

AP Environmental Science Exam Prep Session: Pollution

Robert H. Quarles, Pflugerville High School, Pflugerville, Texas

AP Environmental Science Topic Outline

VI. Pollution (25–30%)

A. Pollution Types

1. Air pollution

(Sources — primary and secondary; major air pollutants; measurement units; smog; acid deposition — causes and effects; heat islands and temperature inversions; indoor air pollution; remediation and reduction strategies; Clean Air Act and other relevant laws)

2. Noise pollution

(Sources; effects; control measures)

3. Water pollution

(Types; sources, causes, and effects; cultural eutrophication; ground- water pollution; maintaining water quality; water purification; sewage treatment/septic systems; Clean Water Act and other relevant laws)

4. Solid waste

(Types; disposal; reduction)

B. Impacts on the Environment and Human Health

1. Hazards to human health

(Environmental risk analysis; acute and chronic effects; dose-response relationships; air pollutants; smoking and other risks)

2. Hazardous chemicals in the environment

(Types of hazardous waste; treatment/disposal of hazardous waste; cleanup of contaminated sites; biomagnification; relevant laws)

C. Economic Impacts

(Cost-benefit analysis; externalities; marginal costs; sustainability)

Important Places

Love Canal, NY: chemicals buried in old canal, school and homes built over it led to birth defects and cancers

Minamata, Japan: mental impairments, birth defects, and deaths were caused by mercury dumped in Minamata Bay by factory. Mercury entered humans through their diet (fish).

Bhopal, India: December 2, 1984, methyl isocyanate released accidentally by Union Carbide pesticide plant kills over 5,000.

Valdez, Alaska: March 24, 1989, tanker Exxon Valdez hits submerged rocks in Prince William Sound—worst oil spill in US waters.

Important Legislation

Safe Drinking Water Act: set maximum contaminant levels for pollutants that may have adverse effects on human health.

Ocean Dumping Ban Act: bans ocean dumping of sewage sludge & industrial waste.

National Wild and Scenic Rivers Act: protects rivers with due to aesthetic, recreational, wildlife, historical, or cultural reasons.

Clean Water Act: set maximum permissible amounts of water pollutants that can be discharged into waterways. Aim: to make surface waters swimmable and fishable.

Clean Air Act: Set emission standards for cars, and limits for release of air pollutants.

Resource Conservation & Recovery Act (RCRA): controls hazardous waste with a cradle to grave system.

Comprehensive Environmental Response, Compensation & Liability Act (CERCLA): The “Superfund” act, designed to identify and clean up abandoned hazardous waste dumpsites.

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Important Terms

Point Source: source from specific location such as pipe or smokestack

Non-Point Source (Area/Dispersed Source): source spread over an area such as agricultural/feedlot runoff, urban runoff, traffic.

Primary Sewage Treatment: first step of sewage treatment; eliminates most particulate material from raw sewage using grates, screens, and gravity (settling).

Secondary Sewage Treatment: second step of sewage treatment; bacteria breakdown organic waste, aeration accelerates the process.

BOD: Biological Oxygen Demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials.

Eutrophication: rapid algal growth (algal bloom) caused by an excess of nitrogen & phosphorus, blocks sunlight, causing the death/decomposition of aquatic plants, decreasing dissolved oxygen (DO), suffocating fish.

Hypoxia: water with very low dissolved oxygen levels, the end result of eutrophication, for example.

CAFE standards: Corporate Average Fuel Economy standards enacted into law in 1975, established fuel efficiency standards for passenger cars and light trucks. The fuel economy ratings for a manufacturer's entire line of passenger cars must currently average at least 27.5 mpg for the manufacturer to comply with the standard.

Primary Air Pollutants: produced by humans & nature (CO, CO₂, SO₂, NO, hydrocarbons, particulates).

Secondary Air Pollutants: formed by reaction of primary pollutants.

Particulate Matter: sources include burning fossil fuels and car exhaust. Effects include reduced visibility, respiratory irritation. Methods of reduction include filtering, electrostatic precipitators, alternative energy).

Nitrogen Oxides: (NO_x) Major source is auto exhaust. Primary and secondary effects include acidification of lakes, respiratory irritation, leads to smog and ozone. Reduced using catalytic converters.

Equation for acid formation: $\text{NO} + \text{O}_2 \rightarrow \text{NO}_2 + \text{H}_2\text{O} \rightarrow \text{HNO}_3$.

Ozone: Secondary pollutant, $\text{NO}_2 + \text{UV} \rightarrow \text{NO} + \text{O}$; $\text{O} + \text{O}_2 \rightarrow \text{O}_3$, with VOCs. Causes respiratory irritation and plant damage. Reduced by reducing NO emissions and VOCs.

Sulfur Oxides: (SO_x) Primary source is coal burning. Primary and secondary effects include acid deposition, respiratory irritation, plant damage. Reduction methods include: scrubbers, burn low sulfur fuel.

Equation for acid formation: $\text{SO}_2 + \text{O}_2 \rightarrow \text{SO}_3 + \text{H}_2\text{O} \rightarrow \text{H}_2\text{SO}_4$

Carbon Dioxide: (CO₂) Sources include the combustion of fossil fuels. Effects: greenhouse gas—contributes to global warming. Reduction accomplished by increased fuel efficiency (gas mileage), mass transit (reduction).

Carbon Monoxide: (CO) Sources include incomplete combustion of fossil fuels. Effects: binds to hemoglobin reducing blood's ability to carry O₂. Reduction accomplished by catalytic converters, oxygenated fuel, mass transit (reduction).

Photochemical Smog: formed by chemical reactions involving sunlight (NO, VOC, O₂)

Acid Deposition: caused by sulfuric and nitric acids resulting in lowered pH of surface waters

Greenhouse Gases: Most significant: H₂O, CO₂, methane (CH₄), CFCs. Trap outgoing infrared energy (heat) causing earth to warm.

Municipal Solid Waste: is mostly paper and mostly put into landfills.

Sanitary Landfill: problems include leachate, which is solved using a liner with a collection system; methane gas, which may be collected and burned; and the volume of garbage, which may be compacted and/or reduced.

Incineration: *Advantages*—volume of waste reduced by 90% and waste heat can be used. *Disadvantages*—toxic emissions (polyvinyl chloride, dioxin), scrubbers and electrostatic precipitators needed, ash disposal.

Best Solution for Waste Problem: reduce the amount of waste at the source.

Brownfield: abandoned industrial sites.

Remediation: return a contaminated area to its original state.

LD-50: the amount of a chemical that kills 50% of the animals in a test population

Mutagen: substances that cause changes in DNA; may result in hereditary changes.

Teratogen: substances that cause fetus deformities (birth defects).

Carcinogen: substances that cause cancer.

Dioxin: one of the most toxic human-made chemicals. Stable, long-lived, by-product of herbicide production enters environment as fallout from the incineration of municipal and medical waste and persists for many years.

PCBs (Polychlorinated Biphenyls): Stable, long-lived, carcinogenic chlorinated hydrocarbons. Produced by the electronics industry.