

Water Pollution

EPA estimates 4.5 trillion liters of contaminated water seeps into the groundwater every day.

Damage to US water bodies

- 44% lakes
- 37% rivers
- 32% Estuaries

TYPES AND EFFECTS OF WATER POLLUTION

1. [Inorganic Chemicals](#)- Heavy Metals: Mercury, Lead, Cadmium, Arsenic and Aluminum, Nutrients, Pesticides, Wastes.

2. [Agricultural Waste and Human Sewage](#)

A. [Cultural Eutrophication](#)- nitrates and phosphates from human (fertilizers, detergents or sewage) or animal sources (waste run off) cause rapid algal growth on water surface. Deeper aquatic plants die (no light), BOD (Biological Oxygen Demand) rises as aerobic decomposers break down plants, Dissolved Oxygen decreases and fish suffocate. Water becomes lifeless.

Hypoxic- septic zone of deadly low DO. Less than 2 ppm.

B. [Red Tide](#)- dense algal blooms containing neurotoxins accumulate in the marine food chain and decimate marine life. Causes paralysis and death in humans.

C. [Pathogenic Organisms and Human Health](#)- (most from food contaminated with feces)

- [Coliform bacteria](#) test: E. coli bacteria is indication of human waste in drinking water.
- Dysentery- amoeba or bacteria
- Typhoid- bacteria
- Giardia- protozoan
- Hepatitis A- virus
- Schistosomiasis- blood fluke spread by snails

3. [Oil Spills](#)- leaking oil tankers and dumping oil down storm drains

- 3-6 million metric tons/year
- Exxon Valdez- 11 million gallons of oil effected 1000 miles of shoreline and killed 300,000 birds and 2500 sea otters.

- By 2015 all tankers must have double hulls.

4. Thermal- from industrial and power plants. Dissolved Oxygen decreases, organisms die from high temperatures and low oxygen. Indian point nuclear power plant emits thermal pollution.

MONITORING WATER QUALITY:

Point vs non point sources:

Point- from specific location such as pipe

Non-point- from over an area such as runoff

1. Chemical Tests- BOD: biological oxygen demand, amount of dissolved oxygen needed by aerobic decomposers to break down organic materials, Dissolved Oxygen: measure the amount of oxygen in water, pH, Nitrates, Phosphates.

2. Aquatic Species Monitoring

A. Pollution intolerant (highly sensitive to pollution): Stonefly nymph, mayfly nymph, water penny and caddisfly larva

B. Somewhat pollution tolerant (mildly polluted water okay): beetle larvae, crane fly larvae, clams, crayfish, dragonfly nymph, damselfly nymph, black fly larvae

C. Pollution tolerant (tolerates highly polluted waters): midge larva, snails, leech, aquatic worms

WATER POLLUTION CONTROL OR LACK THERE OF

1. Sewage "treatment"- 95% of sewage in undeveloped countries goes directly into water bodies! Agh!

2. Water Remediation- Constructed wetlands, deep well injection, sewage treatment plants, open lagoons of duckweed!

3. Water Legislation: Clean Water Act of 1972- sets as national goal to make all surface water fishable and swimmable.

- Required permits for point source pollution.
- Funded the construction of municipal sewage treatment plants.

A Flood of Pigs

- Hurricane Floyd flooded Cape Fear in North Carolina on September 16, 1999
- The flooding created a lake that was 300 km (200 miles) across covering towns, farms,

factories and forests

- The worst of this flood was the open manure lagoons submerged by the water
- North Carolina was the leading turkey-producing state and the second largest pork producing state which contained ponds of 40,000 cubic meters of liquid waste that isn't protected against floods
- It is believed that the waste found in wells is from the waste and bacteria that leaked into areas that the flood got into
- Dead animals were buried in the ground where they continue to contaminate groundwater

What is Water Pollution?

- Point sources-factories, power plants, underground coal mines and oil wells that discharge pollution from specific locations such as drain pipes, ditches or sewer outfalls
- Nonpoint sources-scattered or diffuse so that they have no specific location where they discharge into a particular body of water
- Nonpoint sources include runoff from farm fields and feedlots as well as golf courses, lawns and gardens
- Atmospheric deposition of contaminants carried by air currents and precipitated into watersheds or directly onto surface waters as rain, snow or dry particles
- Sources of some nonpoint chemicals can be thousands of kilometers away
- It is estimated that there is 600,000 kilograms of herbicide atrazine in the Great Lakes
- Studies have shown that health problems are occurring among those who eat fish regularly from the Great Lakes

Infectious Agents

- Serious water pollutants in terms of human health world-wide are pathogenic organisms
- Some of these diseases like malaria, yellow fever and filariasis are transmitted by insects that have aquatic larvae
- The main source for these pathogens is from untreated or improperly treated human wastes as well as inadequately treated animal waste from feedlots
- If everyone had pure water and satisfactory sanitation, the World Bank estimates that 200 million fewer episodes of diarrheal illness would occur each year and 2 million and 2 million childhood deaths would be avoided
- 450 million people would be spared debilitating roundworm or fluke infections
- Coliform bacteria-any type of bacteria that lives in the colon or intestines of humans and other animals
- To test for coliform bacteria, a water sample is placed in a dish containing a nutrient medium

that supports bacterial growth

- The EPA recommended maximum coliform count for swimming water is 200 colonies per 100 ml, but some cities and states allow higher levels

Oxygen-Demanding Wastes

- The amount of oxygen in water can help to determine the quality of the water
- Game fish and other desirable forms of aquatic life exist above 6 parts per million (ppm) while worms, bacteria and fungi exist below 2 ppm of oxygen
- Oxygen is added to the water through diffusion with the air and removed through respiration and chemical processes that consume oxygen
- The affects of materials on water quality is expressed in terms of biochemical oxygen demand (BOD) which is a standard test of the amount of dissolved oxygen consumed by aquatic microorganisms over a five-day period
- The chemical oxygen demand (COD) uses a strong oxidizing agent (dichromate ion in 50% sulfuric acid) that completely breaks down all organic matter in a water sample
- Dissolved oxygen (DO) content measured directly using an oxygen electrode also measures the affects of organic materials on water quality
- Oxygen sag-the decline in oxygen downstream of a pollutant source
- Rough fish such as carp, bullheads and gar can survive oxygen-poor environments

Plant Nutrients and Cultural Eutrophication

- Rivers and lakes hat have clear water and low biological productivity are said to be oligotrophic (oligo = little + trophic = nutrition)
- Eutrophic (eu + trophic = truly nourished) waters are rich in organisms and organic materials
- Eutrophication, an increase in nutrient levels and biological productivity is a normal part of successional changes in most lakes
- An increase in biological productivity and ecosystem succession caused by human activities is called cultural eutrophication
- “Dead zones” often form where rivers dump nutrients into estuaries and shallow seas

Inorganic Pollutants

- Some toxic inorganic chemicals are released from rocks by weathering and are carried by runoff into lakes or rivers
- Other inorganic materials such as acids, salts, nitrates and chlorine that are normally not toxic at low concentrations may become concentrated enough to lower water quality or adversely affect biological communities

- Metals such as mercury, lead cadmium and nickel are highly toxic
- Levels in the parts per million that are so little that you can't see them or taste them and they can be fatal
- Miners in the Amazon River who look for gold use mercury to trap the gold and separate it from sediments
- The mercury is boiled off with a blow torch which is believed to be why miners and their families suffer nerve damage from breathing the toxic fumes
- Lead poisoning has been known since Roman times to be dangerous to human health
- In 1990 the EPA lowered the maximum limit for lead in public drinking water from 50 parts per billion to 20 parts per billion
- Desert soils often contain high concentrations of soluble salts including toxic selenium and arsenic
- Sodium chloride (table salt) is nontoxic at low concentrations and can become toxic to plants when mobilized by irrigation and concentrated by evaporation
- Acids are by-products of industrial processes such as leather tanning, metal smelting and plating, petroleum distillation, and organic chemical synthesis coal mining is an especially important source of acid water pollution because of the sulfur compounds in coal react with oxygen and water to make sulfuric acid
- 200 lakes in the Adirondack Mountains of New York State have been reported having aquatic damage due to acid precipitation

Surface Waters in the United States and Canada

- The 1972 Clean Water Act established a National Pollution Discharge Elimination System (NPDES) which requires an easily revoked permit for any industry, municipality or other entity dumping wastes in surface waters
- Since the Clean Water Act was passed, the US has spent more than \$180 billion in public funds and perhaps ten times as much in private investments on water pollution control
- The goal of the Clean Water Act to make all US surface waters "fishable and swimmable" has not been fully met, but in 1999 the EPA reported that 91.4% of all monitored river miles and 87.5% of all assessed lake acres are suitable for their designated uses
- States are required to identify waters not meeting water quality goals and to develop total maximum daily loads (TMDL) for each pollutant and each listed water body
- The 1970 Water Act in Canada has produced comparable results
- 70% of all Canadians in towns over 1,000 population are now served by some form of municipal sewage treatment
- In the USA as much as 25% of the 46,800,000 metric tons of (52 million tons) of fertilizer

spread on farmland each year is carried away by runoff

- Nitrates and phosphates in surface water have decreased from point sources but have increased about four-fold since 1972 from nonpoint sources
- Fossil fuel combustion has become a major source of nitrates, sulfates, arsenic, cadmium, mercury and other toxic pollutants that end up in water

Surface Waters in Other Countries

- The fall of the “iron curtain” in 1989 revealed appalling environmental conditions in much of the former Soviet Union and its satellite states in eastern and central Europe
- Parts of Russia itself and some other former socialist states in the Balkans and Central Asia remain some of the most polluted places on earth
- In Russia, only half of the tap water is fit to drink
- Life expectancies for Russian men have plummeted from about 72 years in 1980 to 59 years in 1999 and deaths now exceed births by about 1 million per year
- There are also some encouraging pollution control stories such as in 1997 Minamata Bay in Japan, long synonymous with mercury poisoning was declared officially clean again
- Less-developed countries such as South America, Africa and Asia have even worse water quality than do the poorer countries of Europe
- The coliform count in the Yamuna River in New Delhi has 7,500 coliform bacteria per 100 ml that increases to 24 million cells per 100 ml as the river leaves the city

Groundwater and Drinking Water Supplies

- Half the people in the United States including 95% of those in rural areas depend on underground aquifers for their drinking water
- One of the serious sources of groundwater pollution throughout the US is MTBE (methyl tertiary butyl ether) a suspected carcinogen and is added to gasoline
- In one US Geological Survey (USGS) study, 27% of shallow urban wells tested contained MTBE
- The US EPA estimates that every day some 4.5 trillion liters of contaminated water seep into the ground in the United States from septic tanks, cesspools municipal and industrial landfills and waste disposal sites, surface impoundments, agricultural fields, forests and wells
- Although most of the leaky, single-walled underground storage tanks once common at filling stations and factories have now been removed and replaced by more modern ones, a great deal of soil in American cities remains contaminated by previous careless storage and

disposal of petroleum products

- A 1996 survey concluded that nearly 20,000 public drinking water systems in the US expose consumers to contaminants such as lead, pesticides and pathogens at levels that violate EPA rules

Human Waste Disposal

- In poorer countries of the world, most rural people simply go out into the fields and forests to relieve themselves as they have always done
- Major cities of many less-developed countries are often littered with human waste which has been left for rains to wash away or for pigs, dogs, flies, beetles or other scavengers to consume
- Studies have shown that a significant portion of the airborne dust in Mexico City is actually dried, pulverized human feces
- Grease and oils rise to the top of a septic tank while solids settle to the bottom where they are subject to bacterial decomposition
- Primary treatment is the first step in municipal waste treatment, it physically separates large solids from the waste stream
- Secondary treatment is the biological degradation of the dissolved organic compounds
- Tertiary treatment removes plant nutrients such as nitrates and phosphates from the secondary effluent
- Effluent sewerage is a hybrid between traditional septic tanks and a full sewer system in which the effluents are pumped into a central treatment plant instead of a drainfield

The Clean Water Act

- The Clean Water Act of 1972 along with the endangered Species Act and the Clean Air Act are the most significant and effective pieces of environmental legislation ever passed by the US Congress
- To fulfill the main goal of the act make all surface waters “fishable and swimmable” they used a best practicable control technology (BPT) which sets national goals of best available, economically achievable technology (BAT) for toxic substances and zero discharge for 126 priority toxic pollutants
- Industries, state and local governments, farmers, land developers and others who have been forced to change their operations or spend money on water protection aren’t happy with the Clean Water Act
- These people who aren’t happy often times feel imposed upon
- Another flaw with the act is when state or local governments spend money that is not repaid

by Congress

- Small cities that couldn't afford or chose not to participate in earlier programs in which the federal government paid up to 90% of water quality programs are especially hard hit by requirements that they upgrade municipal sewer and water systems