POPs-climate interactions – Assessment Scoping

(version December 2019)

I. Assessment Outline (content and coordinating lead authors)

II. Assessment timeline

III. Policy-relevant questions guiding the assessment work

I. Assessment Outline, Content and Coordinating Lead Authors

Rationale for why this Assessment is needed: Scientific studies have indicated that climate change can have an effect on the fate of contaminants in the Arctic. Climate change can affect the physical environment (e.g. melting of glaciers, reduced ice coverage) and the biological environment (e.g. changes in habitats and migration routes). These changes can further affect the transport of contaminants to the Arctic and their accumulation in the Arctic. This chapter will:

- build on the themes from the AMAP/UNEP report (2011);
- incorporate results from ArcRisk (Carlsson et al. 2016; 2018; Pacyna et al. 2015) and reviews of the topic of climate-POPs interactions (e.g. Ma et al. 2016; McKinney et al. 2015) and other scientific studies;
- include the 'initial" POPs, "new" POPs, halogenated natural products (HNPs), and chemicals of emerging arctic concern (CEACs);
- consider research and monitoring from Antarctic and Tibet to fill data gaps and strengthen and support conclusions.

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2.1.1. Introduction

- Start from the 2011 UNEP/AMAP report… Chapter 2: Release of POPs to the Environment and Chapter 3: Environmental fate and long-range transport of POPs
- Summary of 2011 report and references to review papers

Questions 1-4 [1]

Q1. Where are the primary sources of POPs, and how do they reach the Arctic?

Q2. How are emissions and source locations of POPs and potential future POPs affected by climate change?

Q3. How does climate change affect transport of pollutants to the Arctic?

Q4. How well can we anticipate how old and new persistent chemicals will impact the Arctic in a changing future climate?

2.1.2. Answer with what is known with references...

- Uncertainties
- Unknowns

2.1.3. Chapter discussion

[1] Inspiration for answering questions would be a report ("A scientific perspective on micro-plastics in nature and society", Science Advice for Policy by European Academies) that structures responses according to "what is known", "what is partially known" and "what is unknown"

- Models link emission inventories to measurements.
- Both emissions and environmental levels are uncertain, but often emissions are more uncertain, or estimates are lacking entirely!
- We should strive to apply models in an "integrated approach"…
- Emissions estimates derived from reverse modelling can provide testable hypotheses about emission locations, levels and trends.
- Environmental exposure is determined by primary emissions, so "success" should be measured by reduction of emissions.

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2.2.1. Introduction – Questions presented

Q1: How can effects of Arctic Climate Change on contaminants act as an early warning signal for global climate change impacts on contaminants?

Q2: Does climate change within the Arctic exacerbate/diminish contaminant transport, accumulation and occurrence in different abiotic media (including turbid lakes due to permafrost change, brine accumulation, melt ponds, haze events, light absorbing particles)?

Evaluation tools: Temporal trends in air and water, oceanic/lake sediment cores, ice/snow cores

2.2.2. Influence of Climate Variations on POPs and CEACs (AMAP 2016)

2.2.3. Changing Long-Range Transport, Secondary Emissions, Human Activities and Local Sources

Q3: How do contaminant pathways change into and within the Arctic due to climate change? How do the source strengths change with climate change?

Q4: How do local sources contribute to Arctic contamination compared to LRT under the climate change scenarios?

2.2.4. Effects of Warming and Biogeochemical Change on Air-Surface Exchange (e.g. gas-particle partitioning, precipitation rates, sea-spray aerosols)

Q5: What are the most sensitive transfer processes that affect the movement of contaminants between polar reservoirs?

2.2.5. Changing Arctic Cryosphere (snow, permafrost, sea ice and glacial melts) - contaminant amplification

2.2.6. Impacts/Implications on Terrestrial, Marine and Freshwater Systems

Potential take home messages:

- Demonstrate that the direct and indirect climate change effects exacerbate (remobilization to the Arctic) certain contaminants that do not meet the L, P, B

and T criteria under the Stockholm Convention in the Arctic then they should be regulated.

- Should we prioritize chemicals with different and/or added criteria under climate change? Can we develop an Arctic Climate Change Sensitivity Potential (ACCS Potential)?
- We need new hazard criteria that reflect changes in sensitivity to climate change in the Arctic environment.

Knowledge gaps and prioritization of research gaps

- Changes in chemical profiles and exposure to mixtures
- Gas-particle partitioning
- Permafrost
- Contribution of snow to polar marine surfaces (e.g. open water, ice melt ponds) – marine versus atmospheric input to oceans
- Are chemicals in arctic ocean water becoming less persistent now because of increase in microbial activities?
- Contaminants as co-stressor with climate change – indirect climate forcing effects of contaminants
- Tracers for abiotic media e.g. chirality, levoglucosan, pollen, biomass burning, stable isotopes, satellite images of Br etc.
- Role of extreme weather events in distribution pathways of contaminants (e.g. unseasonal warming in parts of the arctic)
- Geopolitical activities in the polar regions e.g. increased tourism, resource exploration, shipping

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Q1: How do physical changes to the environment affect POPs exposure and bioavailability in Arctic biota?

Q2: How do ecological changes affect POP exposures in Arctic biota and food webs?

Q3: What can we learn from models of climate change effects on food web accumulation?

2.3.1. Introduction

2.3.2. How do physical changes to the environment affect POPs exposure and bioavailability in Arctic biota?

- Temperature and water masses (salinity, etc.)
- Sea ice
- Wind and precipitation
- Terrestrial run-off
- Permafrost degradation and turbidity

- Shifting seasons

2.3.3. How do ecological changes affect POPs exposures in Arctic biota and food webs?

- Phenology
- Primary production
- Species interactions
- Lipid dynamics and energy allocation
- Behavior
- Migratory species – tissue dependent

2.3.4. What can we learn from models of climate change effects on food web accumulation?

2.3.5. Research perspectives and recommendations

- New research toolbox
- Climate change dependent toxicity
- Multiple stressors – Are they on the edge
- Climate indices versus local climate conditions
- Climate variability and extreme events

2.3.6. Case studies

- CASE STUDY 1. Fjord ecosystem – Kongsfjorden
- CASE STUDY 2. Marginal ice zone in the Barents Sea- sea ice as a habitat
- CASE STUDY 3. Sound system - Canadian Arctic - feeding related studies

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Q1: Can we link changes in temporal trends with climate change and/or food web changes?

2.4.1. Introduction

- Temporal trends integrate changes in emissions and in the physical and biological environment. Some studies have linked climate and/or biological parameters to time trends in biota.

2.4.2. Temporal trends from North America

- Alaska
- Canada
    - Introduction

- Freshwater environment
- Marine environment

Conclusions/knowledge gaps

2.4.3. Temporal trends from Greenland and the Faroe Islands

- Faroe Islands
- Greenland
  - Introduction
  - Freshwater environment
  - Marine environment

Conclusions/knowledge gaps

2.4.4. Temporal trends from the other Nordic countries

- Norway
  - Introduction
  - Terrestrial environment
  - Freshwater environment
  - Marine environment
- Iceland
- Finland
- Sweden

Conclusions/knowledge gaps

2.4.5. Temporal trends from Russia

2.4.6. Temporal trends from Antarctica

- Introduction
- Marine environment
- Conclusions/knowledge gaps

2.4.7. Chapter discussion

Preliminary findings:

- Only few time trends in biota have been related to climate parameters (Canada, Greenland, Norway).
- Changes in emissions are still the main explanation for long-term trends, but cannot explain some of the more recent observations.
- Correlations between POPs in biota and North Atlantic / Arctic Oscillation indices, precipitation and sea-ice extension/time of breakup.
- Melting permafrost seems to increase POP levels in fish in Arctic lakes.

    - Changes in the food webs seem to be visible in POP time trends (polar bear, beluga, seabirds, Arctic fox).
- Researchers and monitoring program managers
- National decision makers and Arctic Council
- Global level e.g. UNEP, IPCC?

Q1. What are the implications of the assessment findings for national and international regulations

Q2: What are some of the human dimensions of climate change effects on food web POPs accumulation?

II. Assessment Timeline

- April to September 30, 2019 - Preparation of draft assessment chapters by expert sub-groups.
- 15 January 2020: Draft report of substantive sub-chapters (2.1 to 2.4) and preliminary versions of conclusions/recommendations compiled for circulation for national data check (drafts to be submitted to AMAP 13 January).
- 15 January – 15 February 2020: National data check
- 15 March 2020: Draft report compiled for peer review

  Engagement of science-writer and start of preparation of SPM (which will apply 'what is known/uncertain/unknown' classificaiton)
- 15 March – 15 April 2020: Peer review
- *[SETAC Europe 30, Dublin, 3-7/5/20 – Abstract submitted]*
- 15 April – 30 May 2020: Revisions following peer review
- 7 May – 9 May 2020: POPs assessment leads drafting meeting, Dublin

  Science-writer to participate and present/discuss SPM
- 30 May 2020: Final revised manuscript available

  Draft 1 of SPM
- May - August 2020. Publication process – professional graphics, formatting, etc.
- *[Dioxin 2020, Nantes, 30/8-4/9/20]*
- *[SETAC, Singapore, 6-10/9/20]*
- end of September 2020: Publication

  SPM for approval by HoDs

  [Possible preparation of special issue journal publication]

Assessment leads coordination meetings/conference calls: 18 October 2019, 8 November 2019 (SETAC Toronto + teleconference); 12 December 2019; 14 January 2020. Additionally, chapter leads have organised a number of chapter coordination conference calls.

III. Policy-relevant Questions guiding the assessment work

These questions are included in annotations to section I.