Overview of scientific work on estimation of Hg current and future emissions

Minamata Online Session
Mercury Emission – Estimation and projections
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Major questions to be addressed

- What are the levels of emissions from natural and anthropogenic sources and how accurate are estimates of these emissions?
- What is the spatial distribution of these emissions?
- What are the future emission projections?
- How may research on emissions support the implementation of the Minamata Convention?
How much Hg is in the ocean?

2013: 0.36 ng L\(^{-1}\) = 1.8 pM => 358,000 t
2018: 0.31 ng L\(^{-1}\) = 1.6 pM => 313,000 t
Natural sources and re-emission (in t/y)

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<tr>
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<tbody>
<tr>
<td>1. Natural emissions from land to atmosphere</td>
<td>900</td>
<td>500</td>
<td>80 – 600</td>
<td>90</td>
</tr>
<tr>
<td>2. Re-emission from land</td>
<td>1 500</td>
<td>1 700</td>
<td>1 700 – 2 800</td>
<td>1 664</td>
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<td>3. Biomass burning</td>
<td>-</td>
<td>300</td>
<td>300 – 600</td>
<td>675</td>
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<tr>
<td>4. Re-emission from ocean to atmosphere</td>
<td>2 400</td>
<td>3 700</td>
<td>200 – 2 900</td>
<td>2 778</td>
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<tr>
<td>TOTAL</td>
<td>4 800</td>
<td>6 200</td>
<td>4 080 – 6 900</td>
<td>5 207*</td>
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* Upper and lower bound of Hg emission from natural sources estimated in GMOS: 2157 and 10222 t/y, respectively (accuracy ±100% !)
Estimated source contributions to anthropogenic mercury emission to air in 2015, in percentage (UNEP, 2019)
Geospatial distribution of global anthropogenic mercury emissions to air (2010)
### Available literature on future global anthropogenic emissions

<table>
<thead>
<tr>
<th>Policy scenarios addressed</th>
<th>Projections</th>
<th>Reference</th>
</tr>
</thead>
<tbody>
<tr>
<td>Four IPCC SRES scenarios</td>
<td>2050 – projection year</td>
<td>Streets et al., 2009</td>
</tr>
<tr>
<td></td>
<td>2006 – base year</td>
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<tr>
<td>- Projections of energy consumption</td>
<td>2050 – projection year</td>
<td>Rafaj et al., 2013</td>
</tr>
<tr>
<td>- Activity projections complemented with assumptions on air pollution and Hg control measures</td>
<td>2010 – base year</td>
<td></td>
</tr>
<tr>
<td>Three IPCC SRES scenarios</td>
<td>2050 – projection year</td>
<td>Lei et al., 2014</td>
</tr>
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<td></td>
<td>2000 – base year (from Pacyna et al., 2006)</td>
<td></td>
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<tr>
<td>Projected future activities and emission factors</td>
<td>2035 – projection year</td>
<td>Pacyna et al., 2016</td>
</tr>
<tr>
<td>– CP, NP and MFR</td>
<td>2010 – base year</td>
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</tbody>
</table>
Sector-specific mercury emissions under various emission scenarios

- **Artisanal and small-scale gold production**
  - 1,960 (2010)
  - 2,040 (CP)
  - 1,100 (NP)
  - 390 (MFR)

- **Fossil fuel combustion**

- **Non-ferrous metals production (Cu, Pb, Zn, Al, Hg, large scale Au)**

- **Disposal and incineration of Hg-containing products**

- **Contaminated sites**

- **Cement production**

- **Ferrous metals production**

- **Chlor-alkali industry**

- **Oil refinery**

- **Cremation**
Spatial distribution of mercury emissions in 2035 according to various scenarios.
What to expect in the future?

1. Decrease of Hg emissions from electric power plants, due to implementation of emission control equipment (FGD, CCS), clean combustion technologies (combustion efficiency up to 40%), different energy mix

2. Decrease of Hg emissions from industrial sources through the application of BATs and BEPs (example in non-ferrous metal industry in China)

3. Status quo in Hg emissions from small residential units and waste incineration

4. Decrease of Hg emissions from various users of mercury due to implementation of various bans on Hg use
What to expect in the future?

(2)

5. Possible increase of re-emission of Hg from aquatic and terrestrial surfaces due to climate change impacts

In summary:

Lowering of anthropogenic emissions, constant emissions from natural sources, and potential increase of re-emission
Contribution of future research to the Minamata Convention: Improvement of information on:

1. Emissions from selected sources, such as CHP and residential/commercial units (amount and type of coal, content of Hg in coal) - emission factors and database
2. Chemical speciation in emissions of Hg from various source categories – emission profiles
3. Emission projections for Hg emissions in the future – methodologies for scenario estimates
4. Technological measures to reduce Hg emissions, incl. BAT – efficiency coefficients of various measures
5. Non-technological measures to reduce emissions, incl. BEP on national and enterprise level – list of measures
Thank you!