

Environmental Sciences (ESI101)

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Coal and Water Pollution

Lakes, rivers, streams, and drinking water supplies are all heavily impacted by coal mines and power plants.

Coal Mining

Mining operations can negatively impact water supplies, often with long-lasting effects.

The fundamental issue involves **contamination of nearby rivers, lakes, and aquifers by what comes out of a coal mine - usually highly acidic water containing heavy metals like arsenic, copper, and lead.** The process is known as **acid mine drainage.**

Finally, after coal is mined, it is typically washed with water and chemicals to remove impurities before it's burned.

The resulting coal slurry is then stored, often with coal ash or in improvised ponds that can leak, spill, or fail.

Coal Ash

When coal is burned it leaves behind a grey powder-like substance known as **coal ash**.

Coal ash contains concentrated amounts of toxic elements, including arsenic, lead, and mercury.

- Most coal ash is stored in unlined ponds or pits.
- Over time, heavy metals in the ash can escape into nearby waterways and contaminate drinking water.
- Exposure to coal ash is linked with a heightened risk for cancer as well as heart damage, reproductive problems and neurological disorders.

Coal Power Plants: Water Use and Thermal Pollution

Once-through coal plants

- Once-through coal plants pump the water directly from a nearby water sources, heat it up, then discharge it back.
- The waste water is typically hotter than the water that receives it, creating thermal pollution that can decrease fertility and increase heart rates in fish.

Wet-recirculating plants

- Wet-recirculating plants systems reuse cooling water in a second cycle rather than immediately discharging it back to the original water source.

How Does Nuclear Power Affect the Environment?

Nuclear energy currently provides 10% of the total electricity generation in the world.

Nuclear energy produces radioactive waste

A major environmental concern related to nuclear power is the creation of radioactive wastes such as uranium mill tailings, spent (used) reactor fuel, and other radioactive wastes.

These materials can remain radioactive and dangerous to human health for thousands of years.

Radioactive wastes are classified as low-level waste or high-level waste.

By volume, most of the waste related to the nuclear power industry has a **relatively low level of radioactivity.**

- **Uranium mill tailings** contain the radioactive element radium, which decays to produce the radioactive gas radon.
- Most uranium mill tailings are placed near the processing facility or mill, where they come from.

- The **other types of low-level radioactive waste** are **the tools, protective clothing, wiping cloths, and other disposable items** that become contaminated with small amounts of radioactive dust or particles at nuclear fuel processing facilities and nuclear power plants.

High-level radioactive waste consists of **irradiated or spent nuclear reactor fuel** (i.e., fuel that is no longer useful for producing electricity).

Thermal Water Pollution from Nuclear Power Plant

- Nuclear fission reactions do not directly produce greenhouse gases unlike fossil fuel-fired power plants.
- Both nuclear and fossil fuel plants produce significant thermal pollution to water bodies.
- **Thermal water pollution** is the degradation of water quality due to a change in ambient water temperature.

Effects on Water Quality and Aquatic Ecosystems

Multiple issues occur concurrently when heated water is released to an aquatic ecosystem.

- The most immediate change is a decrease in dissolved oxygen levels and rise in pH.
- Warm water cannot hold as much dissolved oxygen as cold water, and organic matter decomposes faster in warmer temperatures.
- The increase in decomposed aqueous nutrient concentrations causes **eutrophication**, most commonly realized as algae blooms, which block sunlight for underlying aquatic plants.

- The abundance of algae is an easy food source for aerobic microbes that soar in population and further deplete the dissolved oxygen.
- Low oxygen levels create **hypoxic dead zones** that cannot support most aquatic organisms.
- Additionally, rapidly heated water accelerates the metabolism of cold blooded aquatic animals like fish, causing malnutrition due to insufficient food sources.

Open Burning of Waste

Open burning of waste is the purposeful burning of unwanted combustible materials such as **paper, wood, plastics, textiles, rubber, and other debris** **in open-air or in open dumps**, where smoke and other emissions are released directly into the air without passing through a chimney or stack.



Open Burning of Residential Municipal Solid Wastes

- **Residential municipal solid wastes (MSW)** is the non-hazardous refuse produced by households and it includes paper, plastics, metals, wood, glass, rubber, leather, textiles, and food wastes.
- Open burning of residential MSW is a concern mostly in rural areas, where burning is seen as an easier or cheaper alternative to landfilling.
- Most municipalities and some states have laws that prohibit on-site burning of residential MSW.

Harmful Pollutants from Open Burning

Harmful pollutants of particular health and environmental concern from open-air burning include:

Carbon Dioxide (CO₂), Methane (CH₄), Carbon Monoxide (CO), Fine particulates, Polychlorinated dibenzo dioxins (PCDDs), Polychlorinated dibenzo furans (PCDFs), Polyaromatic hydrocarbons, Arsenic, Mercury, Lead, Hydrochloric acid, and Volatile organic compounds.

Health Effects of Open Burning

- Exposure to polyaromatic hydrocarbons, dioxins and furans are linked to problems with cancer, liver, immune system, endocrine system, reproductive system, and developing systems of the young.
- Other pollutants of concern in the smoke can include nitrogen oxides, carbon monoxide, arsenic, mercury, lead, hydrochloric acid, and volatile organic compounds. The ash from a burn may contain these pollutants and be potentially toxic.
- Ash can travel thousands of kilometers before it drops out of the sky and possibly enters the human food chain.

Environmental Effects of Open Burning

- Open-air burning is predominately practiced in rural and agricultural areas so pollutants may settle on crops, plants, in lakes and rivers and where animals graze or live. Thus, the pollutants stay in the food chain.
- Bottom ash (heavier ash) may cause local soil contamination or be carried off-site with surface water runoff.
- Although open waste burning is not the primary anthropogenic source of greenhouse gases (GHGs) worldwide, GHG emissions due to open burning of waste are significant.

Emission Factors

Table : Emissions factors for open burning of municipal waste (EPA, 1995a)

Pollutant	Emissions (lb/ton entire refuse weight)
Sulfur Oxides	1
Carbon Monoxide	85
Methane	13
Nitrogen Oxide	6

Example Estimate CO emission from open burning of household waste in County A.

Survey results

A survey has been completed of 1,000 households in a rural portion of County A. The survey area covered only locations where no public or private garbage pickup services are available. An average household size is 2.5 people determined from U.S. Census Bureau statistics. Average waste generation for a household is 6.75 lbs per day, and 1.38 lbs of the waste is noncombustible material. Sixty-seven of the 1,000 households use burn barrels to dispose of combustible household waste.

Survey scaling

U.S. Census Bureau data lists 17,502 households in the rural portion of County A, and 2,636 of the households are in areas where public or private garbage pickup services are available.

Solution: Number of households where garbage pickup services are not available = (17502-2636) households

= 14,866 households

Number of households that actually burn their household waste

= 6.7 % of 14,866 households **(Given 6.7 percent from survey)**

= 996 households

The emissions calculation using an factor from EPA (1995a) uses total combustable waste.

Total combustable waste for County A:

Total Waste Burned (lb/day) = 996 * 5.37 lb/day

= 5349 lb/day

= 2.68 ton/day

CO emission = 85 lb CO/ton total waste burned * 2.68 ton/day

= 227.8 lb CO/day

Thank You