How Can You Regulate Something if You're Not Sure It's a Problem?

Noelle Eckley Selin

Assistant Professor of Engineering Systems and Atmospheric Chemistry
Engineering Systems Division and Department of Earth, Atmospheric and Planetary Sciences

Massachusetts Institute of Technology

http://mit.edu/selin

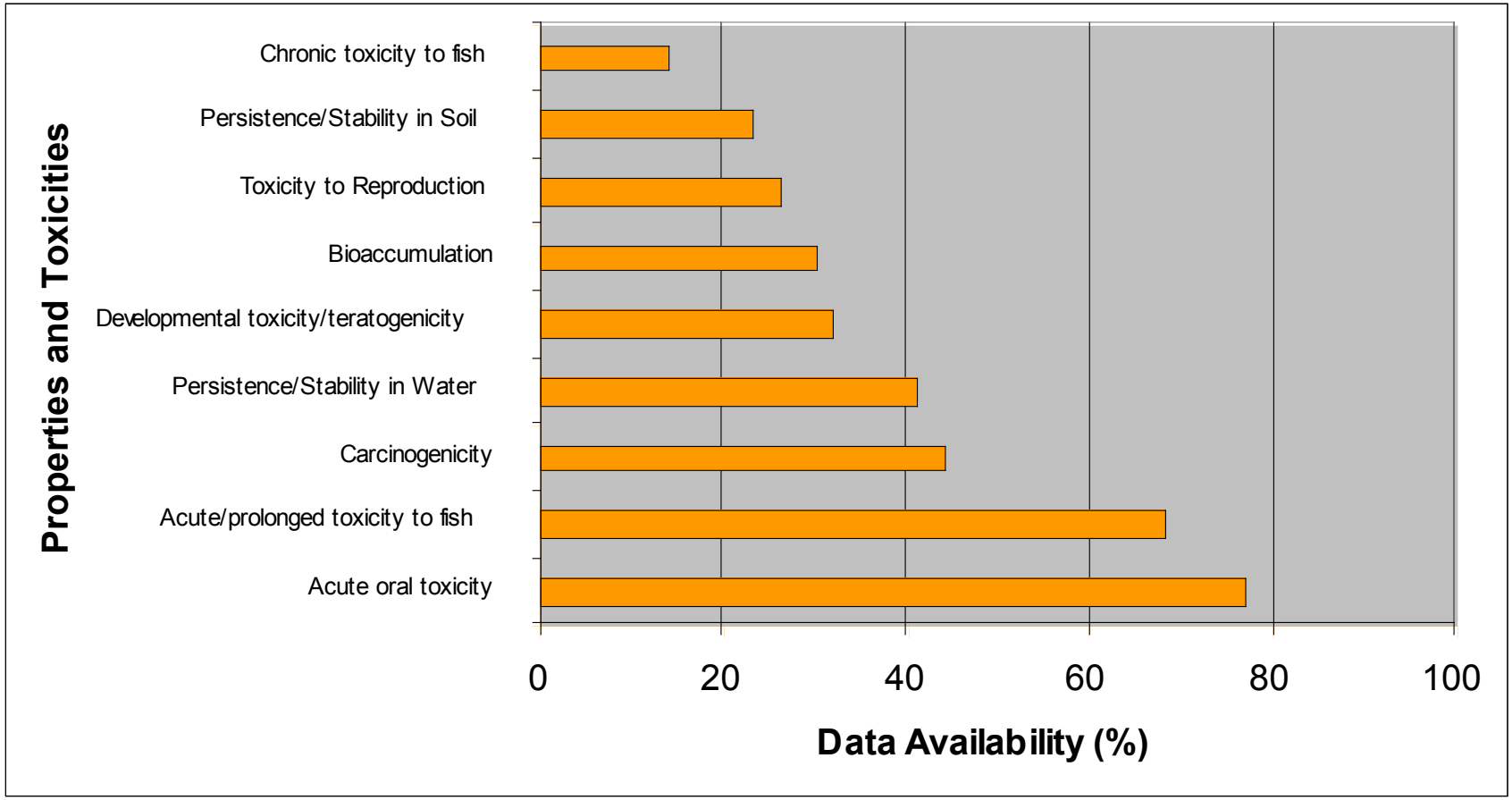
http://mit.edu/selingroup

Metcalf Institute 14th Annual Science Immersion Workshop for Journalists, 7 June 2012

Emerging contaminants in policy perspective

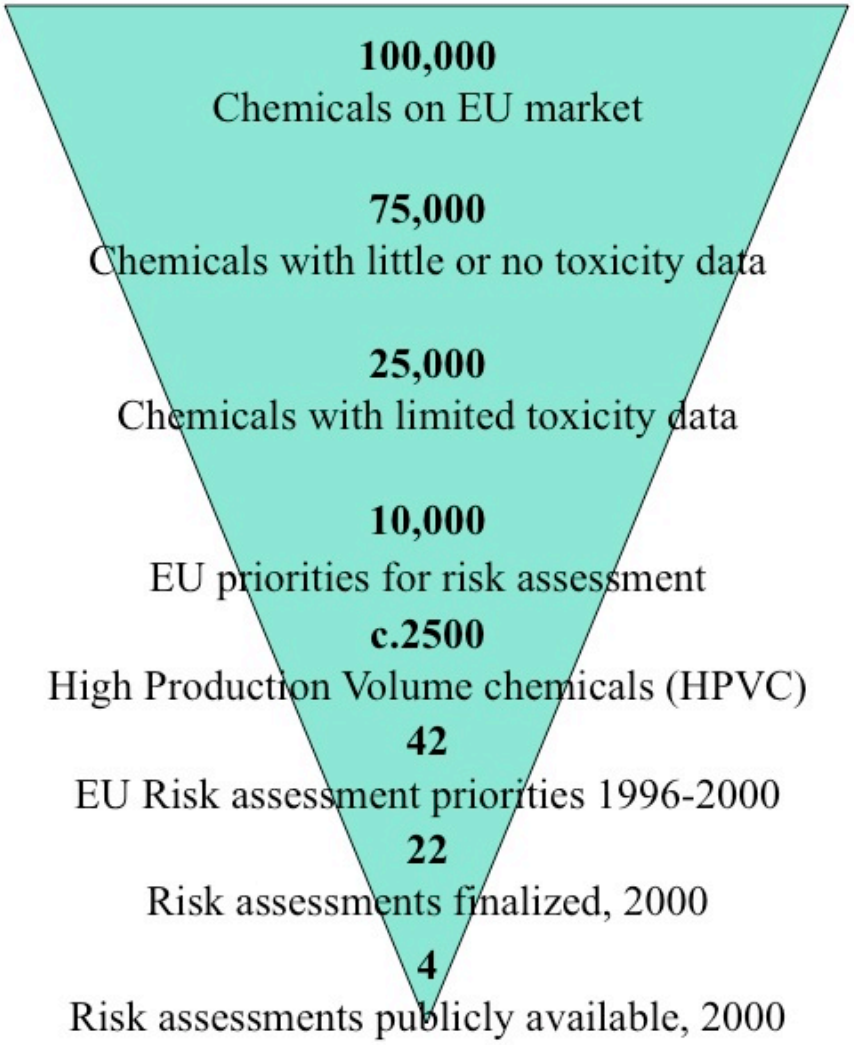
- Information and policy challenges
- Local, regional, national, and international policies
- Example: POPs and Mercury
- Ways forward

Availability of Data on 2465 High Production Volume Chemicals; some illustrative properties and toxicities (IUCLID Database, 1999)



Source: Allanou, R., Hansen, B.G., and van der Bilt, Y. *Public Availability of Data on EU High Production Volume Chemicals.* European Commission, Joint Research Centre, European Chemicals Bureau: Ispra, Italy.

Many chemicals, few risk assessments

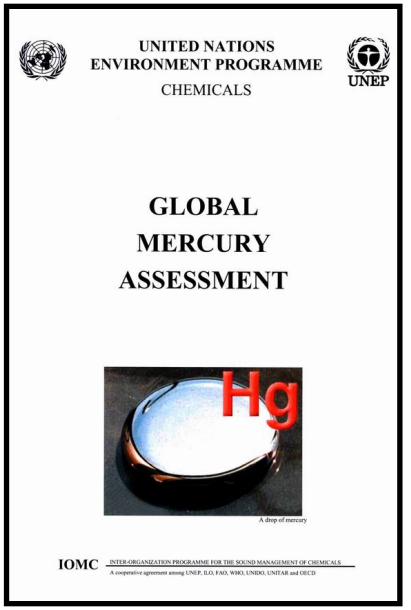


Update of Figure 5, p. 9, 'Low Doses, High Stakes'

POLICY CHALLENGES ON MULTIPLE SCALES

GLOBAL:

Global Treaty: Negotiations began in June 2010, "Minamata Convention" expected 2013.
Global Mercury Assessment (2002): sufficient evidence to warrant international action



REGIONAL:

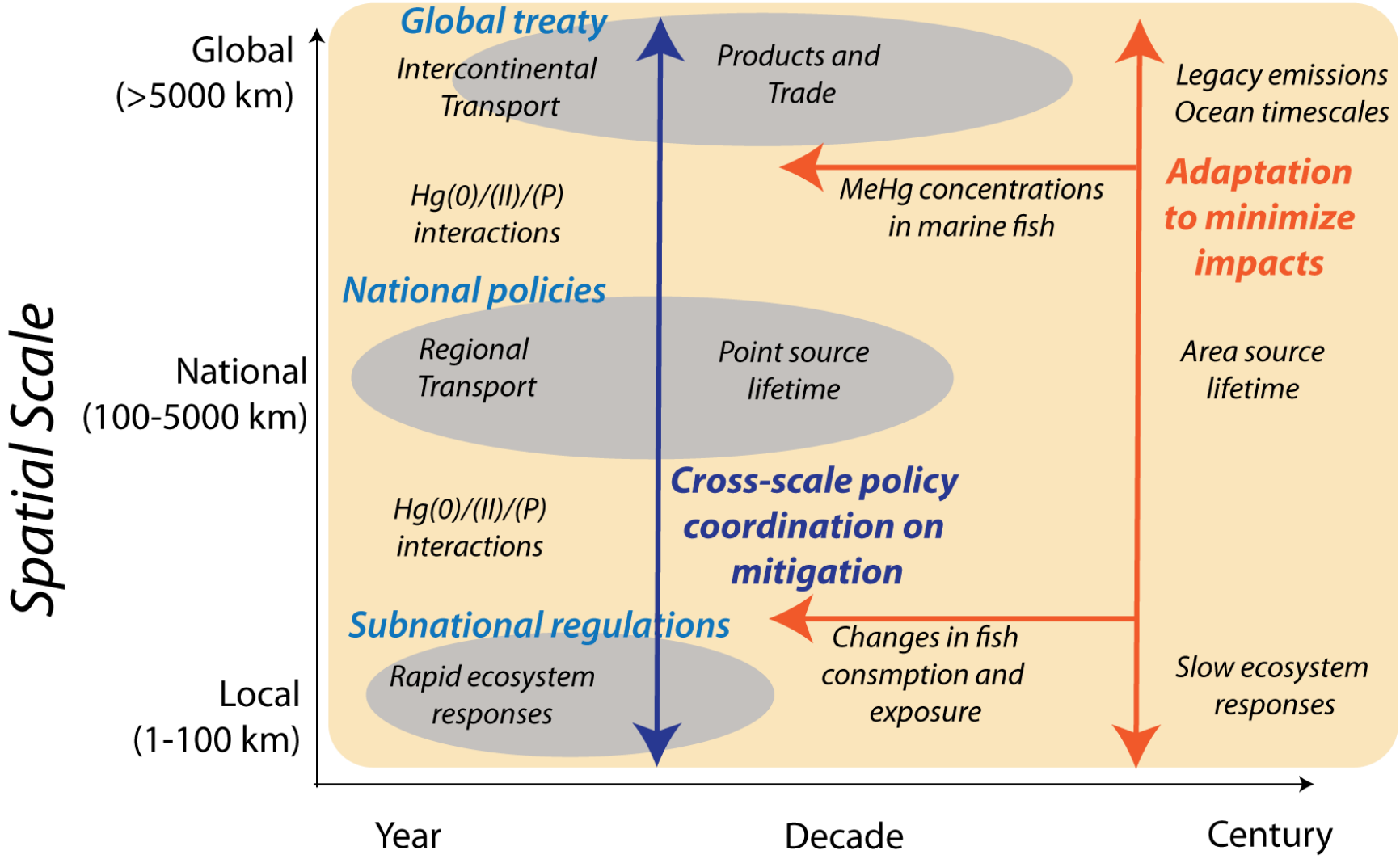
Commission for Environmental Cooperation: U.S./ Mexico/Canada regional action plan (1997,2000)
Convention on Long Range Transboundary Air Pollution: U.S./Canada/Europe/former Soviet Union countries heavy metals protocol (1998)

U.S.:

Power Plant emission regulations: Clean Air Mercury Rule established "cap and trade" approach to regulating mercury from coal-fired power plants (2005), struck down by courts in 2008; new regulations issued spring 2011

[*Selin and Selin, RECIEL, 2006*]

Mercury as a cross-scale science-policy problem



[Selin, JEM, 2011]

Mercury (Hg): A Global Pollutant

Major anthropogenic source is stationary combustion (coal)

Ongoing U.S. efforts to regulate power sector emissions

Atmospheric transport and deposition leads to high fish methylmercury (uncertainties about atmospheric chemistry, processes)

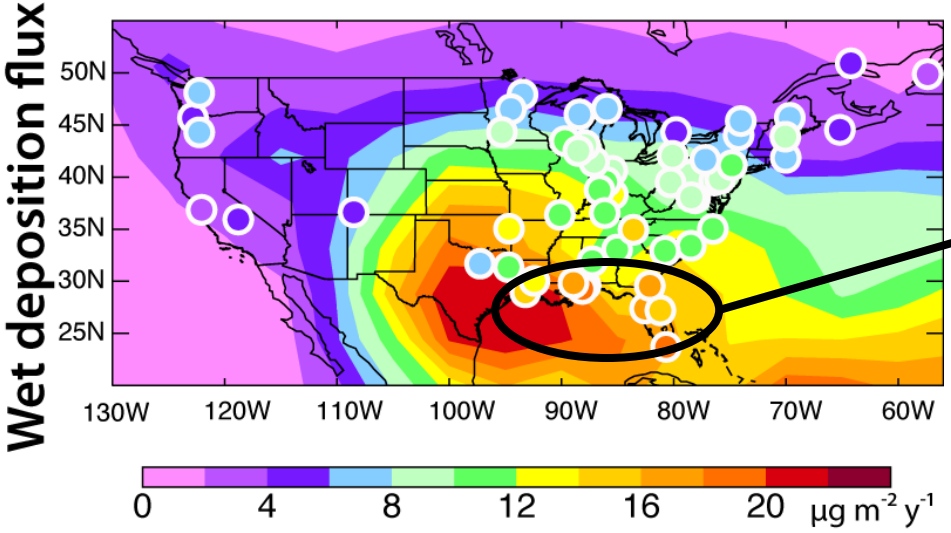
Particular concern in the Arctic environment due to contamination of traditional foods

United Nations Environment Programme
Chemicals
UNEP Mercury Programme

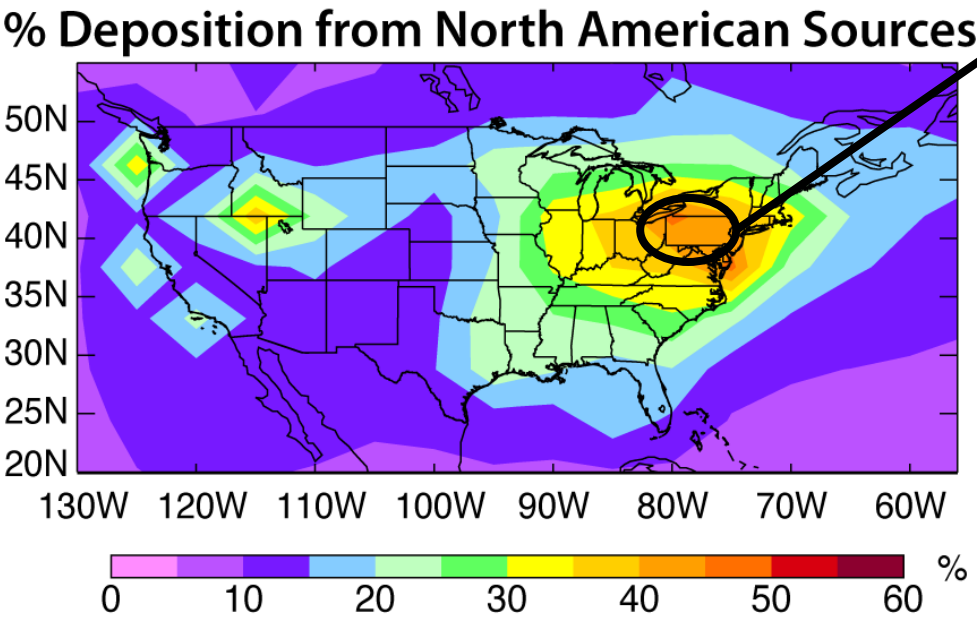
Global treaty negotiations began June 2010

Informing risk reduction policies at multiple scales

Why should the US care about global mercury?



Southeast has highest wet deposition in the U.S., but mostly from non-US sources: this is due to rainout of mercury from higher altitudes in summertime



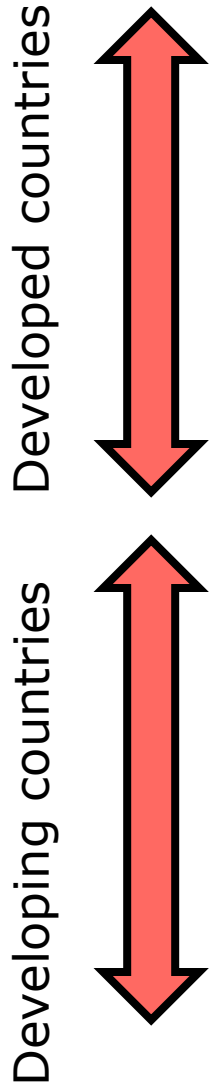
Up to 60% of deposition in Midwest/Northeast U.S. is from domestic sources

Policy implications: *Reducing deposition in both Midwest and Southeast will require policy actions on multiple political scales (national and global)*

[*Selin & Jacob, Atmos. Env. 2008*]

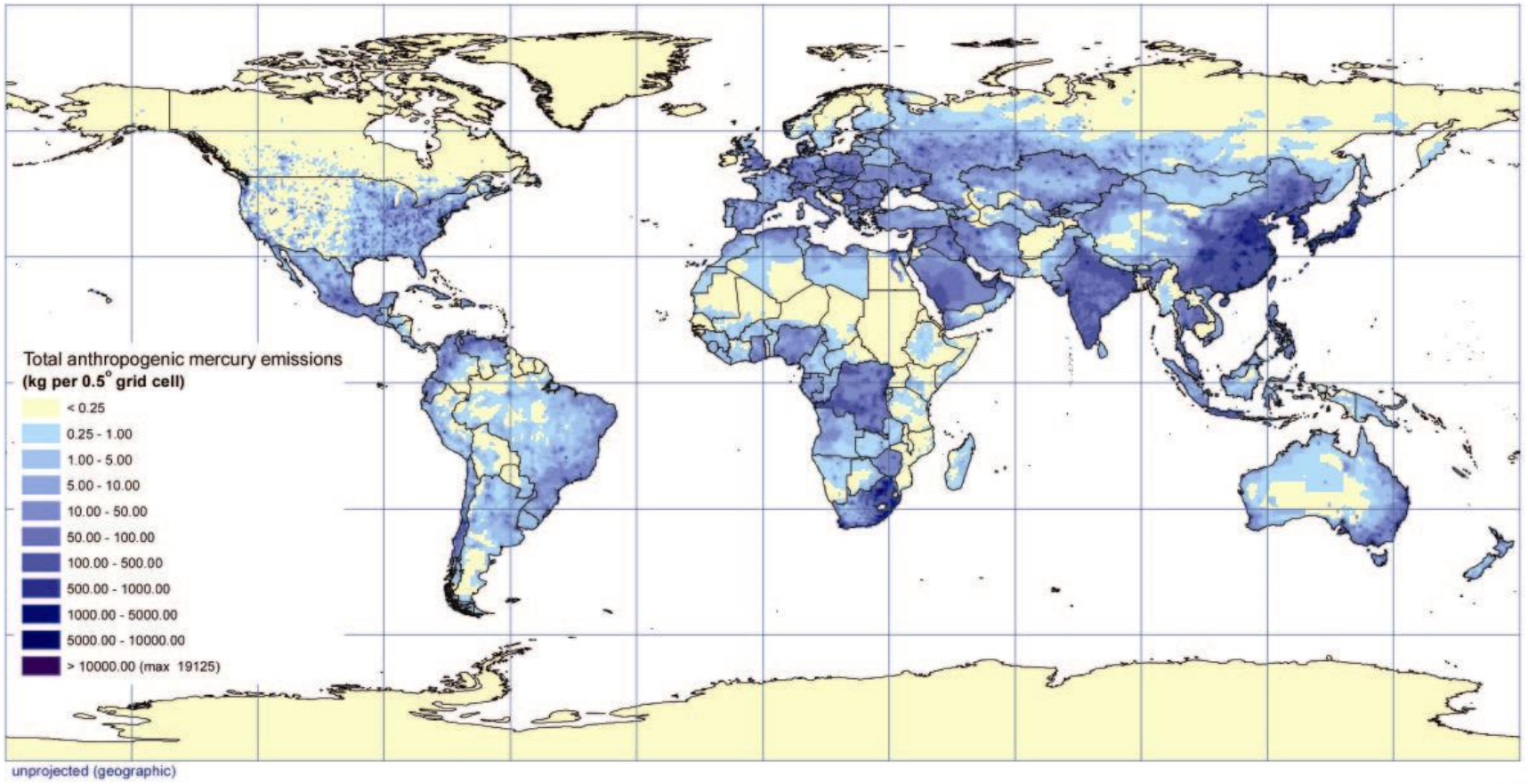
Major Categories of Hg use

- ***Chlor-alkali production***
- ***Dental amalgams***
- ***Thermometers***
- ***Other measuring and control equipment***
- ***Energy-efficient lamps***
- ***Electrical switches, contacts, relays***
- ***Laboratory/education***
- ***Vinyl chloride monomer production***
- ***Artisanal and small-scale gold mining***
- ***Batteries***
- ***Cosmetics and skin lightening creams***
- ***Cultural uses and traditional medicine***
- ***Paints and pesticides/agrcultural chemicals***



Source: UNEP, 2006.

Global Mercury Emissions Map

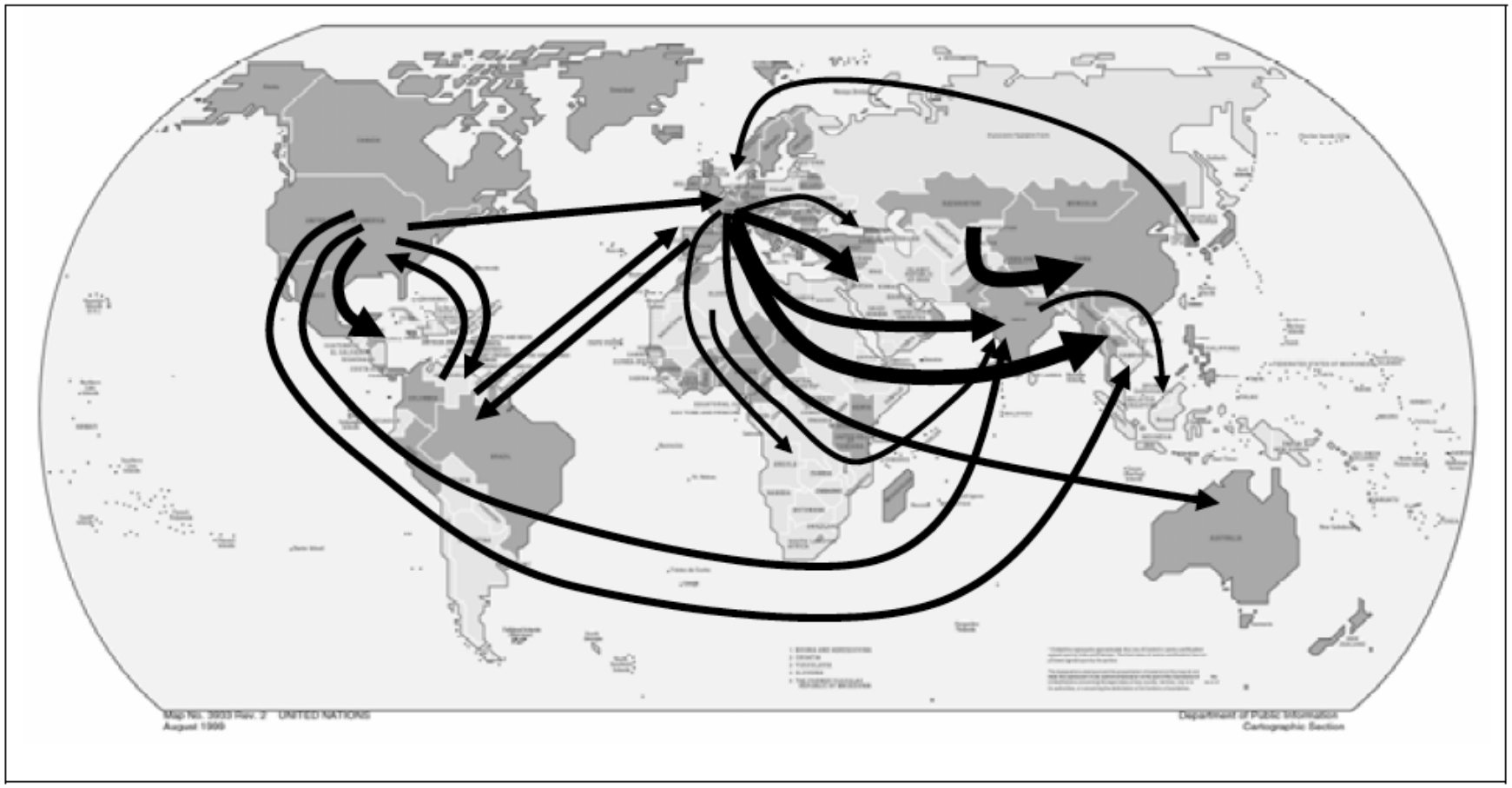


Selin NE. 2009. Annu. Rev. Environ. Resour. 34:43–63

S. Wilson (AMAP), F. Steenhuisen (Arctic Centre, RuG), J. Pacyna (NILU)

Mercury Trade

Figure 4 Commodity mercury shipments among world regions, 2004



Current Hg mining in: China, Kyrgyzstan

Source: UNEP

Artisanal & Small-scale Gold Mining

Involves >20 million people in 70+ countries

12% of world's gold production

Development issues including poverty, gender, biodiversity

Countries include Peru, Colombia, Mozambique, Indonesia, Zimbabwe…

Negotiations progress

- ***2002: United Nations Environment Programme Global Mercury Assessment***
  - "sufficient evidence to warrant international action"
- ***2002-2009: Global Mercury Programme***
  - Several countries were against a global treaty (e.g. USA, China)
- ***2009: Mandate to begin treaty negotiations***
  - US changes its position
- ***2010: First negotiating session (Stockholm)***
- ***2011 (January): Second negotiating session (Japan)***
- ***2011 (October): Third negotiating session (Nairobi)***
- ***2012 (June): Fourth negotiating session (Uruguay)***
- ***2013 (January): Fifth negotiating session (Switzerland)***
- ***Mid-2013: Diplomatic conference and signature (Japan)***

- ***Then, ratification….and implementation…***

Major Global Mercury Issues for the Hg Treaty

- ***Measures to reduce emissions to air, water, land:***
  - Mostly from coal-fired power plants
  - 50% of emissions in Asia (mostly China)
  - Largest 3 contributors: China, India, United States
  - Targets and timetables?
- ***Measures to reduce mercury supply:***
  - Continuing mining
- ***Measures to reduce intentional use:***
  - Bans or restrictions on mercury in products

POPs: Specific category of particularly hazardous chemicals

- "Persistent organic pollutants"
- Characteristics: persistence in environment (air, soil, water); bioaccumulate (fish, marine mammals); toxic
- Category of "POPs" is a science-policy hybrid
- Subject to international agreements (global Stockholm Convention)

What are POPs and why are they a problem?

- Pesticides, e.g. DDT, Chlordane: carcinogenic, ecotoxic
- Subject to international regulation because of long-range transport
- Accumulation in the Arctic, in traditional foods, far from location of use/release

Pesticides Industrial chemicals Byproducts

POPs Included and Proposed under Major Agreements

	CLRTAP	Stockholm	Proposed-Stockholm
Aldrin	√	√	
Chlordane	√	√	
Chlordecone	√	√	
Chlorinated naphthalenes			P
DDT	√	√	
Dieldrin	√	√	
Dioxins	√	√	
Endosulfan		√	
Endrin	√	√	
Furans	√	√	
Heptachlor	√	√	
Hexabromobiphenyl	√	√	
Hexabromocyclododecane			P
Hexachlorobenzene	√	√	
Hexachlorobutadiene	√		P
Hexachlorocyclohexane	√	√	
Mirex	√	√	
Octabromodiphenyl ether		√	
PCB	√	√	
Pentabromodiphenyl ether	√	√	
Pentachlorobenzene	√	√	
Pentachlorophenol			P
Perfluorooctanesulfonate	√	√	
Polychlorinated naphthalene	√		
Polycyclic aromatic hydrocarbons	√		
Short-chain chlorinated paraffins	√		P
Toxaphene	√	√	

How to determine whether a chemical is a POP?

- Data requirements for persistence, bioaccumulation
- "Environmental fate properties and/or model results that demonstrate that the chemical has a potential for long-range environmental transport…" [Stockholm Convention]

Stockholm Convention and additional POPs

- The 2001 Stockholm Convention initially dealt with only 12 persistent organic pollutants (POPs)
- It included a procedure for adding future substances to the agreement, based on scientific criteria of persistence, bioaccumulation, toxicity
- 9 additional substances have so far gone through the process

INTERNATIONAL CRITERIA FOR POPs

Bioaccumulation:

- Bio-accumulation factor (aquatic) > 5000 or log Kow > 5, OR
- Evidence of high bioaccumulation in other species, high (eco)toxicity, OR
- Monitoring data in biota

Persistence:

- Half-life of 2 months in water, or 6 months in soil, or 6 months in sediment, OR
- Evidence of sufficient persistence to justify consideration

Long-range transport potential:

- Measured levels in locations far from releases, OR
- Monitoring showing long-range environmental transport may have occurred, OR
- Environmental fate properties or model results showing potential for transport
- Air half-life > 2 days for chemicals transporting through air

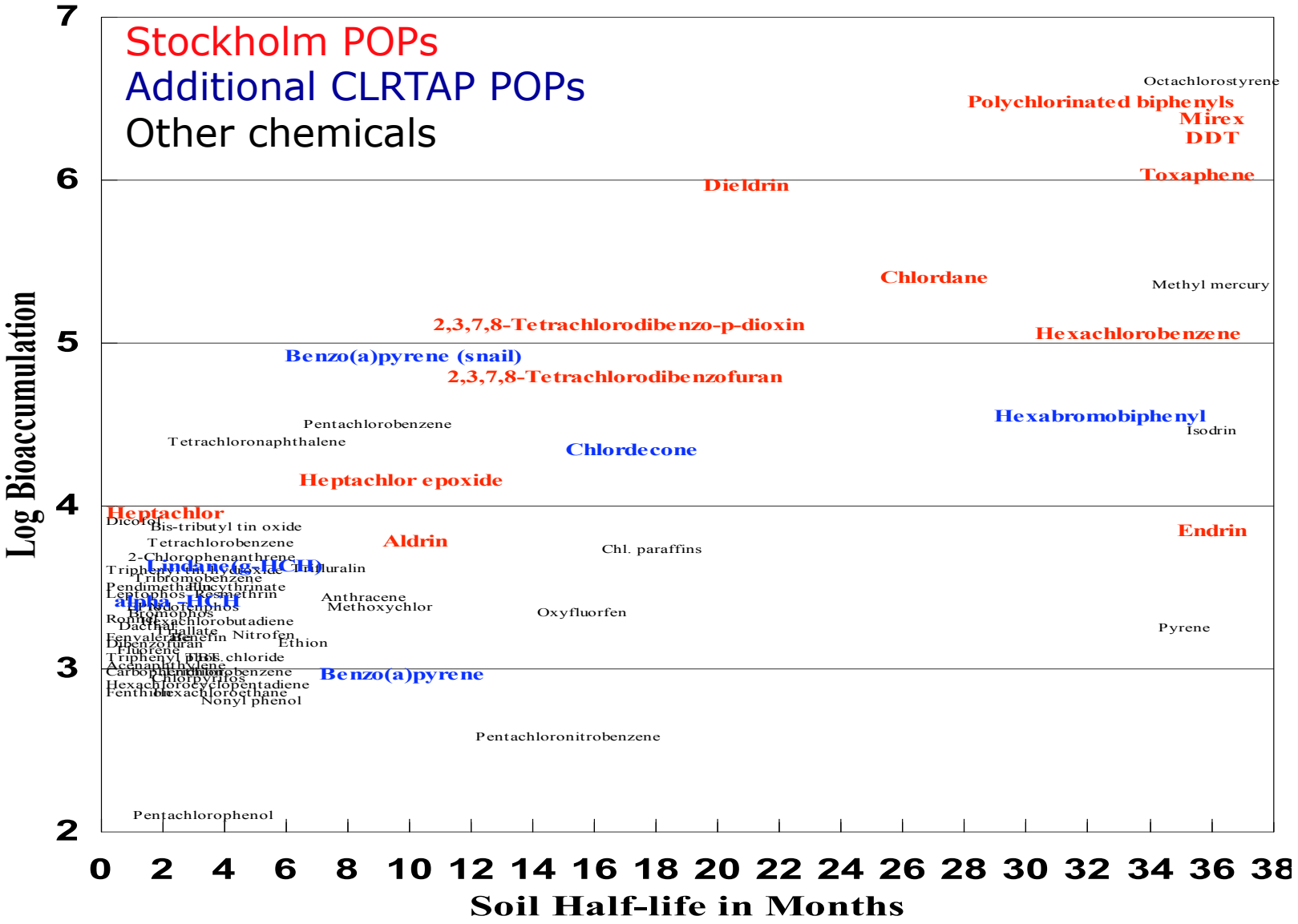
Adverse effects

Criterion		Stockholm
Bioaccumulation	Log Kow	5
	Bioaccumulation Factor	5000
Persistence	Water	2 months
	Soil	6 months
	Sediment	6 months
Transport	Air	2 days

Log Kow=octanol-water partition coefficient, measure of lipophilicity
Bioaccumulation factor: takes into account environmental and dietary sources

[Eckley, *Environment*, 2001; Rodan et al., *ES&T*, 1999]

SETTING CRITERIA: WHERE ARE THE DIRTY DOZEN?



Additional Considerations and Challenges

- Known, regulated POPs (e.g. PCBs, "dirty dozen" pesticides) have data available, but many of the intentionally-produced ones are no longer produced
- "Byproduct" POPs (dioxins, furans) regulated in industrialized countries, continue to grow elsewhere
- Candidate POPs (e.g. PFOS, PBDEs) have some data, and are emerging problems.
- Unidentified POPs -- ???

Procedure for adding POPs to the Stockholm Convention

- Designing the procedure: a product of negotiation
- Criteria Expert Group met during negotiations of the treaty; composed of government scientists, regulators, diplomats

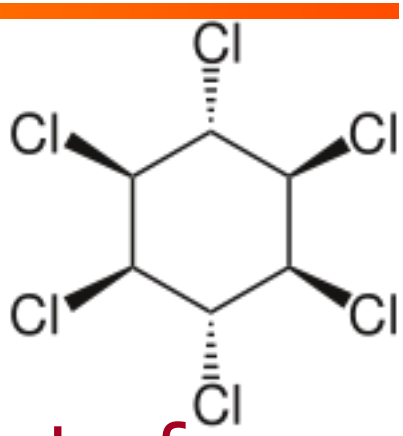
5 step review process

- Party submits a proposal to regulate a new chemical based on information requirement in Annex D (Persistence, bioaccumulation, toxicity info)
- POPs Review Committee (POPRC): 31 government-designated experts decides whether criteria met
- Soliciting of technical comments, development of risk profile by POPRC
- Soliciting of comments, POPRC develops risk management evaluation and submits to the Conference of Parties (COP)
- Conference of Parties takes final decision on whether to list chemical and where

Review Committee Issues

- Composition: regional, disciplinary
- Language
- Procedure and timing (meeting frequency)
- Capacity (for proposing, and analyzing)

Example review process: Lindane



- Proposed by Mexico, June 2005
- Lindane=gamma-hexachlorocyclohexane
- Agricultural insecticide, treatment of head lice
- Measured in the Arctic; toxic to rats; carcinogenic in mice; accumulates in humans

Procedure (Lindane example)

- 6/05: proposal by Mexico
- 11/05: POPRC says satisfies screening criteria
- 11/06: POPRC adopts risk profile
- 11/07: POPRC adopts risk management evaluation
- 5/09: COP includes Lindane on Annex A (Elimination), with specific time-limited exemptions for some head lice use

Ways Forward

- Single substance approaches remain dominant
- Some initiatives to improve data availability (e.g. REACH)
- Upstream approaches (green chemistry, precautionary principle)
- Chemicals use in the context of sustainability