PERSISTENT ORGANIC POLLUTANTS IN THE ARCTIC AND CANADA'S NORTHERN CONTAMINANTS PROGRAM (NCP)

Kurt-Karakus, PB[1], **Muir, DCG**[1]

[1] Science and Technology Branch, Environment Canada, 867 Lakeshore Road, Burlington, L7R 4A6, ON, Canada, Tel: +1 905 319-6921, Fax: +1 905 336-6430

Introduction

Indian and Northern Affairs of Canada (INAC) established the Northern Contaminants Program (NCP) in 1991 in response to concerns about human exposure to elevated levels of contaminants in wildlife species that are important to the traditional diets of northern Aboriginal peoples. Early studies reported a wide spectrum of chemicals such as persistent organic pollutants, heavy metals and radionuclides, most of having no Arctic or Canadian sources but present in high levels in the Arctic environment.

The program's key objective is: ***to work towards reducing and, where possible, eliminating contaminants in traditional/country foods, while providing information that assists individuals and communities in making informed decisions about their food use***[1].

The first phase of NCP (NCP-I) was conducted between 1991 and 1997 and research was focused on data collection to determine the levels, spatial distribution and source of contaminants to the northern environment and its people. Such data improved the knowledge on understanding of the spatial and temporal patterns and trends of the contaminants in the Canadian Arctic confirming that major source of these chemicals was long range transport from the other countries. Results generated thorugh NCP-I were synthesized in the Canadian Arctic Contaminants Assessment Report-I (CACAR-I)[2].

In 1998, NCP started its second phase (NCP-II) and continued until 2003. NCP-II focused on the questions about the impacts and risks of current levels of contaminants to the human health through Arctic food species as well as determination of temporal trends of these contaminants of concern in key Arctic indicator species and air. Building up on the findings of NCP-I, the dialogue between northerners and the scientific community helped to support the ability of communities to deal with specific contaminants issues. Results generated during NCP-II were synthesized in the Canadian Arctic Contaminants Assessment Report II (CACAR-II). Unlike CACAR-I, CACAR II was published as two separate volumes; Physical Environment[3] and Biological Environment[4].

Convincing scientific information from CACAR-I and CACAR-II contributed to legally binding the contaminants under the United Nations Economic Comission for Europe (UN ECE) Convention on Long-range Transboundary Air Pollution Programme (LRTAP), and the Stockholm Convention of the United Nations Environment Programme (UNEP).

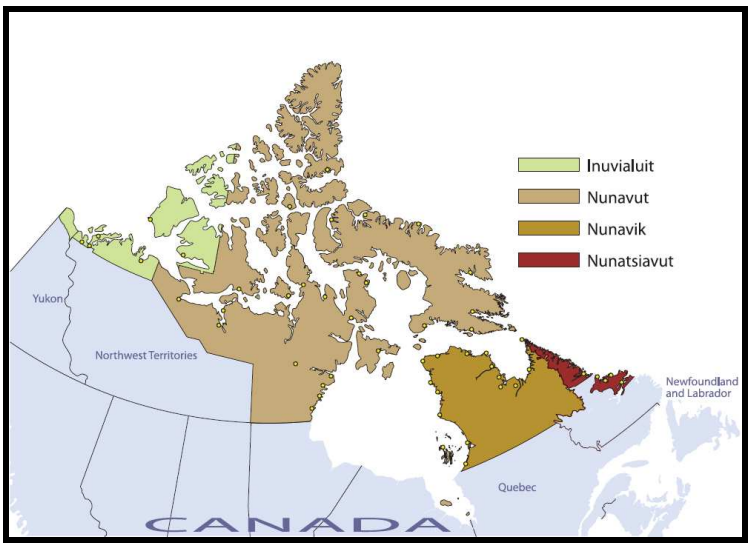
The next phase of NCP (NCP-III) is now underway aiming to build on the findings of the first two phases and the current focus of the program is to address high priority issues in communities where people are being exposed to contaminants levels of concern to health authorities as well as protection of Arctic terrestrial and aquatic environments. Results of NCP-III will be synthesized in a report, intended to be released in spring 2012, where results for both physical and biological environments will be published in the same volume[5].

NCP's current $4.4 million annual research budget comes for INAC and Health Canada. NCP funds research and action by federal and territorial governments, universities and Indigenous peoples' organizations to address various

contaminants including persistent organic pollutants in Canada's north. The program is a rarely heralded success story and is unique in a way that no other nation has been implemented such a dedicated long term monitoring and research program to assess the contamination of Arctic to protect northern people's health and environment. The issues have been addressed in the NCP has provided scientific base for Canada to evaluate the significance of the issue and it equipped the Government of Canada to advocate on the international stage for legal agreements on ban or phase out of POPs that end up in the Arctic.

In this study, we outline the scope of NCP, findings of first two assessment reports and preliminary results of studies that will be synthesized in CACAR III including new chemicals reported in Canadian Arctic.

Geographical Scope of NCP



The geographical focus of the NCP is the Yukon, Northwest Territories and Nunavut (Figure 1). However, if there are communities in which there is significant dietary exposure to contaminants from Arctic marine mammals (i.e. ringed seals, beluga and narwhal), projects may be supported outside this geographical boundary.

Figure 1. Inuit Regions of Canada[6] within Geographical boundary of the Northern Contaminants Program (NCP)

Results

Persistent Organic Pollutants (POPs) in Canadian Arctic

Table 1 summarizes the organic chemicals determined in various environmental compartments of Canadian Arctic during NCP-I and NCP-II whereas Table 2 summarizes the type of environmental media and biological matrices studied in these research activities. As it is seen from tables, a wide variety of physical and biological matrices have been studied during the course of NCP phase II. Polychlorinated biphenyls (PCBs) and organochlorines (OCs) were detected in almost all physical and biological environments. DDTs, toxaphene and chlordanes were the most frequently detected organochlorines in the Arctic environment. Besides legacy chemicals, new chemicals such as current use pesticides (CUPs), perfluorinated compounds (PFCs), polychlorinated dibenzo-p-dioxins/furans (PCDD/Fs) and polychlorinated napthalenes (PCNs) were also at detectable levels in Arctic environmental media. In the atmosphere, the overall decreasing trends of banned OC pesticides provide clues on positive effects of international efforts to reduce sources of POPs to the Arctic. A future reduction of HCHs in the Arctic marine environment can be predicted utilizing chiral tracers as evidence of microbial degradation of HCHs in Arctic Ocean.

PBDEs, PCBs, OCs and PCDD/Fs have been detected in Arctic marine and lake sediments yet providing an example of persistence of these chemicals in the environment.

Table 1. Reported chemicals in environmental compartments of Canadian Arctic in NCP Phase I, II[2-4] and III[7]

	Air	Sea water	Terres-trial Plants	Sediments (marine+lake)	Invertebrates (marine+fresh water)	Fish		Seabirds	Mammals	
						Marine	*Lake*		*Terrestrial*	*Marine*
PCBs[a]	**I,II,III**	**I,II,III**		**I,II**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II**	**I,II,III**
OCs[b]	**I,II,III**	**I,II,III**	**I**	**I,II**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II**	**I,II,III**
HCB	**I,II,III**			**I,II**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II,III**	**I,II**	**I,II,III**
PCDD/Fs	**I,II,III**			**I,II**			**I**	**I,II,III**	**I,II**	**I,II**
PBDEs	**I,II,III**			**II,III**		**I,II,III**	**II,III**	**II,III**	**II,III**	**II,III**
PAHs	**I,II**			**I,II**						
CUPs[c]	**I,II,III**	**II,III**			**III**	**I,II,III**				
PFCs	**II,III**			**II**			**II,III**	**III**	**III**	**II,III**
Chlorinated paraffins	**II**			**I,II**			**II,III**			**II,III**
Coplanar PCBs	**I,II**	**I,II**					**I**	**II,III**		**I,II,III**
PCNs	**I,II,III**	**I,II**			**I,II**			**II,III**		**II,III**
Synthetic Musks										**II**

[a] various congeners depending on the study; [b] DDTs, HCHs, chlordanes, toxaphene; [c] Current use pesticides such as endosulfan, methoxychlor, trifluarin, pentachloroanisole (metabolite of pentachlorophenol), chlorpyrifos, atrazine

Table 2. Physical and biological matrices studied in Canadian Arctic during NCP-I, NCP-II[2-4] and III[7]

Environmental Compartment/Organism Groups	Details
Air	vapor phase and particle phase
Sea water	dissolved phase
Terrestrial Plants	lichens, tree bark, willow
Terrestrial herbivores	deer mice
Terrestrial mammals	caribou, moose, bison, mule deer, wolves, wolverine
Mammals Associated with freshwater	beaver, muskrat
Invertebrates	calanoid capepod, herbaceous copepod, omnivorous capepod, mysid, amphipod, arrowworm, shrimp
Benthic Invertebrates	blue mussel, amphipod, basketstar
Freshwater fish	pike, walleye, burbot, inconnu, lake trout, land-locked char
Marine and anadromous fish	sculpin, arctic cod, arctic char, Greenland shark, turbot(Greenland halibut)
Waterfowls and Seabirds	king and common eider ducks, glaucous gulls, dovekie, thick-billed murre, black guillemot, black-legged kittiwake, ivory gull, northern fulmar
Marine Mammals	ringed seals, walrus, beluga, narwhal, polar bear, arctic fox

New Persistent Chemicals in Canadian Arctic

Brominated flame retardants (BFRs) such as PBDEs, PFCs, short-chain chlorinated paraffins (SCCPs), CUPs such as endosulfan, trifluralin, methoxychlor, PCNs and coplanar PCBs were the new persistent chemicals reported in Canadian Arctic in CACAR II assessment reports[3,4]. There have not been enough data collected to interpret long-term spatial and temporal trends of these chemicals in Arctic physical environment; but, results in biological environment suggest that levels of these chemicals in the Arctic might be increasing[4].

PBDEs were the most abundant "new" persistent chemicals in the Arctic. It was reported that concentration of this chemical group was increased in ringed seal blubber in Canadian Arctic from the early 1980s to early 2000s[4]. Air measurements at Alert, Canada indicated a slightly increase in BDE-99 concentration[8], one of the most abundant component of commercial penta-BDE. Perfluorinated compounds are another group of new chemicals at detectable levels in Canadian Arctic whereas 8:2 FTOH, 10:2 FTOH and perfluorooctanesulfanamidoethanols (FOSEs) were the most frequently detected flourinated compounds[8] in air at Alert, Canada. However, current available data is not enough for trend analysis purposes; therefore, continuous measurement is required to assess the trends of these new chemicals in Arctic air.

Future Work

The critical gaps in knowledge on persistent organic pollutants in the Arctic can be summarized as follows; temporal trends of most contaminants including new persistent chemicals in air, water and biological matrices, application of predictive modeling on Arctic contaminants, studies on reliable physical and chemical properties data for chemicals detectable in Arctic and modeling efforts on the determination of chemical fate and bioaccumulation of contaminants in Arctic food web. Moreover, results should be interpreted by taking into account the climate change and its effects on time trends of chemicals in physical and biological environment. The ongoing NCP-III studies and CACAR-III assessment report, which is in progress now and planned to be released in spring 2012, are expected to fulfill the majority of these gaps.

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