AP Environmental Science

Case Studies · 案例分析

APES rewards specificity: a named place, a named pollutant, a named process. These cases are the ones that recur in released questions, written so that each carries the mechanism as well as the story. 本册案例均给出具体地点、污染物与作用机制。

Water

The Gulf of Mexico dead zone — Nitrogen and phosphorus from fertiliser across the Mississippi basin wash into the river and reach the Gulf each spring. The mechanism is the one to write out: nutrient enrichment causes an algal bloom; the algae die and sink; bacterial decomposition of that biomass consumes dissolved oxygen; the resulting hypoxic zone, which has reached several thousand square miles, kills or displaces bottom-dwelling organisms. The case supplies the standard answer to any eutrophication question, and the standard mitigations – riparian buffers, cover crops, precision fertiliser application, wetland restoration.

The Aral Sea — Diversion of the Amu Darya and Syr Darya for cotton irrigation cut the inflow to the Aral Sea, which lost the great majority of its volume. The consequences chain together neatly: as water evaporated the remaining lake became hypersaline and the fishery collapsed; the exposed lakebed released salt and pesticide-laden dust that damaged health downwind; and the loss of the water body's thermal mass made local winters colder and summers hotter. It is the leading example of an irrigation-driven environmental collapse and of the salinisation that follows heavy irrigation.

Flint, Michigan – infrastructure and lead — After a switch in water source, the more corrosive water was not treated with a corrosion inhibitor, so lead leached from old service pipes into the drinking supply. Lead is a neurotoxin with disproportionate effects on children's cognitive development. The case is used for questions on point-source versus non-point-source contamination, on environmental justice – the affected population was disproportionately poor and Black – and on the difference between a pollutant entering water at the source and one entering during distribution.

Air and energy

The Montreal Protocol and stratospheric ozone — Chlorofluorocarbons released at the surface drift into the stratosphere, where UV radiation frees chlorine atoms that catalytically destroy ozone – one chlorine atom can destroy many thousands of ozone molecules before it is removed. Thinning ozone allows more UV-B to reach the surface, raising rates of skin cancer and cataracts and damaging phytoplankton. The Montreal Protocol phased out CFCs and the ozone layer is recovering, which makes it the exam's standard example of an EFFECTIVE international environmental agreement, and the usual contrast with climate agreements.

London smog and the two kinds of smog — The 1952 London smog killed thousands within days. Coal burning released sulfur dioxide and particulates, and a temperature inversion trapped them near the ground. This is industrial or sulfurous smog, and it is distinct from photochemical smog, which forms when nitrogen oxides and volatile organic compounds react in sunlight to produce ground-level ozone – the Los Angeles pattern. Knowing which pollutants and which conditions produce which smog is a recurring multiple-choice and short-answer distinction.

Three Mile Island, Chernobyl and Fukushima — Three accidents with three different causes: a partial meltdown from equipment failure and operator error with minimal release; a reactor design without adequate containment combined with an unsafe test, releasing large quantities of radioactive iodine and caesium; and a tsunami disabling backup cooling. Used together they answer questions about the risks of nuclear power honestly – high-consequence, low-probability failures, long-lived waste – against its advantage of generating electricity with essentially no carbon dioxide or air pollutants during operation.

Land and biodiversity

The Dust Bowl — Deep ploughing of the southern Great Plains removed the deep-rooted native grasses that held the soil, and when a multi-year drought arrived in the 1930s the exposed topsoil blew away. It is the standard case for wind erosion, for the value of soil conservation practices – contour ploughing, windbreaks, cover crops, no-till farming – and for the idea that a land use can be viable in wet years and catastrophic in dry ones. The soil conservation service founded in response is the usual example of policy following an environmental disaster.

The cane toad in Australia — Introduced deliberately to control a beetle in sugar cane, the cane toad failed at that task, spread across northern Australia, and poisoned native predators that had no evolved tolerance for its toxin. It is the clearest example of an invasive species introduced intentionally, and of why introduced species succeed: no natural predators, high reproductive rate, and generalist diet. Pair it with the zebra mussel for an accidental introduction through ballast water.

Yellowstone wolves – a trophic cascade — Reintroducing wolves after a seventy-year absence reduced and redistributed the elk population, allowing willow and aspen to regenerate along streams, which in turn supported beaver and stabilised riverbanks. The case illustrates a keystone species and a top-down trophic cascade, and it is the usual answer to questions on the ecological role of predators or on the goals of restoration ecology. Note the honest caveat worth adding in an evaluation: the magnitude of the vegetation effects is debated, and other factors changed over the same period.