POPs of concern. It also highlights the coordination between AMAP and key national and international monitoring programmes, such as the Canadian Northern Contaminants Program (NCP) and UNECE EMEP programme to illustrate how effective coordination can reduce duplication and maximize efficiency for all parties concerned.

The AMAP monitoring network

The AMAP POPs monitoring programme (see www.amap.no) is comprised of several sub-programmes covering atmospheric, freshwater, terrestrial, and marine environmental media, and human biomedia. As such it is well aligned with the GMP both with respect to GMP core media (air and human biomedia) and other media that are now being utilized in GMP and SC effectiveness and sufficiency evaluations.

The AMAP network includes 7 key background air monitoring sites in the North American and European Arctic where high-volume air samples have been collected dating back, at some sites, to the early 1990s. There are recognized gaps in the network. In the Russian Arctic sector monitoring of POPs has been performed in the past only on a campaign basis (covering 1-2 year periods at four locations). However, work is now underway to establish POPs (hi-vol) air monitoring as part of the AMAP network at two Russian sites (Amderma and Tiksi).

Human biomedia are the second core matrix for monitoring under the GMP. In the Arctic, the AMAP studies are based mainly on monitoring contaminants in blood rather than breast-milk, largely for logistical reasons associated with sampling in remote communities and meeting quality assurance objectives; breast-milk studies are however also conducted in some Arctic countries as part of national monitoring programmes. The success of the Arctic human blood monitoring studies has led to these studies being adopted in other parts of the world. AMAP strongly promotes, therefore, the inclusion of both blood and breast-milk as core media under the GMP as both have potential utility under different circumstances.

While air and human biomedia are identified as the core media under the GMP, AMAP very much welcomes the inclusion in the current SC GMP evaluation of information from studies utilizing 'other media' such as water and 'biota'. Animals, in particular aquatic biota are widely used in the Arctic (and other regions) for monitoring trends in POPs. The AMAP programme now has a comprehensive network of over 60 sites where levels of POPs are routinely monitored in marine mammals, fish, invertebrates and birds. The majority of these studies were established in the 1990s, but some deliver time-series extending back to the late 1960s. Increasingly studies using retrospective analysis of archived samples are contributing to this work, and this is especially important for following time tends in 'emerging POPs'.

AMAPs geographical coverage is circumpolar, broadly following the Arctic Circle in Scandinavia and western Russia but including terrestrial and marine areas at lower latitudes in other sectors, as far south as 52 degrees N in the Bering Sea and Hudson Bay areas. Thus, AMAP covers large parts of the Stockholm Convention WEOG and CEEC regions. With the concurrence of the countries concerned, and endorsement of the Arctic Council (AMAP's parent organization), AMAP has been requested to support the SC and deliver input to GMP assessment activities conducted under the auspices of WEOG and CEEC.

AMAP Quality Assurance, data compilation and assessment methods

Quality assurance, including not only laboratory QA/QC but also QA during other stages of monitoring (sample collection, transport) and data management (reporting/analysis) are essential to the provision of reliably information for use in policy-development.

AMAP promotes, and to a large degree now requires that all contributing activities are associated with participation in relevant QA schemes, whether these are schemes developed under other programmes (e.g. NCP-organized inter-laboratory studies that are now open to laboratories in other AMAP countries), schemes implemented jointly by AMAP and other parties (e.g. joint AMAP/EMEP activities) or activities initiated by AMAP alone.

As an example of the latter, AMAP identified (in the late 1990s) that available laboratory QA/QC programmes for blood analysis were not sufficient to meet AMAP needs. As part of its human biomedia monitoring programme, AMAP therefore developed a laboratory QA/QC study for analysis of blood samples that has now been running for 15 years and has expanded into an international exercise with participating laboratories from

Europe, Africa, South America and Asia as-well as from all of the Arctic countries. AMAP have produced protocols for biomonitoring using blood sampling that are now being implemented internationally.

Joint activities implemented in cooperation with others (NCP, EMEP, OSPAR, HELCOM, etc.) are particularly valuable as these both share costs, improve participation (and therefore reliability and usefulness of results) and enhance networking and sharing of experience which is often the key to capacity building in the field of QA/QC.

Similar cooperation in the area of data management has resulted in the use of shared data centres for managing data for many of the large environmental monitoring programmes in the North American/European/Arctic region. For example, the Norwegian Institute for Air Research (NILU) functions as the data centre for atmospheric data collected under the AMAP, EMEP, OSPAR, HELCOM and other international programmes. This way a data originator can submit data once to satisfy multiple programme data-reporting requirements (a procedure much appreciated by the data originator), data are held in one place and not duplicated (a basic 'best practice' for data management), and both metadata and data are available online through the NILU EBAS system (ebas.nilu.no) to users such as AMAP and SC assessment groups – avoiding duplication. Such win-win solutions are critical under conditions of increasingly limited resources. AMAP has implemented similar data centre arrangements for other types.

In relation to data analysis, AMAP is using widely-applied statistical methods, in particular for analysis of time-series data sets, consistent with those recommended under the GMP. This ensures that results coming out of the AMAP programme meet (or at least take account of) targets for statistical power associated with monitoring activities. If such issues are not addressed in assessment work, results can be misleading and inappropriate advice communicated to decision-makers.

From legacy to emerging POPs

Part of the ongoing AMAP assessments of POPs (and human health) in the Arctic have been fast-tracked to provide input to ongoing WEOG and CEEC work. Air and biota trend studies in particular provide evidence of the progress that has been achieved as a result of control measures applied both prior to and since the establishment of the Stockholm Convention. At the same time, these results demonstrate the need to be aware of other factors that can influence trends in POPs in biota (including human) media – such as changes in dietary-habits, especially in a world where climate change is already influencing POPs use patterns, and environmental transport pathways and fate. These aspects prompted joint UNEP/AMAP work on climate change and POPs such as that reported in 2011[10] and in the AMAP coordinated EU-funded ArcRisk project[11] (both of which build on the foundation laid in the AMAP 2002 assessment[5]).

The presentation will include examples of some recent AMAP results that are supporting SC activities.

Much of the AMAP work to date has focused on 'legacy POPs' such as PCBs, DDTs, HCHs, etc. – contaminants that are present in the environment largely as a result of past use. These substances are addressed under the Stockholm Convention, and in many cases were already subject to regulation at the national level in Arctic countries before the SC was established. AMAP continues to follow these substances mainly from a temporal trend perspective.

In its 2009 POPs assessment, AMAP re-orientated parts of its assessment work to prioritize 'emerging POPs', substances that (although in some cases in use for some considerable time) were now being detected in Arctic studies – either as a result of improvements in detection/quantification methods or due to increasing use and resulting environmental distribution. The 2009 AMAP POPs assessment included major reviews of occurrence and fate in the Arctic of brominated flame retardants, perfluorinated compounds, polychlorinated naphthalenes, endosulfan and other current use pesticides. This information is communicated to the SC Persistent Organic Pollutants Review Committee (POPROC) – with the result that some 'emerging POPs' are themselves now becoming 'legacy POPs'. The AMAP POPs assessment that is currently under preparation (due to be delivered

between 2015 and 2017) will include a further update on emerging POPs and include the results of screening studies that have been conducted in the Arctic to identify further POPs of potential concern in the region.

Other components of the next AMAP POPs assessment will focus on new information concerning biological effects of POPs on Arctic biota and ecosystems, and a review of the latest material on climate change impacts on POPs transport and fate (now and in the future) building on the results obtained in the ArcRisk project in particular.

As new substances enter the market, including replacements for phased-out chemicals, the challenges will grow, despite the many new important initiatives to improve chemical regulation. Within the Arctic, local sources may well increase as regional development expands. Ever increasing lists of POPs, but also the challenges associated with chemicals that may not formally qualify as POPs will need to be a focus of future AMAP work**.**

Acknowledgements
AMAP would like to acknowledge the continuing support it receives from, in particular the Arctic countries, but also other countries and organizations. These contributions allow AMAP to produce assessments (including POPs assessments) at regular intervals that provide the basis for informed policy-making, and support initiatives such as the Stockholm Convention. However, the real acknowledgment belongs to the individual scientists, experts, indigenous participants, etc. involved in this work from 1991 to the present.

References*:
1. AMAP. (1998). AMAP Assessment Report: Arctic Pollution Issues. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii+859 pp.
2. AMAP. (1997). Arctic Pollution Issues: A State of the Arctic Environment Report. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii+188 pp.
3. AMAP. (2004). AMAP Assessment 2002: Persistent Organic Pollutants in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xvi +310 pp.
4. AMAP. (2003). AMAP Assessment 2002: Human Health in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xiv+137 pp.
5. Macdonald RW, Harner T, Fyfe J, Loeng H, Weingartner T. (2003). AMAP Assessment 2002: The Influence of Global Change on Contaminant Pathways to, within, and from the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii+65 pp.
6. AMAP. (2002). Arctic Pollution 2002: Persistent Organic Pollutants, Heavy Metals, Radioactivity, Human Health, Changing Pathways. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xii+112pp.
7. AMAP. (2010). AMAP Assessment 2009 - Persistent Organic Pollutants (POPs) in the Arctic. *Science of the Total Environment.* Special Issue. 408:2851-3051. Elsevier, 2010.
8. AMAP. (2009). AMAP Assessment 2009: Human Health in the Arctic. Arctic Monitoring and Assessment Programme (AMAP), Oslo, Norway. xiv+254 pp.
9. AMAP. (2009). Arctic Pollution 2009. Arctic Monitoring and Assessment Programme, Oslo. xi+83pp.
10. UNEP/AMAP. (2011). Climate Change and POPs: Predicting the Impacts. Report of the UNEP/AMAP Expert Group. Secretariat of the Stockholm Convention, Geneva. 62 pp.
11. AMAP, 2014. ArcRisk Results Overview (www.amap.no/documents/doc/arcrisk-results-overview-and-brochure/1063) and ArcRisk results website (www.arcrisk.eu)

All listed reports listed above are available from the AMAP website www.amap.no