Annex 6: Problems and Drivers

1. The Mercury Problem

*Mercury in air*

Mercury is naturally emitted into air from various natural sources such as volcanoes, erosion and natural fires. Its accumulation in the air in Europe is largely influenced by external sources, as it is estimated that mercury emissions from outside Europe contribute about 50% of the anthropogenic mercury deposited annually within the continent, of which 30% originates in Asia\(^1\). Globally, the most prominent sources of mercury emissions to air are artisanal and small-scale gold mining (ASGM) (37%), coal combustion (24%) and non-ferrous metal production (13%)\(^3\). Most estimates indicate that global mercury emissions to the atmosphere stand at 2000 to 2500 t per year, with a persistence of up to two years, before deposition into water or soil\(^4\). Mercury emissions to air in the EU were around 200 tonnes in 1990 and decreased to around 60 t in 2016\(^5\).

*Mercury in water*

Mercury deposited in water poses a greater danger to human health than that emitted to air and deposited on soil, as water can store mercury for longer periods and, under certain conditions, can be converted into methylmercury\(^6\,\(^7\). Data on historical and future mercury releases to water are less comprehensive than for air, but an approximate assessment of global mercury emissions deposited into the oceans in 2018\(^8\) concluded that global emissions from anthropogenic sources in 2015 amounted to around 54.6 t. The main activities contributing to this level of deposition were waste management and discharges; non-ferrous metals production; and coal-fired power plants. It is estimated that the European contribution of mercury emissions to freshwater is around 8 t\(^9\).

**Mercury in European waters**

The EEA State of Water Report\(^10\) highlights that in the 2\(^{nd}\) River Basin Management Plans (2015-2021), only 38% of surface water bodies (e.g. rivers, lakes and coastal waters) were reported to be in good chemical status; 46% of water bodies failed to achieve good chemical

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5. Methylmercury is formed from inorganic mercury by the action of microbes that live in aquatic systems. People are exposed to methylmercury when eating fish and shellfish that contain this compound or when inhaling mercury vapour. In pregnant women, methylmercury can adversely affect a baby’s brain and nervous system. Similar effects can be observed in adult population (World Health Organization).
status; and for 16% of surface water bodies their status is unknown. Mercury is one of the few substances responsible for a widespread failure to achieve good chemical status with 24 Member States reporting water body failures caused by mercury.

Across Europe, mercury (alongside brominated diphenylethers) is also responsible for failure to achieve good chemical status in the highest number of water bodies: out of a total of 111,062 surface water bodies, 45,973 are not achieving good chemical status for mercury equating to about 41% of all surface water bodies in Europe11. If the widespread pollution by ubiquitous priority substances12, including mercury (priority hazardous substance), were omitted, the proportion of water bodies failing to achieve good chemical status would fall to 3% (as opposed to 46% for all such ubiquitous priority substances).

According to the EEA State of Water Report, atmospheric deposition of mercury leads to contamination of over 45,000 water bodies that fail to achieve good chemical status, while releases from urban wastewater treatment plants (UWWTP) lead to contamination with mercury and other heavy metals13 of over 13,000 water bodies. Whilst dental amalgam appears to be the main contributor to releases of mercury from UWWTP to water bodies, it must be noted that inputs from UWWTPs constitute a less significant factor in achieving good environmental status of water than atmospheric depositions14. Currently, atmospheric deposition affects 38% of surface water bodies, with mercury being the main pollutant responsible for failure to achieve good chemical status15. The EEA State of the Environment Report states that diffuse pollution remains a problem in Europe due to both historical and current emissions of mercury to the atmosphere and subsequently surface waters16.

**Mercury in soil and groundwater**

Climate change has a negative effect on mercury content in soil, through intensification of various phenomena, e.g., increased floods can lead to mercury releases through erosion, while increased rainfall will cause higher deposition of mercury from the atmosphere. Mercury accumulated in trees and forest litter is released during forest fires caused by increasingly occurring draughts causing higher emissions to air. In addition, mercury contained in permafrost is predicted to be released to the oceans, as this is expected to thaw over the coming centuries. Once mercury is deposited on land, it can enter the food chain, especially through food grown in water environments (e.g., rice). Deposited mercury has a long lifetime, especially when transformed into methylmercury, which can persist in soils for

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12 Other ubiquitous, persistent, bioaccumulative and toxic substances causing failure to meet good chemical status next to mercury are pBDEs, tributyltin and certain polycyclic aromatic hydrocarbons (benzo(a)pyrene, benzo(g,h,i)perylene, indeno(1,2,3-cd)pyrene, benzo(b)fluoranthene and benzo(k)fluoranthene). Mercury is the most common. Out of some 111,000 European water bodies identified in an EEA report No 18/2018, more than 45,000, across 24 Member States, are failing to reach good chemical status due to mercury pollution
14 European Commission (2016), Commission Staff Working Document Impact Assessment Ratification and Implementation by the EU of the Minamata Convention on Mercury
decades\(^\text{17}\). The anthropogenic mercury contamination in soil and groundwater may result in much higher concentrations compared to other environmental media, particularly in contaminated sites\(^\text{18}\). Unlike in water bodies, where mercury tends to accumulate over time, in soils, mercury tends to accumulate until an event (e.g., erosion, floods and forest fires) causes its release. Globally, it is estimated that there are approximately 10,000 tonnes of mercury in vegetation, 863,000 t in the active layer of the soil, 793,000 t in permafrost and 454,000 tonnes in other types of soil\(^\text{19}\).

**Movement of mercury**

Mercury is a global pollutant, as airborne mercury can be transported over long distances (i.e., across continents) depending on the speciation of mercury emissions and reaction pathways, before being deposited on the Earth’s surface. Across different areas of the EU, the origin of atmospheric mercury deposition can differ substantially\(^\text{20}\). Currently it is estimated that European emissions contribute up to 60% in certain areas, while in others (e.g., the Mediterranean), the atmospheric deposition originating from sources in Europe corresponds to only 20% or less of the total deposition. This significant transboundary component of mercury indicates that addressing the problem requires action at the global level together with measures implemented at EU level. Despite this transboundary nature of mercury, in the last two decades only the EU and a few other countries (e.g., Norway, Switzerland, the USA, Canada and Japan) have implemented restrictions and other measures that aim to decrease or cease the use of mercury and eventually the contribution to the global pool of mercury. In fact, in several countries in Asia the exact opposite trend has been observed with increases of mercury pollution in several Asian countries due to their industrialisation\(^\text{21}\).


\(^{21}\) European Commission (2016), Commission Staff Working Document Impact Assessment Ratification and Implementation by the EU of the Minamata Convention on Mercury
Properties

Mercury, an elemental heavy metal, is a persistent pollutant and a toxic compound for humans and the environment, which exists in different forms on earth (elemental, inorganic and organic). Under anaerobic conditions, in soil or water, bacteria can metabolise inorganic mercury to a highly potent neurotoxin, methylmercury. In contaminated ecosystems, methylmercury can enter organisms, especially plants and predatory fish that are tolerant to a high amount of mercury.

Source

Mercury is a global pollutant, as airborne mercury can be transported over long distances (i.e. across continents) before being deposited on the Earth’s surface. Mercury emissions are distributed in all environmental media including air, water and soil and affect human health, fauna and flora.

Human health

The release of mercury from anthropogenic sources, including dental amalgam, induces a progressive increase in the amount of mercury in the environment. Mercury, as a persistent substance which can enter the water cycle. Under anaerobic conditions, in soil or water, bacteria can metabolise inorganic mercury to a highly potent neurotoxin, methylmercury.

In contaminated ecosystems, methylmercury can then bioaccumulate in organisms, especially plants and fish that are tolerant to a high amount of mercury. Levels of mercury in fish vary by species and their environment. Methylmercury introduced into the food chain via plants or fish can be ingested by humans.

The mercury concentrations in organisms, including humans are affected by two major amplification processes: bioaccumulation that refers to the increase of mercury
concentrations along the lifetime of an individual and biomagnification that is defined as the increment of mercury concentration between the successive consumer levels of the food chain\textsuperscript{22}. In humans, these processes can lead to toxic effects (nervous system damage in adults and neurological development damages in infants)\textsuperscript{23}.

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Minamata Accident  \\
Between 1932 and 1968, a devastating incident occurred in the city of Minamata, Kumamoto Prefecture, Japan, whereby a large amount of mercury was released by a petrochemical factory directly into the Minamata Bay via industrial wastewater. The released mercury subsequently converted into methylmercury, contaminating shellfish and fish. The contaminated seafood was consumed by the local population of Minamata, leading to mercury poisoning and significant and lasting impacts on their health. Specifically, the poisoning affected the central nervous system. This effect was named the Minamata disease. Its signs and symptoms include ataxia, numbness in the hands and feet, general muscle weakness, loss of peripheral vision, and damage to hearing and speech. In extreme cases, coma and death follow within weeks of the onset of symptoms. This unprecedented incident led to an increased awareness of the risks of exposure to mercury and particularly the effect of methylmercury on human health. \\
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\textbf{Environmental health}

Mercury emitted to the atmosphere, travels through the air and is eventually deposited to soil and water bodies. Current global levels of mercury in the atmosphere are about 500\% above natural levels resulting from anthropogenic activities and around 40\% of the EU’s surface water bodies are currently assessed as contaminated with dangerous levels of mercury\textsuperscript{24}.

2. Problem drivers

2.1 Dental amalgam and associated emissions from crematoria

Dental amalgam is the biggest source of intentionally used mercury in the EU, and despite its use steadily decreasing, it is expected to still be in use in the EU in 2030 if no action is taken. Mercury from dental amalgam is released into the environment (soil, atmosphere, water) via dental practices (surplus of amalgam or tooth extraction); deterioration in the mouth; burial or cremation; and waste management. The overall problem tree for dental amalgam is presented below.

\begin{itemize}
\item According to the US Agency for Toxic Substances and Disease Registry (ATSDR) when mercury is swallowed, only a small amount (less than 0.01\%) will be absorbed by the body unless the stomach or intestines, are diseased. However, when mercury is breathed most (about 80\%) of the mercury enter the bloodstream directly from your lungs, and moves to other parts of the body, including the brain and kidneys where it can be accumulated for weeks or months.
\end{itemize}
Recognising the transboundary nature of mercury pollution, crematoria are an important source of mercury emissions in the EU which are expected to follow the general trends of dental amalgam use. The OSPAR and Helsinki (HELCOM) Commissions recommend the use of Best Available Techniques (BAT) to address mercury emissions from crematoria but, with only 11 and 8 EU Member States signatories to the Conventions respectively, the level of action on crematoria emissions varies across Europe. The overall problem tree for crematoria is presented below.

Figure 3: Overall problem tree for mercury emissions from crematoria
### 2.2 Mercury-added products

Some mercury-added products (MAPs) although already banned for sale within the EU are still allowed for manufacture and export to third countries. This situation causes continuing demand for mercury within the EU, sustains supply for MAPs and contributes to mercury releases in importing countries.

Due to its unique physical and chemical properties, mercury has historically been used in a wide range of products. Concerns about its environmental and health risks pushed manufacturers and legislators to develop and promote effective mercury-free alternatives and to restrict or ban the manufacture, sell and trade of mercury-added products. Most known MAPs are no longer allowed to be placed on the European market. The European Mercury Regulation also bans the export of a range of products, but it mainly limits the scope of trade restrictions to those products that are addressed by the Minamata Convention. Consequently, export is still allowed for numerous products that are prohibited for sale within the EU.

Products that contain a hazardous substance such as mercury pose a risk to human health and the environment during use and disposal. Stopping the manufacture and export of such products for which effective, affordable, and safer alternatives already exist, would further decrease EU internal demand for mercury, reduce the supply of MAPs to non-EU countries and may contribute to lower mercury emissions and releases. For some products such as lamps reduction of supply may also be an incentive to switch to more energy-efficient lamp types such as LEDs, leading to lower CO$_2$ emissions and contribute to achieving climate change goals.

The overall problem tree for mercury-added products is presented below.

**Figure 4: Overall problem tree for mercury-added products**