Climate and Energy Impacts on Environmental Contaminants and Human Health

Elsie M. Sunderland
ems@seas.harvard.edu
http://bgc.seas.harvard.edu
• **Understand** impacts of changing ecosystems
• **Identify** vulnerable human populations
• **Engage** in dialogue with regulators on changes
Environmental releases of pollutants (i.e., mercury) driven by global energy demands
Northern communities are especially vulnerable to climate change and environmental pollutants
Longitudinal Birth Cohorts in the Faroe Islands

Weihe, 2014
Health Effects include neurodevelopment, immunotoxicity, and metabolic disruption.

50% Reduction in antibody concentrations for each doubling of PFASs.

**Diphtheria** for Children from the Faroe Islands.

Anti Diphtheria (IU/ml) at 7 years. 2012, JAMA

**PFOS Age 5**

Grandjean et al., 2012, JAMA
We try to anticipate the impacts of future climate and industry.

Global 3-D Models for Environmental Contaminants in the Atmosphere & Ocean

Human Exposures & Health Outcomes

Elsie M. Sunderland 03/04/16
Phytoplankton distribution in the ocean drives uptake of contaminants into wildlife

Fraction of Total Methylmercury in Phytoplankton (percent)

- **Diatoms** (12 µm)
- **Other large** (10 µm)
- **Other picoplankton** (1.8 µm)
- **Trichodesmium** (10 µm)
- **Coccolithophores** (5 µm)
- **Prochlorococcus** (0.6 µm)
Climate and industry drive changes in Hg inputs to the global oceans

Contributions of global rivers to seawater mercury concentrations

Western Pacific

Arctic Ocean

Total Hg concentrations in seawater (pM)

Zhang et al., 2015, GBC
Modeled PFOS in North Atlantic seawater (10 m)

Year 2000

Year 2010

Zhang et al., 2016, in-prep.
Our work helps to catalyze regulatory changes

Arlene Blum: Green Science and Policy Institute

Mercury and Air Toxics Standards
Protecting our children and communities by limiting emissions of mercury and other air toxics from power plants
Hydroelectric Development is underway throughout the Canadian North.

Flooding causes a pulse in methylmercury, methane and carbon.

Schartup et al., 2015, PNAS
This is a human problem

There’s a high cost in doing Muskrat Falls wrong.
There’s power in doing it right.

#makemuskratright
Lake Melville research program
Immediate Impacts on Communities

Hundreds of Inuit pushed above regulatory guidelines for methylmercury due to flooding planned for 2017

Calder et al., 2016
Undergraduates are key team members
On the Horizon: Mitigating Toxicity through Better Materials Design