

Aquatic and Terrestrial Pollution

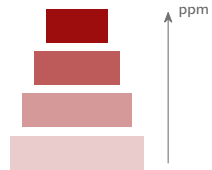
AP Environmental Science ■ Unit 8

AP Environmental Science



What we will cover

- 1 Point and nonpoint sources
- 2 Eutrophication
- 3 Persistent toxins
- 4 Waste and sewage
- 5 Toxicology
- 6 Pollution and health





Point and nonpoint sources

Pollution is sorted by whether we can trace it:

- **point source** : one clear pipe or stack
- **nonpoint source** : many spread-out places

Nonpoint (farm run-off) is far harder to control – no single pipe to plug.



Mangroves

Thermal pollution

what it is

heat added to water, usually from power-station cooling

why it harms

warm water holds **less dissolved oxygen**, and stresses species adapted to a cooler range

who suffers first

cold-water fish – trout and salmon – and the invertebrates they feed on

the fix

cooling towers and holding ponds, so the water sheds its heat before it returns to the river

Thermal pollution adds no substance at all. It is the one pollutant you cannot filter out – only let go of.

Human Impacts on Ecosystems

Human activities – pollution, habitat destruction, overharvesting, introducing species – degrade ecosystems and reduce biodiversity.

Because species are interconnected, harming one part can ripple through the whole system.

Endocrine Disruptors

Endocrine disruptors are chemicals (some pesticides, plasticizers like BPA) that mimic or block hormones, disrupting growth, reproduction.

Human Impacts on Wetlands and Mangroves

Wetlands and **mangroves** filter pollutants, store floodwater, and nurse young fish, but they are drained and cleared for farms, shrimp ponds, and development.

Losing them removes valuable ecosystem services and coastal protection.



Eutrophication

Too many nutrients set off a chain that suffocates the water:

- nutrients run off → **algal bloom**
- algae die, bacteria decay → **hypoxic** dead zone

Cultural eutrophication :
human phosphorus and nitrogen speed it up.



Algal bloom: nutrient run-off fuels hypoxia

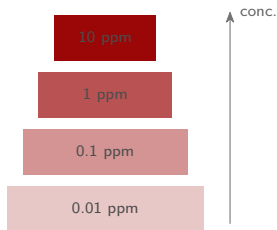


Persistent toxins

POPs (DDT, PCBs) **resist breakdown** ,
so they last decades and travel far.

- **bioaccumulation** : builds up in one body
- **biomagnification** : rises up the food chain

Top predators (and people who eat them) carry the highest **mercury** dose.



Pollutants that do not go away

Persistent organic pollutants

Persistent organic pollutants resist breakdown, dissolve in fat and so bioaccumulate – DDT, PCBs, dioxins.

Biomagnification

Each trophic level concentrates what it eats, so top predators carry the highest burden.

Algal blooms

Algal blooms follow nutrient runoff; when the algae die, decomposition strips the oxygen and the fish suffocate.

Disease and water

Contaminated water spreads cholera and dysentery; crowding spreads **tuberculosis (TB)** – both are pollution problems as much as medical ones.

Persistence, solubility in fat, and trophic position. Those three predict where a toxin ends up.

Worked example – DDT up the food chain

Lake water holds DDT at 0.01 ppm. Plankton reach 0.5, small fish 2, large fish 25 ppm. How concentrated is the top predator's dose?

- $\frac{25}{0.01} = 2,500\times$ the water concentration
- **bioaccumulation** : one organism builds it up over its life
- **biomagnification** : each trophic level concentrates what it eats

The water can test almost clean while the top predator is poisoned. **Persistent, fat-soluble** compounds are the ones that do this.



Waste and sewage

Landfills bury waste; a sanitary landfill lines the base and captures leachate & methane.

Best order: reduce, reuse, recycle;
compost food scraps.



Landfill: line, capture leachate, manage methane

Where solid waste actually goes

sanitary landfills

buried in lined cells to limit **leachate** ; takes land and can still leak

incinerators

burning cuts the *volume* sharply but emits air pollutants and leaves toxic ash

composting

organic waste returned to soil – the cheapest diversion there is

e-waste

phones, computers, televisions – small in volume, but loaded with **toxic metals**

garbage patches

ocean-dumped plastic gathered by currents into vast floating fields far out at sea

The hierarchy is **reduce**, **reuse**, **recycle** – and reducing is best because waste you never make needs no disposal at all.

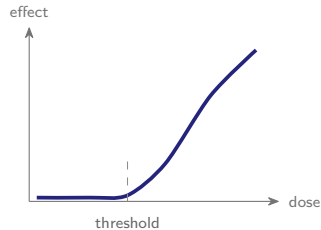


Toxicology

LD₅₀ is the dose that kills half a test group.

- lower LD₅₀ = *more toxic*
- below the **threshold dose** : no effect

Acute : one big dose. **Chronic** : small doses over years.



Harm only past
the threshold.

Worked example – reading an LD₅₀

Chemical A has an LD₅₀ of 5 mg/kg of body mass; chemical B, 500 mg/kg. Which is more toxic?

- LD₅₀ = the dose that kills **half** a test population
- $500/5 = 100$: A needs a hundredth of the dose
- so **A is 100 times more toxic**

A **smaller** LD₅₀ means a **more** toxic chemical – the scale runs backwards, and the exam checks that you know it. Dose, duration and individual sensitivity all shape the real effect.



Pollution and health

Harm depends on **dose** , time, and sensitivity.

- **acute** vs **chronic** effects
- **risk analysis** sets safe limits

Infectious disease spreads by **pathogens** ; **environmental change** widens its reach.

dirty water → cholera

air → flu

vectors : mosquito → malaria

Pathogens and Infectious Diseases

Pathogens (bacteria, viruses, parasites) spread through contaminated water and food.

The exam names specific diseases and expects you to know **how each one is transmitted**, because the transmission route decides the defence:

The pathogens the exam names, and how each travels

dysentery

bacterial – untreated sewage in streams and rivers

plague

bacterial – an infected flea's bite, or infected fluids

tuberculosis

bacterial – breathing in an infected person's bacteria

malaria

parasitic – an infected **mosquito** ; sub-Saharan Africa

West Nile / Zika

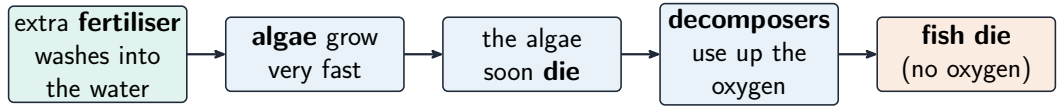
viral – an infected mosquito again; Zika also passes sexually

SARS / MERS

viral – infected fluids; MERS crosses from animals

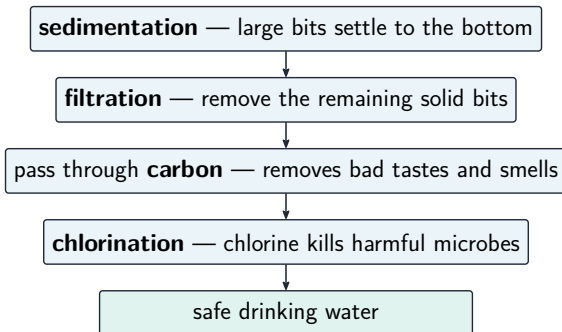
Poverty deepens all of it: low-income areas often lack sanitary waste disposal and clean water in the first place.

Eutrophication, continued



Extra fertiliser makes algae bloom, then the water loses its oxygen

Sewage Treatment



Treating water to make it safe: sedimentation, filtration, then disinfection

Sewage treatment in three stages

primary

physical: solids **settle out** in tanks

secondary

biological: **bacteria** break down the remaining organic matter

tertiary

chemical: removes **nutrients** (N and P) and disinfects, where the discharge needs it

Skip the tertiary stage and the outflow is clean of solids and pathogens but still nutrient-rich – which is how treated sewage still causes **eutrophication** .

Dose Response Curve

A **dose–response curve** plots the effect against the dose.

Generally, a higher dose causes a greater effect.

Exam tips

- Trace **eutrophication** step by step: nutrient runoff → algal bloom → decay → oxygen depletion → fish die.
- **Bioaccumulation** builds up in one organism; **biomagnification** increases up the food chain, so top predators are hit hardest.
- Read an **LD50**: a **lower** value means **more** toxic; multiply by body mass for a lethal dose.
- Order the waste hierarchy **reduce** > **reuse** > **recycle**, and the stages of sewage treatment.
- Link pathogens to contaminated water and to clean-water/sanitation defences.



Worked example – reading a BOD result

A river below a sewage outfall has high BOD and almost no fish. Explain the link.

- BOD = the oxygen **decomposer bacteria** use to break down organic waste.
- Sewage feeds the bacteria $\Rightarrow$ they multiply and **respire hard**.
- Dissolved oxygen **crashes** $\Rightarrow$ fish suffocate and only tolerant species survive.
- Further downstream the waste runs out $\Rightarrow$ oxygen recovers $\Rightarrow$ **a classic oxygen sag curve**.

High BOD = dirty water: it means a big oxygen demand, not a lot of oxygen. Fish die of **suffocation**, not poisoning.

Unit 8 – key takeaways

1

Sources

point (one pipe) vs nonpoint
(spread-out run-off)

2

Water harm

eutrophication dead zones; bio-
magnified toxins

3

Waste

sanitary landfills; re-
duce/reuse/recycle; 3-stage
sewage

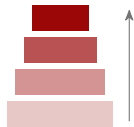
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Toxicology

lower LD₅₀ = more toxic; thresh-
old; acute vs chronic

Check yourself

- 1 Is farm run-off a point or nonpoint source?
- 2 What uses up the oxygen in a eutrophic dead zone?
- 3 Who carries the highest biomagnified toxin dose?
- 4 Does a lower LD_{50} mean more or less toxic?



Answers 1. nonpoint 2. bacteria decomposing dead algae 3. top predators 4. more toxic