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# INFLUENCE OF CLIMATE CHANGE ON TRANSPORT, LEVELS, AND EFFECTS OF CONTAMINANTS IN NORTHERN AREAS

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## Introduction

The Arctic Monitoring and Assessment Programme (AMAP) was established in 1991 by the circum-Arctic nations in order to implement part of the Arctic Environmental Protection Strategy (AEPS). This presentation will show the results from the project "Combined Effects of Selected Pollutants and Climate Change in the Arctic Environment", which was coordinated by AMAP. The main questions asked during the project were:

• What are the most relevant exchange processes for environmental pollutants between atmosphere, ice and oceans in a changing Arctic climate setting?
• How are levels and distribution pathways for compounds of emerging concern (CECs) in Arctic ecosystems affected by climate change?
• What are the relevant indicators for elucidation of combined effects on environmental fate of persistent organic pollutants (POPs), CECs, polyaromatic hydrocarbons (PAHs) and heavy metals on human health?

The scientific information in this report was validated for implementation into relevant ongoing Arctic monitoring programs in order to develop new strategies for assessing distribution, fate and occurrence of pollutants in a changing Arctic environment.

## Methods

A wide range of interdisciplinary scientific methods were applied, e.g. organic and inorganic trace analyses, fate and transport modelling and human epidemiology. Information about methods as well as comprehensive results and discussions on the findings can be found in the project report (AMAP, 2015b).

Modelling: The Danish Eulerian Hemispheric Model (DEHM) covers the Northern Hemisphere and includes a suit of polychlorinated biphenyls (PCBs), hexachlorocyclohexanes (HCHs) and seven Hg species (Christensen, 1997; Hansen et al., 2015). Real metrological input validated DEHM before the model was run with climate meteorological data (AMAP, 2011). Temperature and POP concentration results were used as input into the bioaccumulation food-web model AQUAWEB of an Arctic marine food web (Arnot and Gobas, 2004; Borgå et al., 2010). The model predicted net accumulation of POPs based on uptake and elimination rates. The lipid content of the organisms was assumed to vary seasonally in the model.

Organic pollutants: Samples from Svalbard reindeers (Rangifer tarandus platyrhynchus), halibuts (Hippoglossus hippoglossus) and shrimp (Pandalus borealis) from northern Norway were analysed for perfluorinated alkylated substances (PFAS).
Atmospheric particles were characterized to assess contribution from combustion sources of particle associated PAHs.

Heavy metals: Mosses (Hylocomium splendens) absorb heavy metals from the atmosphere and have been sampled across Norway to investigate atmospheric depositions over several years.

Human cohort studies and epidemiology: Human cohorts in north Norway and Russia were included in this report. The blood samples were part of the Northern Norway Mother-and-Child Contaminant Cohort study (MISA) and the Tromsø-study (Nost et al., 2014; AMAP, 2015a). CoZMoMAN was used to predict the environmental fate and human food chain bioaccumulation of POPs in different birth cohorts (Breivik et al. 2010).

**Results and discussion**

Models

The DEHM model runs showed that higher temperatures will enhance volatilization of some contaminants (γ-HCH, PCB52 and PCB153) from soil to air and thus increase their atmospheric transport to the Arctic. An increased degradation of legacy POPs due to higher temperatures are expected to counter-act that process. In the marine food-web, effects of the annual cycle of e.g. lipid content was greater than changes in food-web biomagnification of POPs with regards to impact of climate change.

Heavy metals

Mosses have been used to monitor heavy metals in air for decades. The time trends shows that atmospheric deposition of Hg has not changed over time and the concentration in moss is uniform in Norway. The atmospheric deposition of Pb and Cd were higher in southern Norway compared to the northern areas. Pb showed a decreasing trend over the last 30 years, while Cd was decreasing until 2005. The Hg cycle is very complex. Hence, it is very difficult to determine whether the effect of climate change on the cycle will result in increased or decreased concentrations of Hg in the atmosphere.

Atmospheric particles and PAHs

Characterization of atmospheric particles can be used as a tool to understand source and origin of pollutants associated with the particles. With the increasing number of local sources of emerging contaminants in the Arctic, particle characterization can be an important tool for investigation of pollution sources. The present study identified differences between particles from different settlements on Svalbard.

PFAS in Arctic biota

PFAS pattern in Svalbard reindeers were dominated by long-chain PFAS, but in low concentrations. PFOS (C8) ranged from <detection limits to 0.7 ng/g ww in livers from the reindeers. PFAS in halibuts and shrimps from northern Norway were also found to be low, although concentrations in unpeeled shrimps were higher than in halibut fillets (Carlsson et al., 2016).

Human health

Epidemiological human cohort studies from northern Norway and Russia showed that regulated POPs such as PCBs and PFOS have decreased over the last 30 years in human blood. However, unregulated PFAS increased. This emphasizes the importance and effectiveness of international cooperation and regulations of environmental pollutants (Nost et al., 2014; AMAP, 2015a).

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