Past, Present, and Future of Mercury Problem

Reflections on the Minamata Convention on Mercury:
Towards Mercury Management in the Global South

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Outline

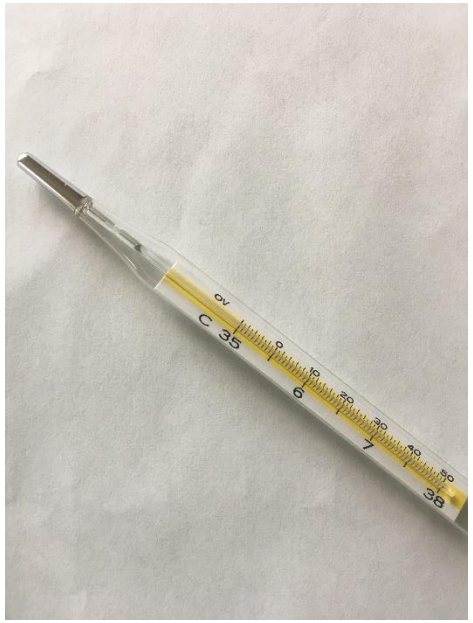
- Introduction (Past and Current Situation)
- Minamata Convention on Mercury
- Future Projections and Challenges (ERCA SII-6 Project)
- Conclusions
- Acknowledgements

Ancient and Familiar Element: Mercury

出典：フリー素材

- According to the Nara Period Todaiji Great Buddha Record, 50 tons of mercury and 9 tons of gold were used for the gilding of the Great Buddha.
- The name of [丹nyu]・[丹生 nyu] is a place of mercury production（丹生都比売神社 Nyutsuhime Jina, Shinto, Shrine）alchemy

- Mercury is the only liquid metal at room temperature and atmospheric pressure and has been used in a variety of products.



Minamata Disease Damages vs. Calculated Cost of Pollution Prevention Measures

- Minamata disease is a mercury poisoning caused by daily intake of fish and shellfish highly contaminated by methylmercury. Between 1953 and 1960, a total of 628 patients were recognized, of which 78 had already died.
- Calculated Cost of Pollution Prevention Measures

  ：_____billion Japanese Yen/year
- Damages：**12.631** billion Japanese Yen/year
  - Health damage：**7.671** billion Japanese Yen/year
  - Environmental Pollution damage：**4.271** billion Japanese Yen/year
  - Fishery damage：**0.689** billion Japanese Yen/year

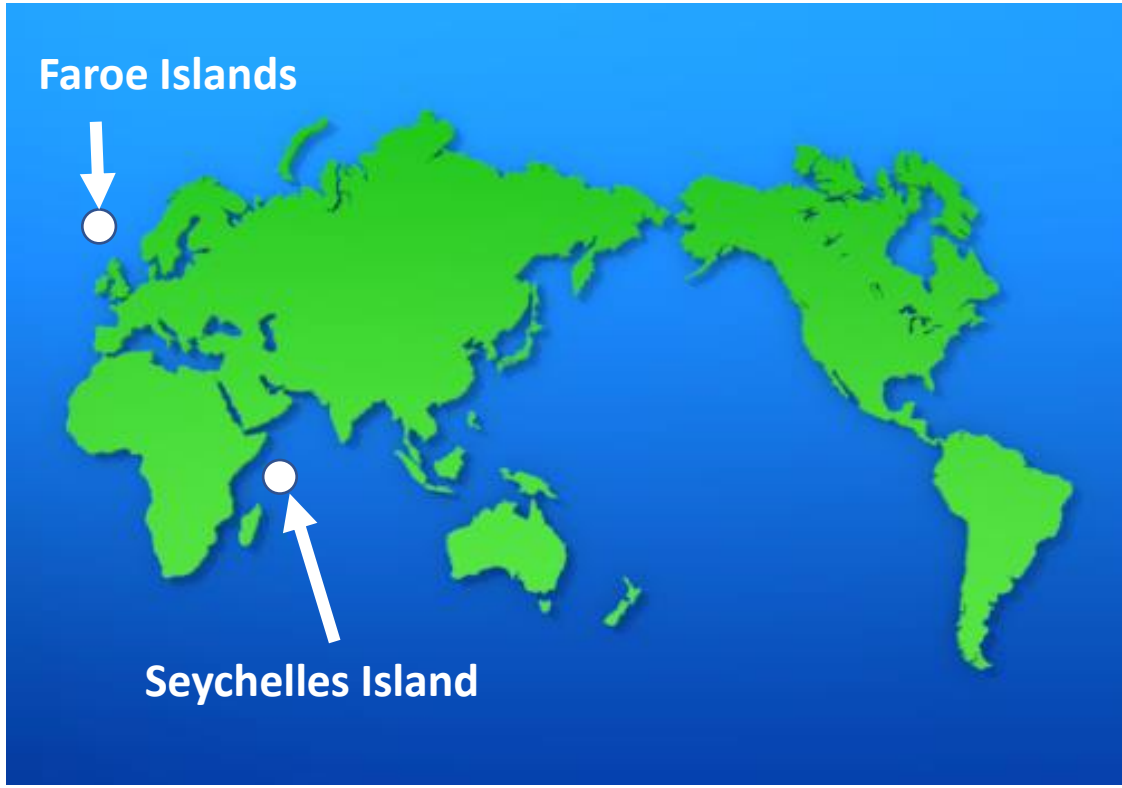
Activities that prioritize economic development and neglect the environment can cause a variety of serious damage that is not easily remedied later, including health damage.

Source: Research Group on Global Environmental Economy : Japanese Experience of Environmental pollution, 1991 (in Japanese)

Post Minamata Disease

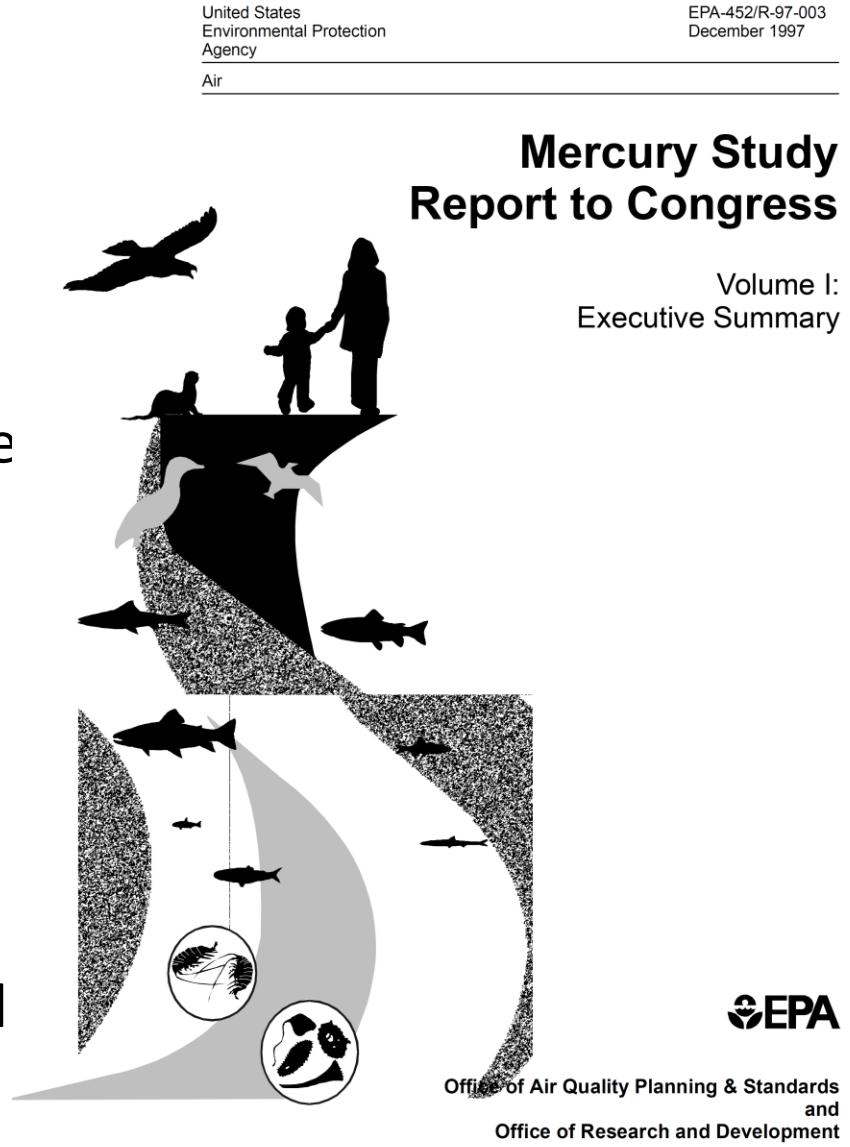
- **Mercury pollution by Artisanal Small-scale Gold Mining**
- At the 1992 United Nations Conference on Environment and Development in Rio de Janeiro, mercury contamination of the Brazilian Amazon River became known worldwide.
- **Principle 15 in Rio Declaration**
- In order to protect the environment, the precautionary approach shall be widely applied by States according to their capabilities. Where there are threats of serious or irreversible damage, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation.

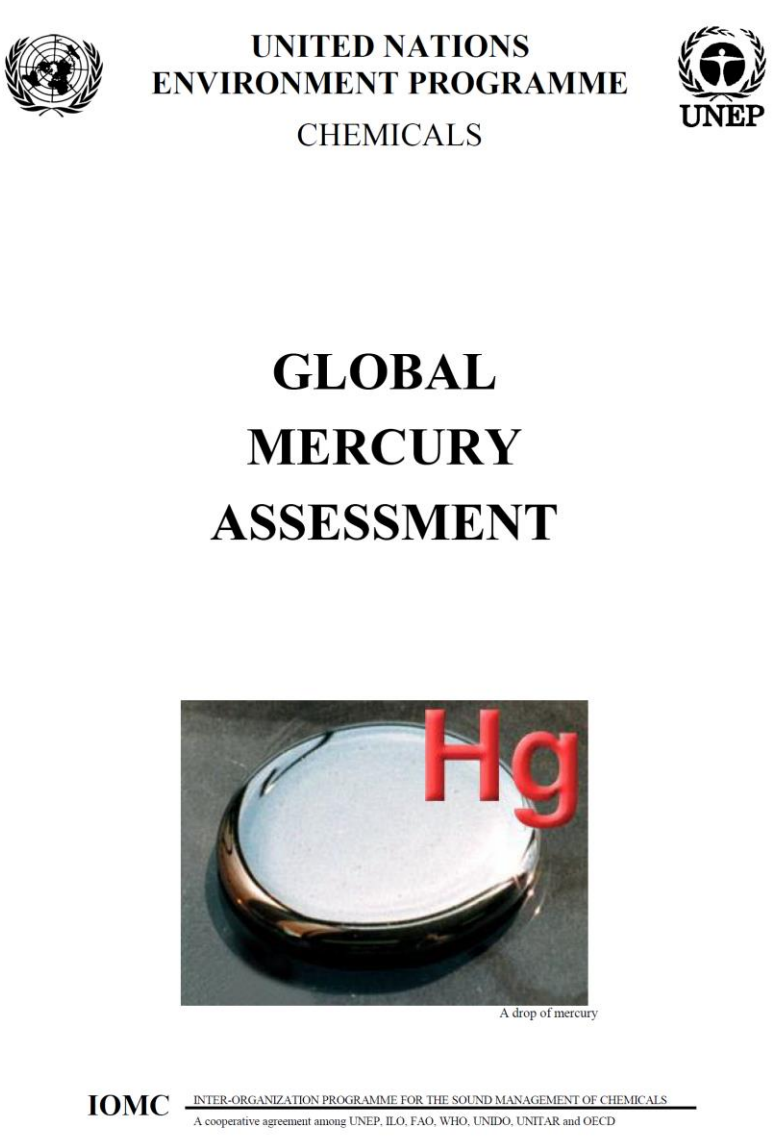
Large-scale epidemiological study of ingestion exposure to low concentrations of methylmercury from 1980s



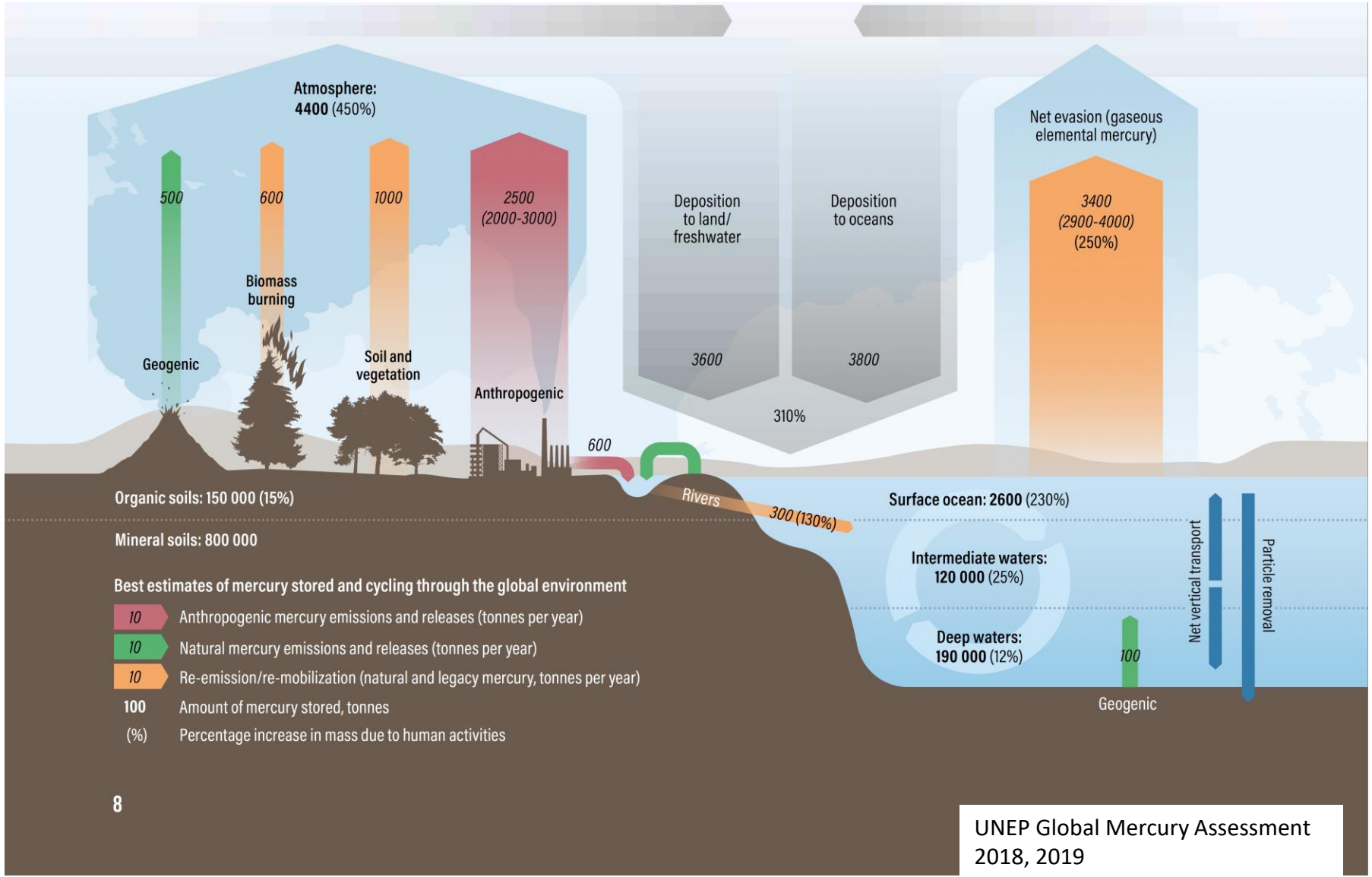
Mercury as a Global Pollutant

- Mercury Study Report to Congress（US EPA: 1997) consists of eight volumes.
- U.S. mercury emissions by source, the health and environmental impacts of those emissions, and an assessment of the availability and cost of control technologies.
- The UNEP decided to promote activities related to mercury pollution on a global scale in 2001 and conducted the Global Mercury Assessment.



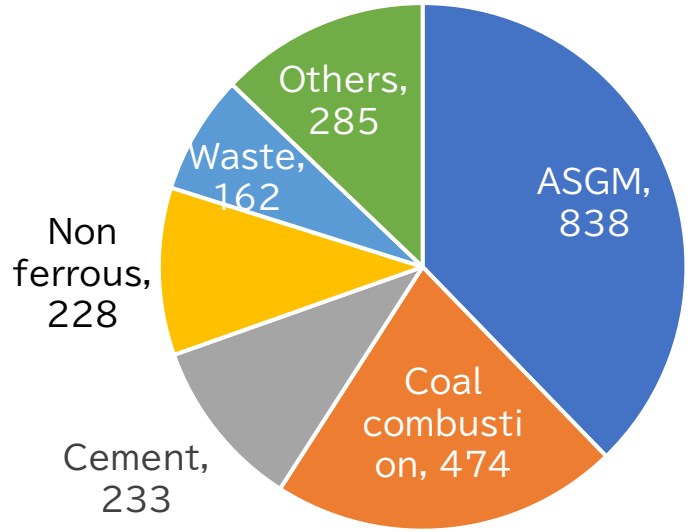


Mercury Cycles



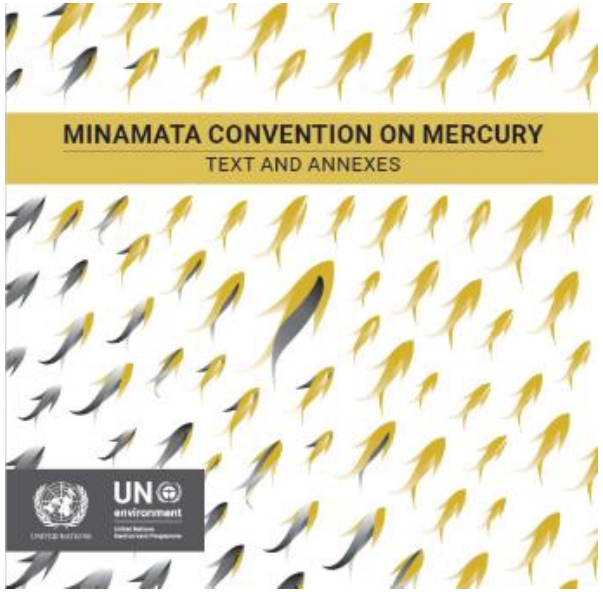
UNEP Global Mercury Assessment 2018, 2019

Mercury Atmospheric Emission（2015）
（Total: 2,200 tones）



UNEP homepage

Minamata Convention on Mercury (MCM)



- Based on the review of the 2003 Assessment, UNEP formally established the Mercury Program.
- In 2009, an agreement was reached to hold an intergovernmental negotiating committee in 2010 to establish a treaty on mercury control (negotiations were due at UNEP's 27th Governing Council Meeting in 2013).
- After five rounds of negotiations, the MCM was adopted at a diplomatic conference held in Kumamoto City in October 2013.
- The MCM entered into force in August 2017.
- There are 128 signatories to the treaty and 147 parties.

- Aims to protect human health and the environment from anthropogenic emissions of mercury and mercury compounds
- Article1-35.
  - Article 3 Mercury Supply Sources and Trade
  - Article 4 Mercury-added products
  - Article 5 Manufacturing Processes in which mercury or mercury compounds are used
  - Article 7 Artisanal and Small-scale gold mining
  - Article 8 Emissions
  - Article 9 Releases
  - Article 11 Mercury Waste
  - Article 12 Contaminated sites
  - Article 13 Financial resources and mechanism
  - Article 14 Capacity-building, technical assistance and technology transfer
  - Article 22 Effective evaluation

COP-5 Outcome

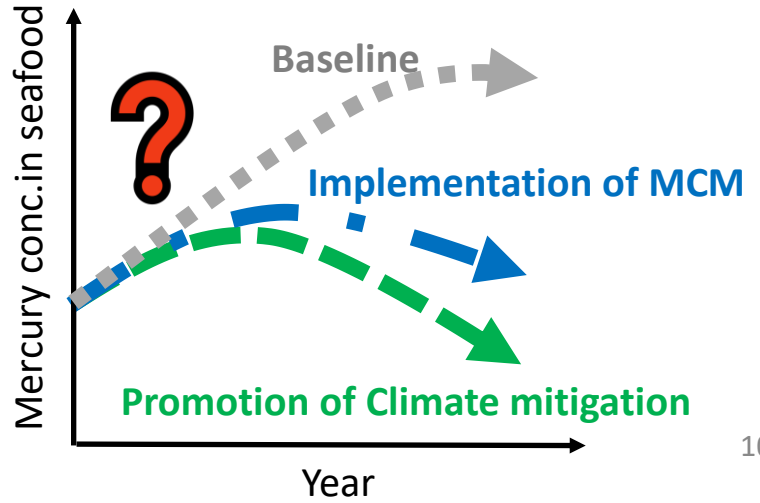
- The 5th Conference of Parties was held last November in Geneva, Switzerland.
- Parties decided to **amend Annex A** to the Convention with new phase-out dates for certain batteries, switches, relays and fluorescent lamps. Parties agreed on a new requirement to advance the phase-down of dental amalgam and, as of 2025, no mercury level will be allowed in cosmetics. They also decided to **amend Annex B** with a 2025 phase-out date for the production of polyurethane using mercury catalysts.
- Other technical decisions covered the adoption of guidance for controlling **mercury releases** to land and water, and the request for Parties to continue to advance their efforts to control the **emissions** of mercury to the atmosphere. After seven years of negotiation, Parties agreed on a 15 mg/kg total concentration of mercury as the **threshold for wastes contaminated with mercury or mercury compounds**.
- The COP established a group to oversee the development of the first report to evaluate the **effectiveness of the Convention**, following the agreed indicators, most of them based on national reporting submissions. Considered a standalone agenda item for the first time, the COP pushed to reduce **mercury supply sources and trade** by strengthening capacities at the national level and developing a study on the global supply, trade, production and use of mercury compounds.

Future projection and quantitative evaluation of the effectiveness of countermeasures (ERCA SII-6 Project)

✓ For appropriate implementation of the Minamata Convention on Mercury around the world, measures that combine various technologies and systems, such as the conversion of industrial processes and application of advanced emission control technologies, are necessary.

- A baseline scenario and an "intervention scenario" incorporating the effects of the measures are necessary, but the intervention scenario must take into account future social changes.
- Currently, it is difficult to quantitatively understand and evaluate the overall effectiveness of individual measures.
- It is desirable to develop and use models that can quantitatively express behavior under natural conditions and anthropogenic activities, and that can be used to predict the future and quantitatively evaluate the effects of countermeasures.
- It is also necessary to determine the extent to which the estimated exposure brought about by mercury concentrations in seafood, obtained by model calculations considering intervention scenarios, changes and transitions.

Projected changes in mercury concentrations in seafood by scenario



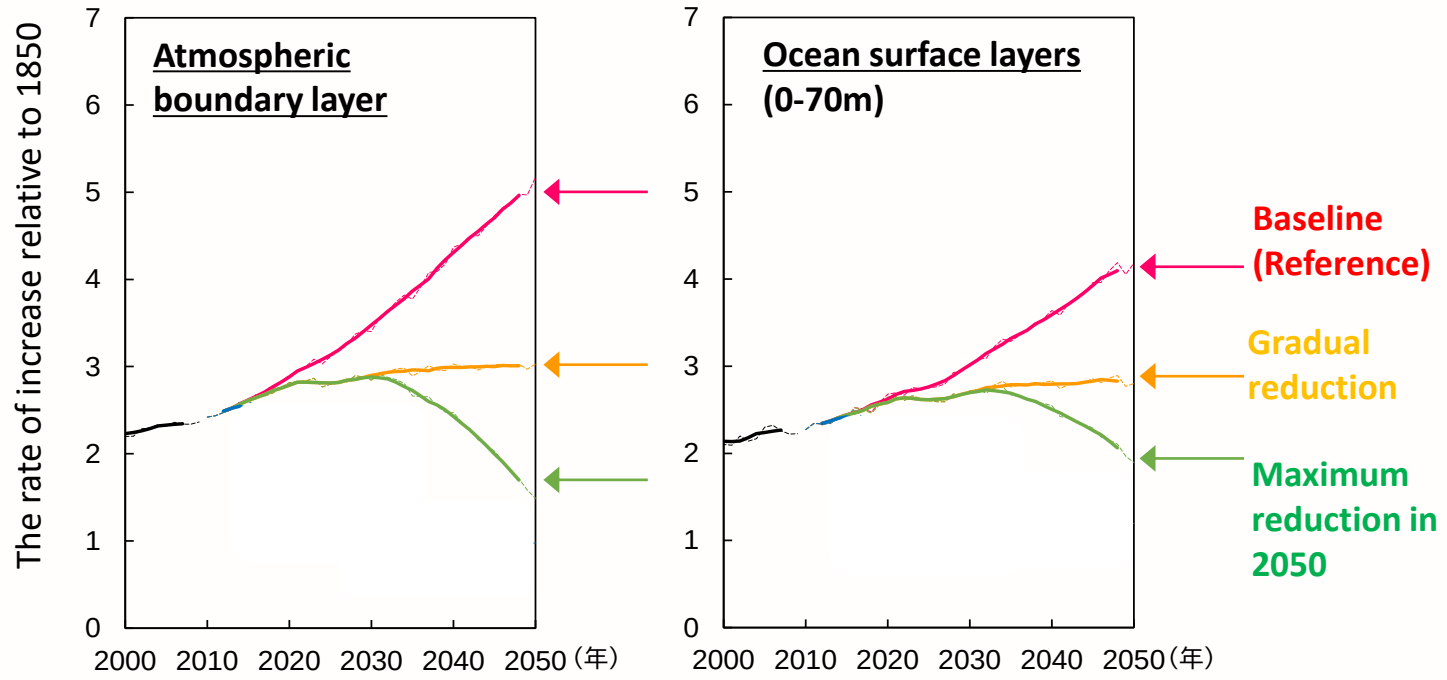
Reducing anthropogenic mercury emissions to the atmosphere can reduce global mercury levels in the atmosphere and surface seawater (from SII-6-3)

Future climate change and anthropogenic mercury emissions projection data were used to simulate future atmospheric and ocean surface global total mercury (2000-2050) and to calculate the rate of increase relative to 1850 (post-industrial revolution). The moderate climate change scenario was used for the projection, based on the results that the impact of different climate change scenarios on global mercury emissions is expected to be small up to 2050.

Input data

Future Climate Change scenario（ssp-245）
Future emission scenario of atmospheric emissions
：Baseline (Reference)
：Gradual reduction
：Maximum reduction in 2050

Projected increase in mercury compared to 1850 for each scenario



Countermeasures under the Convention will contribute to halting the increase of mercury in the atmosphere and ocean surface layers. With maximum measures, it is possible to reduce the amount of mercury in the atmosphere and ocean surface layers by 2050. However, gradual reductions in emissions may only halt the increase in the environment.

Source: https://www.erca.go.jp/suishinhi/seika/db/pdf/end_presentation/S2-6.pdf

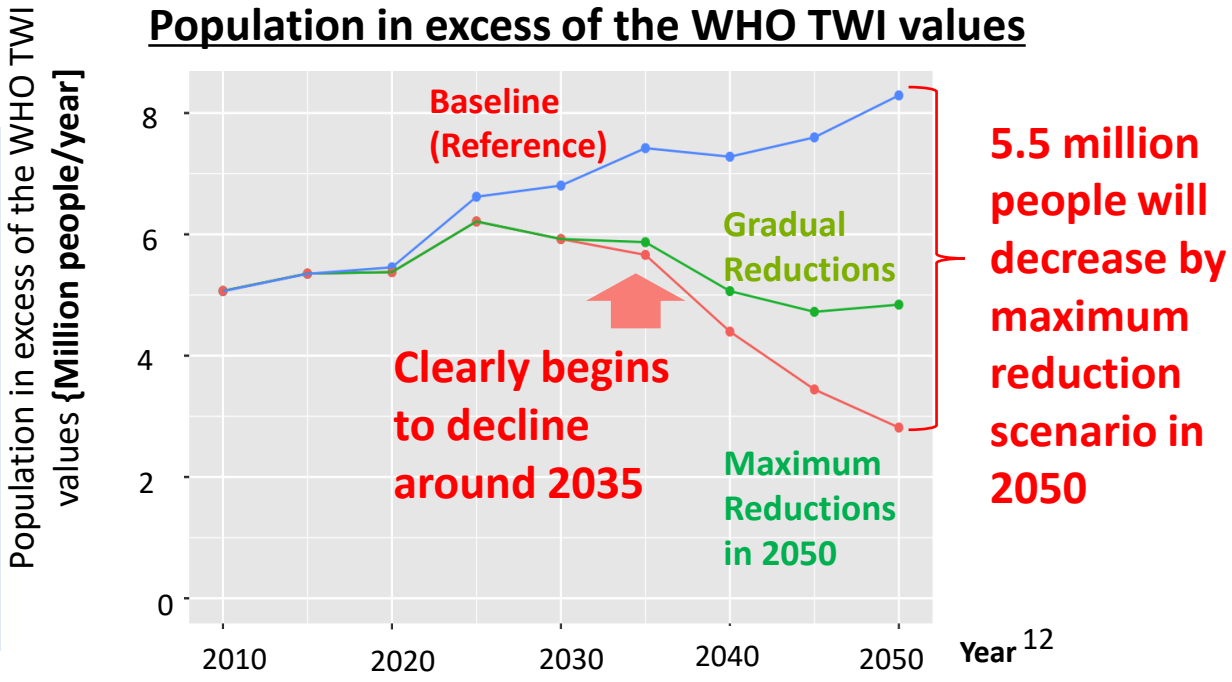
Although there is a time lag before the effects of the measures are clearly visible, they will make a big difference as of 2050. Measures taken from an early stage are effective (from SII-6-1)

- Mercury intake can impair neurodevelopment and increase cardiac mortality.
- Based on the mercury intake of each country calculated from the global model projections, the health risk from mercury was quantified in terms of (1) population in excess of the WHO Tolerable Weekly Intake (TWI) values, (2) IQ reduction, (3) cardiac deaths, and (4) total economic cost as impact indicators.

In the maximum reduction scenario, the following **benefits** were projected at 2050, compared to the reference scenario without additional measures.

- ✓ **IQ: +10 million points/year**
- ✓ **About -27,000 cardiac deaths/year**
- ✓ **Economic benefits of about +27 trillion yen/year**

Source: https://www.erca.go.jp/suishinhi/seika/db/pdf/end_presentation/S2-6.pdf

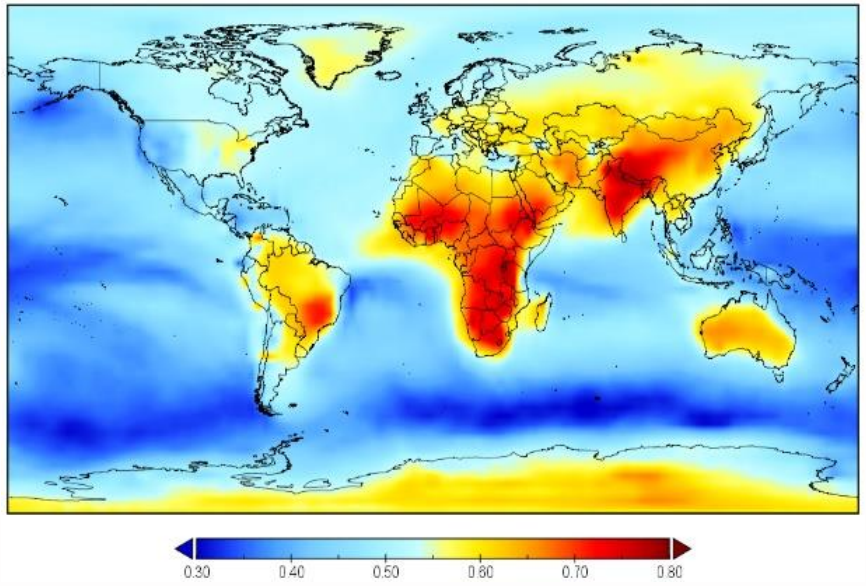


Establish strategic mercury monitoring guidelines that consider climate change to assess the Minamata Convention's effectiveness! (from SII-6-3)

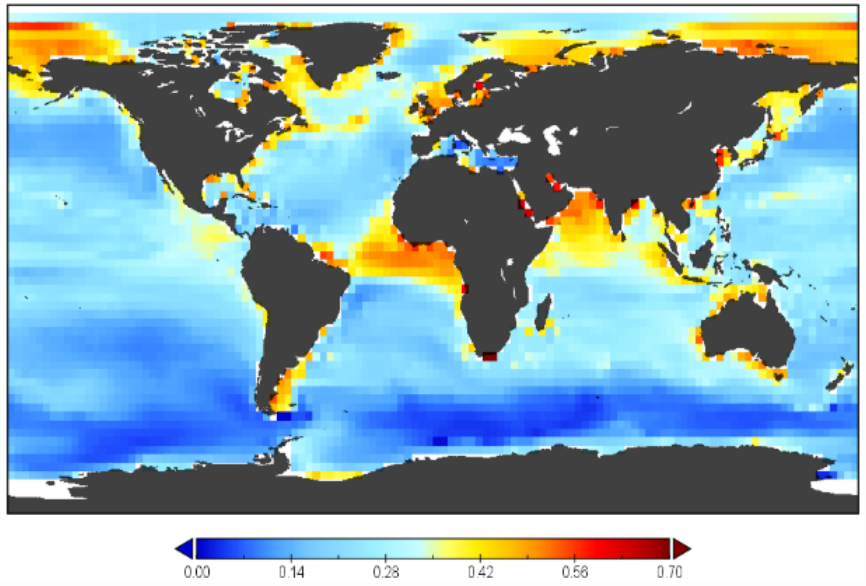
The Convention's effectiveness assessment is expected to evaluate **changes in mercury concentrations in the atmosphere and biota**. We analyzed the distribution of percent reduction in mercury concentrations in the atmospheric and marine environment for different scenarios.

Distribution of percent reduction in mercury concentrations in 2050 under the maximum reduction and gradual reduction scenarios

Gaseous metal mercury in the atmosphere



Monomethyl mercury in particle-form organic matter in the upper ocean layer (0 - 200 m)

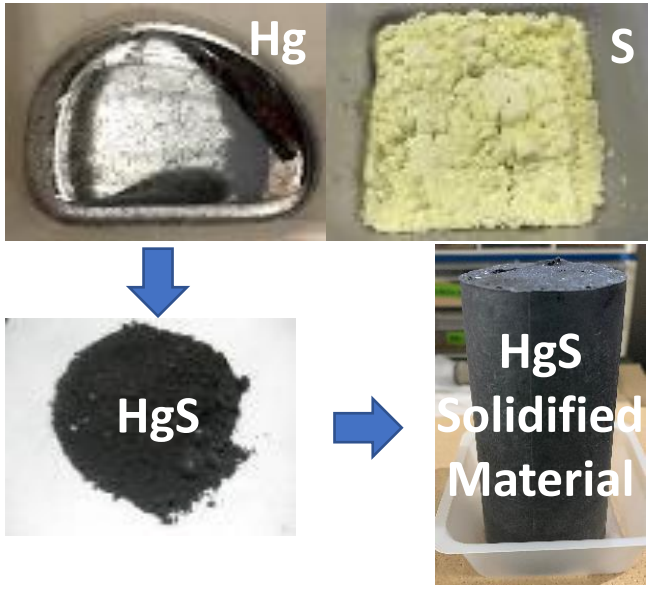


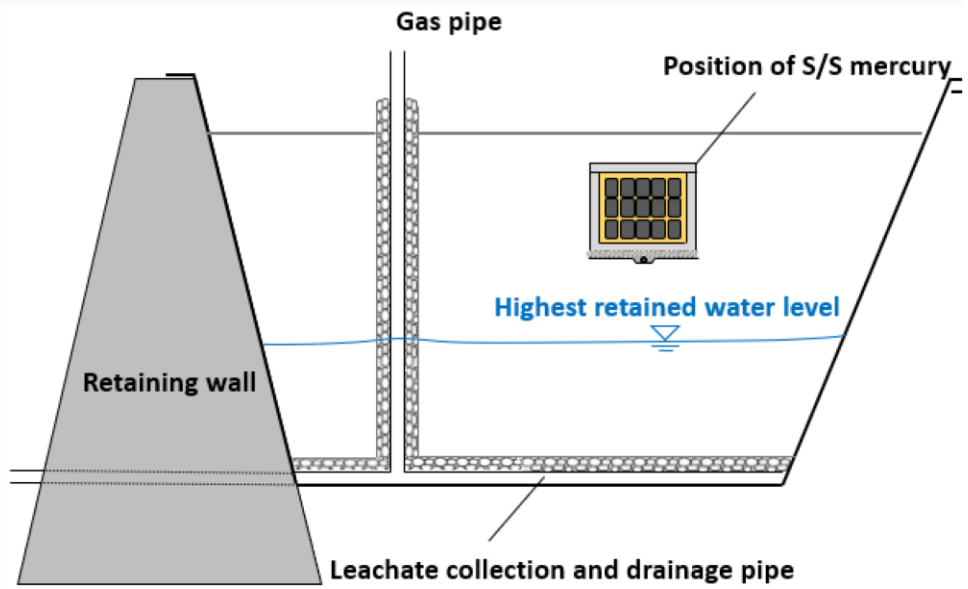
Under the maximum reduction scenario, **atmospheric mercury concentrations in South Asia, Africa, and parts of South America, and biota mercury concentrations in the ocean around the equator and the Arctic** could be relatively reduced. Acquisition of monitoring data in these regions may allow verification of the effects of reductions.

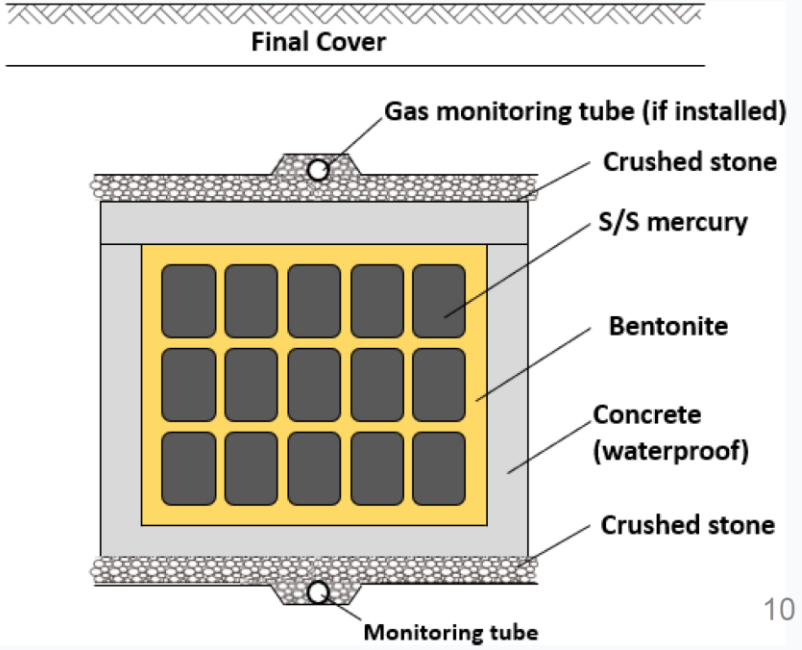
Source: https://www.erca.go.jp/suishinhi/seika/db/pdf/end_presentation/S2-6.pdf

Long-term stable storage of mercury is inevitable to break the mercury cycle in the environment (SII-6-1)

- A **defense-in-depth approach** is important to minimize the mercury release to the environment.
- **High purity, stabilization methods** and **solidification methods** are key elements for the production of long-term stable mercury waste.
- The solidified material has to be confirmed for long-term environmental safety by various methods.
- Appropriate environmental conditions must be maintained at the disposal site.
- Monitoring and risk communications are also essential.
- **Mercury can be safely sequestered for long periods without waste rock salt mines**.







Source: https://www.erca.go.jp/suishinhi/seika/db/pdf/end_presentation/S2-6.pdf

Conclusions

- Activities that prioritize economic development and neglect the environment can cause a variety of serious damage that is not easily remedied later.
- Reducing anthropogenic mercury emissions to the atmosphere can reduce global mercury levels in the atmosphere and surface seawater.
- Even if measures to reduce emissions as envisioned by the Minamata Convention are taken, atmospheric mercury concentrations will only offset economic growth and remain status quo. Reduction as much as possible is desired.
- If measures are not taken, economic losses due to health hazards in 2050 will increase.
- It is important to establish strategic mercury monitoring guidelines that consider climate change to assess the Minamata Convention's effectiveness.
- Long-term stable storage of mercury is inevitable to break the mercury cycle in the environment.

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