

Global Chemical Pollution - Emissions to air, water and soil

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Emissions to air

- **Ozone depleting Substances (ODS)**
 - The Montreal Protocol, 1987, has effectively eliminated ODSs from the atmosphere and the holes in the ozone layer over Antarctica are recovering. The Montreal Protocol is identified as the most effective international environmental agreement.
- **Green House Gas (GHG)**
 - The principal greenhouse gases are; carbon dioxide, methane and nitrous oxide
 - Main emissions are from the burning of fossil fuels with the manufacturing of cement and fertiliser adding significant amounts.
 - In 2016, the GHG emissions from waste sites was estimated to be 1.6 billion tonnes, 5 per cent of total global GHG emissions. By 2025, municipal and domestic dumps will account for 8-10 per cent of global anthropogenic GHG emissions.
 - The chemical industry is a significant source of greenhouse gas emissions with 5.5% of global CO₂ emissions and 17% of all industrial CO₂ emissions.
 - Chemical industry products contribute to GHG emissions, for example, nitrogen-based fertilisers release nitrous oxide.
- **Air Pollution**
 - Release of chemicals to the atmosphere are mainly generated by combustion, e.g. particulate matter, ground level ozone, carbon monoxide, lead, sulphur and nitrogen oxides are monitored and show a long-term decline except lead which varies between countries.
 - Chemicals from industrial sources, show a 58% decrease from 2006 to 2016.

- Emissions of volatile organic chemicals (VOCs) also declined
- Emissions of heavy metals, e.g., lead, cadmium, mercury, decreased by 67% from 1990 to 2012.
- Europe reported that 94% of air emissions of ammonia is from agriculture and that these emissions decreased by 23 % between 1990 and 2015.
- Emerging economies with expanding cities are thought to have polluted urban air. In the absence of national monitoring programmes, the release of industrial chemicals is not known.

- **Persistent Organic Pollutants (POP)**

- The Convention of Parties (COP) on long-range transboundary pollution noted significant decreases on some pollutants, e.g. hexachlorobenzene 95%, polychlorinated biphenyls (PCB) 75%.
- The Arctic Monitoring and Assessment Programme (AMAP) indicates that over 20 years the emissions of most POPs first listed under the Stockholm Convention are declining.
- Due to being absorbed and rereleased some POPs, e.g., chlorinated biphenyls (PCB) are not reducing significantly.
- In lower-income countries some POPs are still manufactured and released, and DDT is manufactured in India and used for disease control.
- In general, the Stockholm Convention has been successful in reducing the levels of POPs in humans and the environment.

- **Mercury**

- Anthropogenic mercury emissions to the atmosphere are currently more than 2,000 tonnes per year, approximately 30 % of the total. A significant share of these emissions comes from industrial areas in East and South Asia, Central Europe, South Africa and eastern North America.
- 60% comes from natural processes that cause re-emissions of mercury previously deposited to soils and water (much of which are derived from earlier anthropogenic emissions and releases) and from natural sources (10%).
- Artisanal and small-scale gold mining (ASGM) is a significant source of mercury released to air.

- Other important sources of mercury emissions include coal power plants, vinyl chloride monomer production, non-ferrous metal and cement production and domestic/residential burning.
- **Waste dumps**
 - Approximately 33% of the world's solid waste ends up in open dumpsites. Decomposition of waste releases volatile chemicals originating from decomposing products, in addition the greenhouse gases.
 - Open burning is common in many low-income countries. In 2016 it was estimated that 620 million tonnes of global domestic waste are burned openly every year. Burning waste, usually at low temperatures, can release hazardous substances, e.g. carbon black, dioxins, to the environment.
 - Due to the uncontrolled nature of waste burning air emissions from waste dumps are significantly underestimated.
- **Releases to indoor air**
 - Combustion of fuel for cooking and heating in lower-income countries is the main source of indoor air pollution.
 - In higher-income consumer economies there are many sources of indoor air pollution, e.g., building materials, household furnishings and consumer products.
 - The World Health Organisation (WHO) has identified the most common chemicals emitted to household indoor air include benzene, carbon monoxide, formaldehyde, naphthalene, nitrogen dioxide, polyaromatic hydrocarbons, trichloroethylene and tetrachloroethylene.

Emissions to freshwater and oceans

- **Emission sources**
 - It is estimated that 80% of ocean pollution comes from land-based sources.
 - It is estimated that 80% of the municipal and industrial wastewater is released without adequate treatment.
 - In many lower-income countries between 80 to 90% of the municipal and industrial sewage entering coastal waters is untreated.
 - The rates of releases to water are falling in the US, Japan and northern Europe.

- The American hazardous surface water discharges fell by 24% between 2006 and 2016 with most of the decrease due to reductions in the discharges from agriculture.

- **Agriculture**

- In many higher-income countries and most of the lower-income countries, pollution from agriculture exceeds that from municipal and industrial discharges.
- Farming and food processing generate some 40 per cent of water pollution in higher-income countries and 54 per cent in lower-income countries.
- In the United States agriculture is the main source of water pollution of lakes, rivers and streams.
- In the EU the water quality status has been degraded by agricultural runoff in 38% of water authorities.
- In China, agriculture it is mainly responsible for groundwater pollution by nitrogen.
- The use of pesticides globally has been falling.
- The growth of intensive livestock production has introduced a new class of agricultural pollutant: veterinary medicines such as antibiotics, vaccines and growth promoters contaminate both surface and groundwater.

- **Releases of pharmaceuticals to water**

- About 4,000 active pharmaceutical ingredients are administered worldwide in prescription medicines, over-the-counter therapeutic drugs and veterinary drugs. Globally some 100,000 tonnes of active ingredients are produced every year.
- Conventional wastewater treatment facilities are often ineffective in fully removing pharmaceuticals from wastewater, with removal efficiencies ranging from 20 to 80 per cent for individual pharmaceuticals.

- **Releases from industry**

- Despite progress in reducing discharges of chemical pollutants to water, pesticides, industrial chemicals and household chemicals continue to affect the quality of regional groundwater in many areas.
- There are growing concerns about groundwater contamination by the chemicals used in hydraulic fracturing.

- **Plastic release to water**

- Plastic enters the oceans along various pathways. Land-based sources (e.g. waste disposed at beaches) are the largest source of releases to the marine environment; others include aquaculture and fishing.
- Reports suggest that about 6-10 per cent of global plastic production is released to the ocean. It has been estimated that 275 million tonnes of plastic waste were generated in coastal countries in 2010, of which 4.8 to 12.7 million tonnes entered the ocean.
- There are various sources of macro-plastic litter, including poorly managed plastic recycling, agriculture and construction packaging and coastal tourism.
- Recent studies suggest that the largest share of microplastic wastes in the ocean are secondary wastes generated from the breakdown of clothing and textiles during machine washing (around 35 per cent) and erosion of tyres on roadways during normal vehicular travel (around 29 per cent). A smaller share comes from primary microbeads added as functional constituents to detergents and personal care products.

Emissions to soil

Activities such as agriculture, mining, manufacturing and treatment of sewage sludge, or solid and hazardous wastes deposited in dumps and landfills can release chemicals to the soil. Conventional applications of pesticides and fertilizers in agriculture result in direct releases of pesticides to soil.

- **Releases to soil through mining and metal processing.**

- The mining and metal processing industries are responsible for the largest releases of hazardous pollutants in North America. The top five pollutants in 2013 reported in North America (Canada, the United States and Mexico) were zinc, lead, manganese, copper, and nitric acid and their compounds, all of which are found in mining wastes.
- In addition, wastes from mining often contain hazardous chemicals such as arsenic, lead and cyanide in concentrations that pose serious hazards to ecosystems and human health. Acid mine drainage (AMD) is one of the largest sources of the mining industry's soil and water pollution.
- In many parts of the world gold, gems, precious stones and metals are extracted by artisanal and small-scale miners. About 25 per cent of the world's gold is produced through artisanal and small-scale gold mining (ASGM) operations in over 55, mostly lower-income, countries. Mercury releases from tailings and vaporized mercury at these mines

exceed 1,000 tonnes per year, making ASGM responsible for the largest releases of mercury to the soil of any sector globally.

- **Fertilizer and pesticide applications to soil are increasing, but application rates are decreasing**

- The market for pesticides and fertilizers is increasing globally. Global manufacture of pesticide active ingredients increased from 1.9 million tonnes in 2008 to 2.8 million tonnes in 2016.
- Application rates have declined over the past decades, for example, average application rates in the 1950s were 1,200, 1,700, and 2,400 grams of active ingredient used per hectare for fungicides, insecticides, and herbicides, respectively. By the 2000s the average use rates were reduced to 100, 40, and 75.
- It is understood that a 1 per cent increase in crop output per hectare was associated with a 1.8 per cent increase in pesticide use per hectare, and that the pesticide use levelled off as countries reached a higher level of economic development.
- A study in the United States on trends in pesticide use for 21 of that country's largest-volume crops found that use increased from the 1960s to 1980 and levelled off thereafter, at some 500 billion pounds per year. Herbicides made up the largest share of the pesticides, and the most common herbicides were glyphosate-based.
- Trace elements such as cadmium, boron and iron are increasing in agricultural soils where there has been prolonged use of rock phosphate and phosphorus-containing fertilizers. Increased use of treated municipal sewage can also distribute various heavy metals, including lead and cadmium, to the soil.

- **Microplastics are another source of soil pollution**

- If discarded plastic is not incinerated, most of it ends up in dumps and landfills where it may disintegrate into microplastic particles (5 millimetres in diameter or less) that break down further into nanoparticles (between 1 and 100 nanometres in size).
- One-third of all plastic waste ends up in soils or freshwater.
- It is reported that 80-90 per cent of the microplastics in municipal sewage ends up in the sludge that is typically spread on farms or forests. Application of sewage sludge was identified by the Norwegian Institute for Water Research (2018) as an important source of releases of microplastics to agricultural soils.

Reference:

Principal source: UNEP Global Chemicals Outlook II 2019