Policy brief on heavy metals

The input of heavy metals is a conventional environmental problem but still actual

Baltic Marine Environment Protection Commission

What are heavy metals?

Heavy metals are a group of metals and metalloids that have relatively high density and are sometimes toxic even at low concentration levels. Heavy metals are naturally present in the environment and their concentrations vary broadly depending on chemistry of geological rocks which comprise certain areas, forming so called geochemical background. Since heavy metals are actively used in industrial products and processes, they are released in the environment from anthropogenic sources. Heavy metals are released to water with industrial and municipal wastewater; emitted to air from industries, car traffic and energy sector; spread with mineral fertilizers; leached with stormwaters; leaked from landfills and paints and from other sources and pathways ending up in the marine environment.

Heavy metals as elements do not degrade in the environment, being accumulated in biota and sediments. Many of their toxic effects are well known due to grievous historical experience and proved by scientific studies. Gastrointestinal and kidney dysfunction, nervous system disorders, skin lesions, vascular damage, immune system dysfunction, birth defects, and cancer are just examples of the complications of heavy metals' toxic effects. Toxicity of heavy metals varies greatly between different elements. For example, mercury and cadmium are toxic in very low concentrations, while other, like copper or nickel, are common in our daily used products.

The 2021 Baltic Sea Action Plan recognizes heavy metals as legacy pollutants. In general, the input of some of them, included in the priority list of HELCOM Recommendation 31E/1, is constantly decreasing. However, for example, assessment of the level of contamination by mercury does not demonstrate good environmental status of the marine environment. The Baltic Sea Action Plan includes a number of concrete actions aimed to prevent contamination of the marine environment by heavy metals, e.g. mercury (actions HL16-20) and lead (HL14).

Observed facts

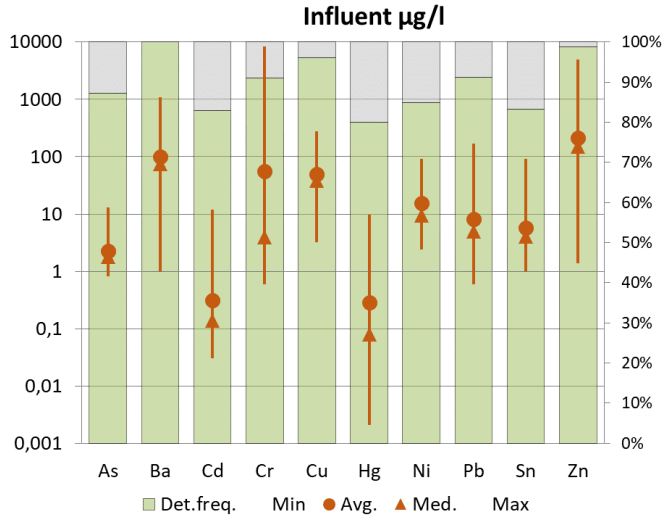
Data on concentrations of ten heavy metals in about 240 wastewater treatment plants (WWTPs), mainly observed in period 2011-2016 with a few datapoints from 2005, were reported to HELCOM by Denmark, Estonia, Germany, Latvia, Poland and Sweden. Most data on heavy metals in WWTPs, more than 4000 measurements, were reported for effluents. Measurements of heavy metals in sludge and influents were reported for about 1000 and 2000 samples respectively.

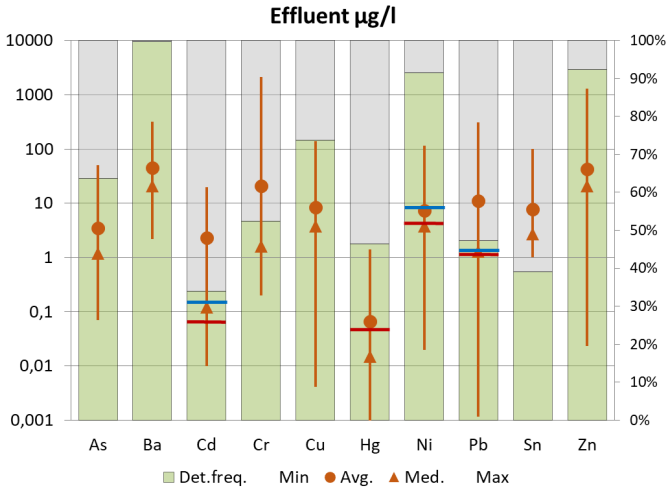
The highest detection frequency was in sludge – almost 100% of the cases. In influents heavy metals were detected in 89% and in effluents in 64% of samples. Barium, nickel and zinc demonstrate the highest frequency of detection, being detected in more than 80% of cases. Arsenic, chromium and copper were detected in more than 80% of influent and 50% of effluent samples. Mercury, cadmium and lead were also detected in more than 80% of influent but less than 50% of effluent samples.

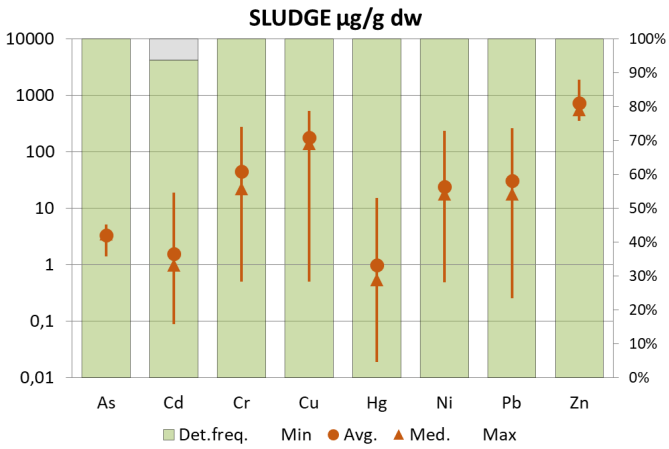
Average concentrations of chromium, copper, barium and zinc in influents are close or even exceed (for Zn) 1000 µg/l. Average concentrations of arsenic, nickel, lead and tin are approximately 1-2 orders of magnitude lower. Averages for cadmium and mercury are 0.31 and 0.29 µg/l respectively.

In general, average concentrations of all heavy metals in effluents are an order of magnitude lower than in influents. Average concentrations of Cd, Hg and Pb exceed the annual average Environmental Quality Standard (AA-EQS) for inland waters set by the EU WFD, while medians are below these thresholds. Thus most of measured concentrations are below the AA-EQS. Elevated average concentrations are provided by relatively small number of measurements. Both average and median concentrations of nickel are below the AA-EQS for inland waters.

There is no common approach to limit values for concentrations of heavy metals in sewage sludge. Reported data on concentration of heavy metals in sewage sludge demonstrate that none of the samples exceed limit values set by the EU directive 86/278 for application of sewage sludge in agriculture. Only a few threshold values set by national legislation in Denmark, Finland, Lithuania, Russia and Sweden are exceeded in a limited number of samples. As for average concentrations, the only exceedance is limit values for Cd and Hg set in Denmark.







Concentrations of heavy metals in WWTP influents, effluents and sludges. Only concentrations above limits of quantification (LOQ) are reflected. Red lines indicate annual average Environmental Quality Standards (AA-EQSs) for inland surface waters and blue for other surface waters (DIRECTIVE 2013/39/EU). EQS values are used here for indicative comparison but not for the assessment of contamination level.

Key messages

Large amount of data on occurrence of heavy metals in influents, effluents and sludges of WWTPs were collected. Reported data displays high detection frequency of heavy metals and sufficient accuracy of analytical methods to detect them even at low concentrations.

In general, concentrations of heavy metals in effluents are order of magnitude lower than in influents which is mainly due to their affinity to solid particles and accumulation in sludge. However, individual samples demonstrate high concentrations of heavy metals in effluents which exceed environmental quality standards by an order of magnitude. It alarmingly signals that under certain conditions these contaminants are still released to the aquatic environment from the WWTPs. Thus, continuous monitoring of heavy metals in effluents should be obligatory maintained in WWTPs, where appropriate.

Since heavy metals often originate from industrial pollution, the observed high concentrations of these contaminants in effluents of municipal WWTPs might be caused by releases of highly contaminated industrial wastewaters to municipal sewerages. This calls for measures to strengthen control over industrial releases and supervision of the implementation of the legislation aiming to prevent contamination of municipal wastewater by industrial releases.

Heavy metals removed from wastewater concentrate in sludge, where moderately elevated concentrations of these contaminants were observed. The level of contamination in most cases complies with existing safety criteria. However, these criteria vary largely between countries within the Baltic Sea region which does not allow regional assessment of the level of sewage sludge contamination.

Only three heavy metals – cadmium, mercury and lead are included in the HELCOM regional assessment of the Baltic Sea environmental health as core indicators. The Report on micropollutants indicates that some other heavy metals (e.g. copper or arsenic) might be of relevance for the assessment, which requires the development of HELCOM indicators and establishing of the regional environmental quality standards.

Recycling of nutrients from wastewater requires development of respective safety standards for the sewage-based products. These standards are intended to assure safe recycling of nutrients and set equal conditions for recycled nutrients and mineral fertilizers, which often demonstrate elevated concentrations of heavy metals. These safety standards could be based on harmonized regional criteria for assessment of wastewater sludge quality that might be a part of the HELCOM Recommendation on sewage sludge handling.

Since heavy metals are being continuously released from WWTPs, treatment technologies should be advanced to minimize release of these contaminants to the environment. Regional effort to minimize the release of heavy metals to the aquatic environment should not be limited by advancement of wastewater treatment technologies, thus also the sources of heavy metals to wastewater, including industrial wastewaters and storm waters are to be addressed.

References

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DIRECTIVE 2013/39/EU OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL of 12 August 2013

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