

EWCE 131
Ecology and Environmental Pollution

Lecture 11

Instructor

Maj Dr. Kazi Shamima Akter, Engrs

Department of EWCE, MIST

Lecture outline

Pollutants and Pollution

Topics

- **Water pollution from agricultural activities, pesticide and fertilizer application**
- **Air pollution from fossil fuels**

Pollution by Agricultural Chemicals

- Agricultural chemicals are usually defined as pesticides, fertilizers and health products.

- The US Environmental Protection Agency (EPA) defines pesticides as any materials manufactured or formulated to kill a pest.

- This means that herbicides, fungicides, insecticides and miticides are pesticides.

Pollution by Agricultural Chemicals

- Fertilizers are nutrient chemicals that enhance the growth of the plant.

- The important elements in the fertilizers are nitrogen, phosphorus and potassium.

- Nitrogen is usually in the form of ammonia, ammonium nitrate, ammonium sulphate, ammonium phosphate or solutions of these materials.

Pollution by Agricultural Chemicals

- Ammonium phosphate is the normal source of phosphorous.
- Potash (potassium oxide) is the potassium nutrient.
- Animal health products are any chemicals that are used to promote the health or growth of an animal.
- This includes products that are used topically by drenching or pouring-on, orally as a tablet or gel, and injectibles.

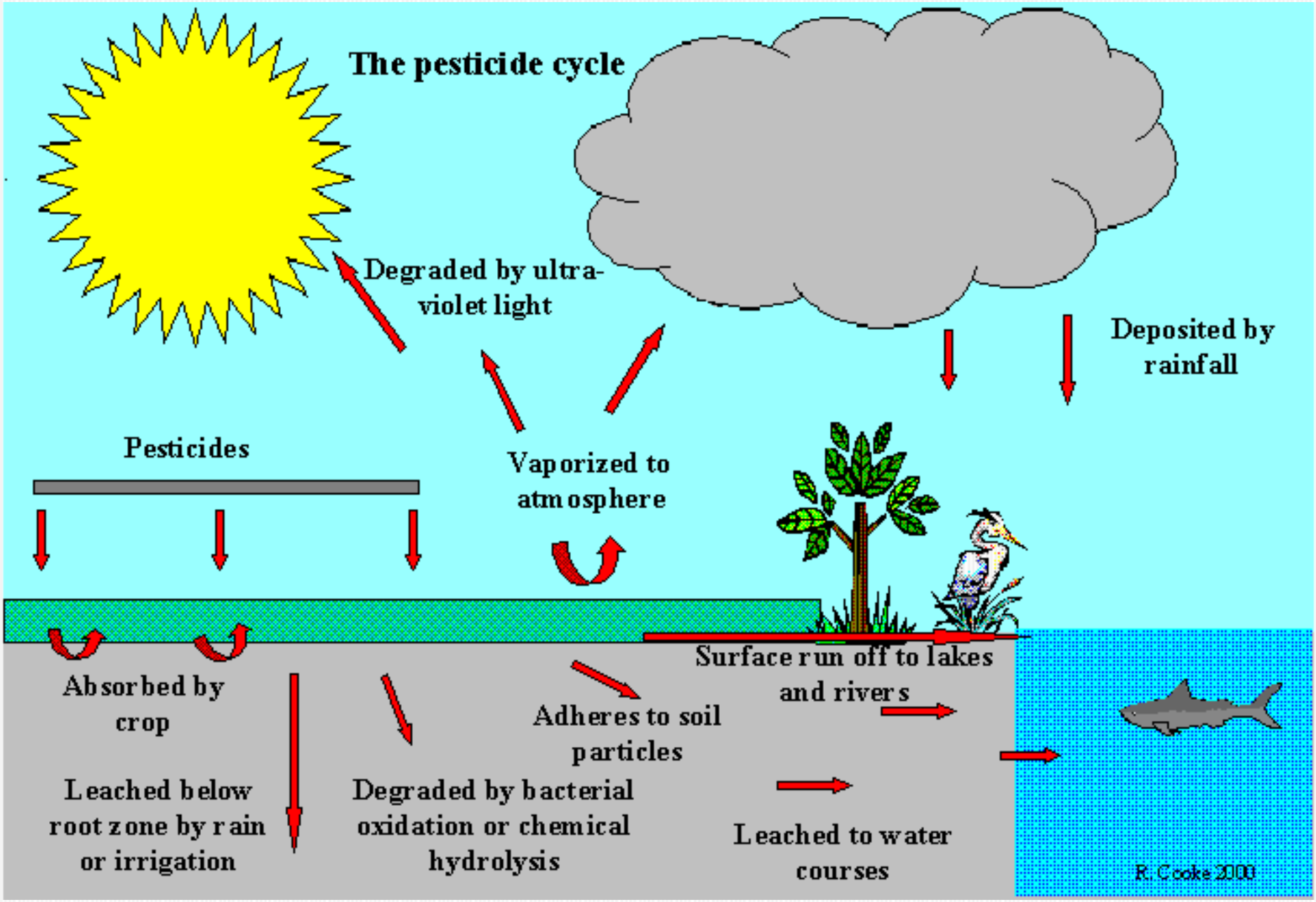
Agricultural Chemicals - Pesticides

- The word pesticide generally denotes –
  - ✓ a chemical substance, which may be mixed with other substances and
  - ✓ is used for the destruction of an organism deemed to be detrimental to humans.



- In agriculture pesticides include –
  - ✓ insecticides (insect),
  - ✓ fungicides (fungi),
  - ✓ herbicides (weeds) ,
  - ✓ rodenticides (vertebrate, such as rats),
  - ✓ nematocides (nematodes)

Agricultural Chemicals - Pesticides



Factors Affecting Pesticides Toxicity

(a) Toxicity/ Toxic Dose:

✓ Mammalian and non-mammalian toxicity usually expressed as LD_{50} ("Lethal Dose": concentration of the pesticide which will kill half (50%) of the test organisms over a specified test period).

✓ The lower the LD_{50}, the greater the toxicity; values of 0-10 are extremely toxic (OMAF, 1991).

Factors Affecting Pesticides Toxicity

(b) Toxic Response:

- ✓ Toxic response (effect) can be –
- ❑ acute (death) or

- ❑ chronic (an effect that does not cause death over the test period but which causes observable effects in the test organism such as cancers and tumours, reproductive failure, growth inhibition, teratogenic effects, etc.).

Factors Affecting Pesticides Toxicity

(c) Persistence:

✓ Measured as half-life (time required for the ambient concentration to decrease by 50%).

✓ Persistence is determined by biotic and abiotic degradation processes.

✓ Biotic degradation processes are biodegradation and metabolism;

✓ Abiotic degradation processes are mainly hydrolysis, photolysis, and oxidation (Calamari and Barg, 1993).

✓ Modern pesticides tend to have short half lives that reflect the period over which the pest needs to be controlled.

Factors Affecting Pesticides Toxicity

(d) Degradates:

✓ The degradation process may lead to formation of "degradates" which may have greater, equal or lesser toxicity than the parent compound.

✓ As an example, DDT degrades to DDD and DDE.

Factors Affecting Pesticides Toxicity

(e) Environmental Fate:

✓ The environmental fate (behavior) of a pesticide is affected by the natural affinity of the chemical for one of four environmental compartments (Calamari and Barg, 1993):

- ❑ solid matter (mineral matter and particulate organic carbon),
- ❑ liquid (solubility in surface and soil water),
- ❑ gaseous form (volatilization), and
- ❑ biota.

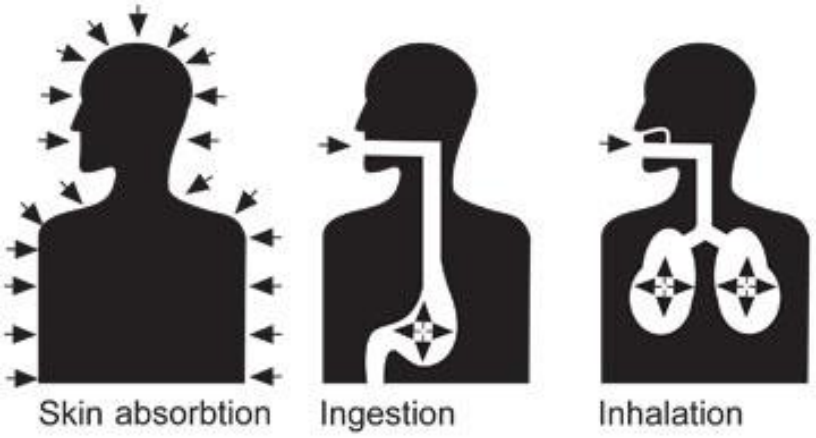
Factors Affecting Pesticides Toxicity

- ✓ This behavior is often referred to as "partitioning" and involves, respectively, the determination of:
  - ❑ the soil sorption coefficient (K_{OC})
  - ❑ solubility
  - ❑ Henry's Constant (H) and
  - ❑ the n-octanol/water partition coefficient (K_{OW})

- ✓ These parameters are well known for pesticides and are used to predict the environmental fate of the pesticide.

Human Health Effects of Pesticides

Human health effects are caused by:



Skin contact: handling of pesticide products

Inhalation: breathing of dust or spray

Ingestion: pesticides consumed as a contaminant on/in food or in water.


Skin problems caused by pesticide exposure.

Ecological Effects of Pesticides

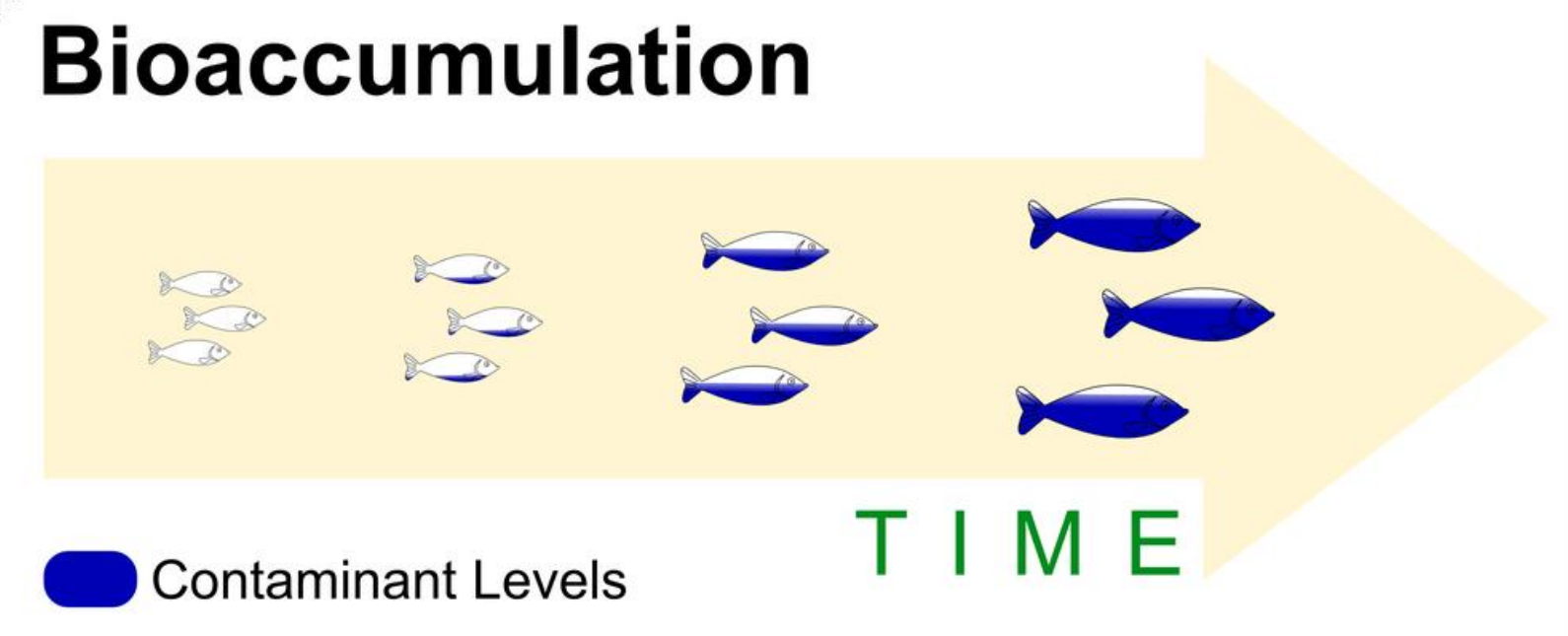
- Pesticides are included in a broad range of organic micro pollutants that have ecological impacts.
- Different categories of pesticides have different types of effects on living organisms, therefore generalization is difficult.
- Although terrestrial impacts by pesticides do occur, the principal pathway that causes ecological impacts is that of water contaminated by pesticide runoff.
- The two principal mechanisms are bioconcentration and biomagnification.

Ecological Effects of Pesticides

Bioconcentration/ Bioaccumulation:

- This is the movement of a chemical from the surrounding medium into an organism.

- The primary "sink" for some pesticides is fatty tissue ("lipids").



Ecological Effects of Pesticides

Bioconcentration / Bioaccumulation :

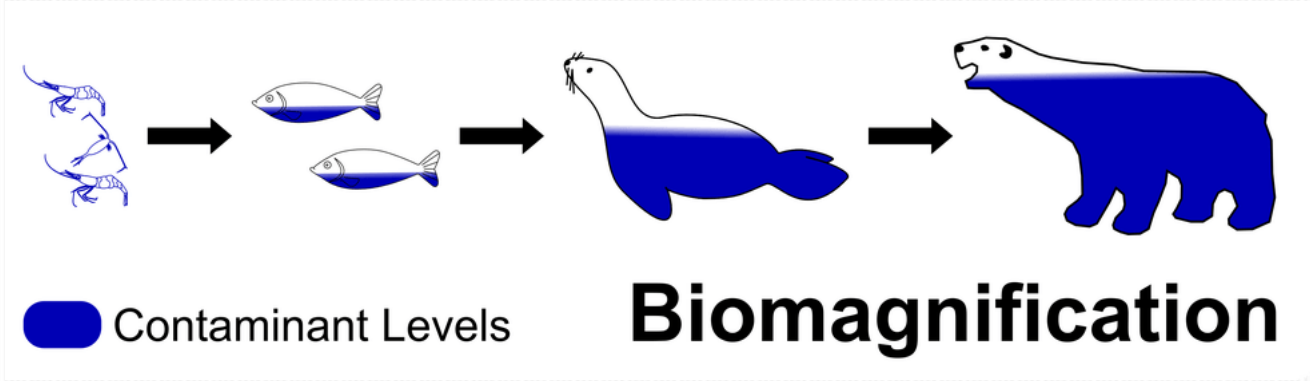
- Some pesticides, such as DDT, are "lipophilic", meaning that they are soluble in, and accumulate in, fatty tissue such as edible fish tissue and human fatty tissue.

- The process of increasing concentration of a chemical in an organism over time is termed as bioaccumulation.

- Other pesticides such as glyphosate are metabolized and excreted.

Ecological Effects of Pesticides

Biomagnification:



- This term describes the increasing concentration of a chemical as food energy is transformed within the food chain.
- As smaller organisms are eaten by larger organisms, the concentration of pesticides and other chemicals are increasingly magnified in tissue and other organs.
- Very high concentrations can be observed in top predators, including man.

Ecological Effects of Pesticides

- The ecological effects of pesticides (and other organic contaminants) are varied and are often inter-related.

- Effects at the organism or ecological level are usually considered to be an early warning indicator of potential human health impacts.

Impacts of Pesticides on Aquatic System

Impacts on Surface Water

- Runoff of pesticides leads to contamination of surface water and biota

- Dysfunction of ecological system in surface waters by loss of top predators due to growth inhibition and reproductive failure (biomagnification effect)

- Public health impacts from eating contaminated fish.

Impacts of Pesticides on Aquatic System

- Pesticides are carried as dust by wind over very long distances and contaminate aquatic systems 1000s of miles away (e.g. tropical/subtropical pesticides found in Arctic mammals).

Impacts on Ground Water

- Some pesticides may leach into groundwater causing human health problems from contaminated wells.

Agricultural Chemicals - Fertilizer

- Fertilizer, when applied excessively and in wrong time, it can be easily washed into storm drains and then flow untreated into lakes or streams.

- Fertilizers contain "nutrients" such as nitrates and phosphates.

- Excess nutrients over-stimulate the growth of aquatic plants and algae, termed as eutrophication.

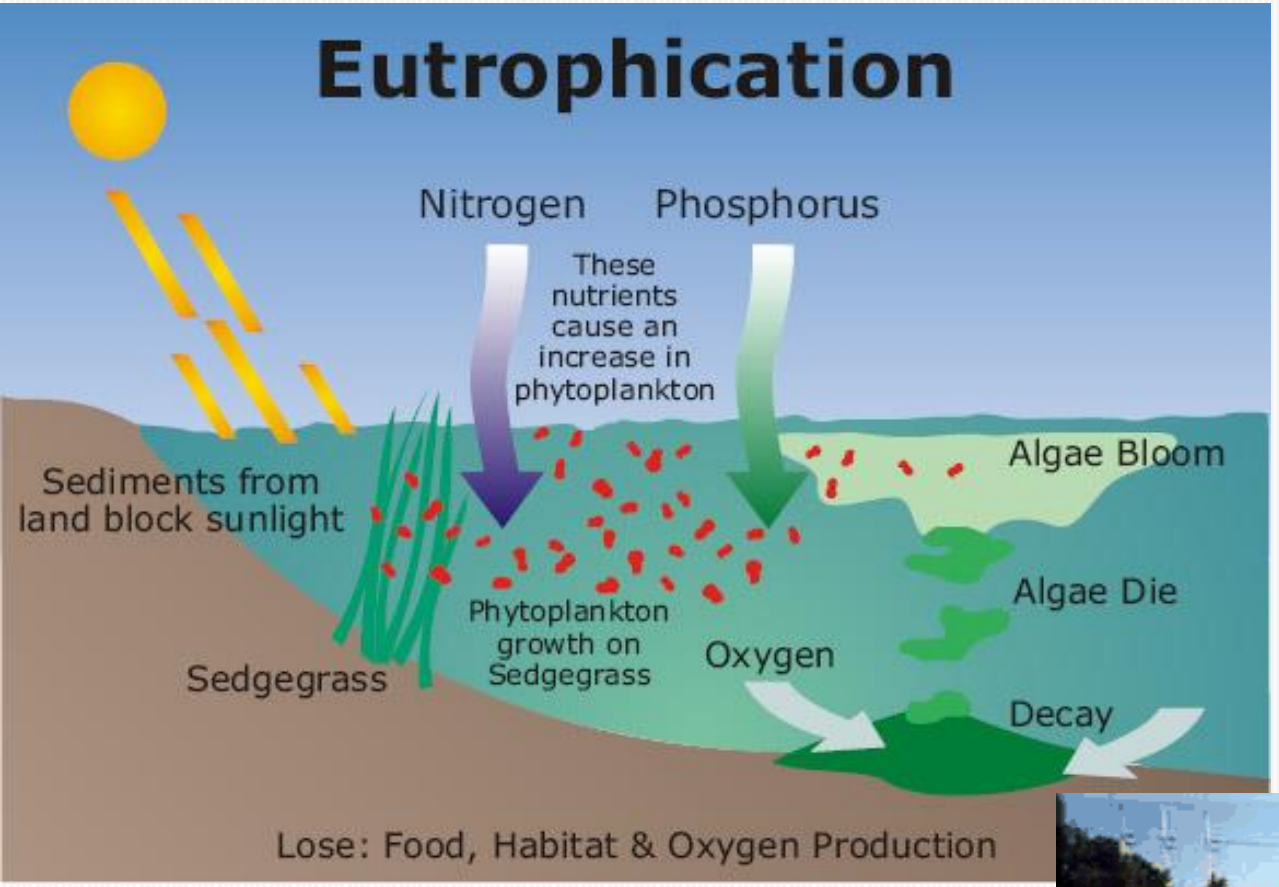
Agricultural Chemicals - Fertilizer

- Eutrophication clog the waterways and block light to deeper waters while the organisms are alive.

- When the organisms die, they use up dissolved oxygen as they decompose, causing oxygen-poor waters that support only diminished amounts of marine life.

- Such areas are commonly called dead zones (like in the Gulf of Mexico every spring).

Agricultural Chemicals - Fertilizer





Air Pollution from Fossil Fuel Burning

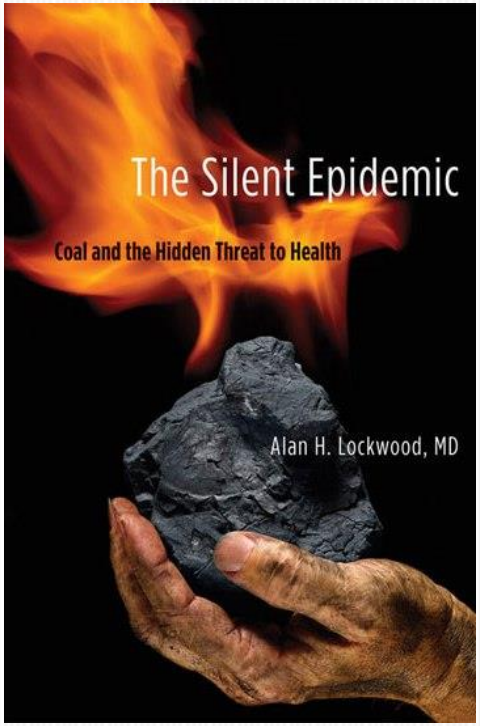
- Air pollution results from human activities such as burning fossil fuels (oil, coal, and gasoline) to create electricity and power automobiles, and manufacture industrial products such as chemicals and plastic.

- The air pollutants generated from fossil fuel are HC, CO_2, CO, NO, NO_2, SO_3, where the sources may be industrial, autos, etc.

- The increased carbon dioxide in the atmosphere contributes to the warming of the global climate, the so-called "greenhouse effect."

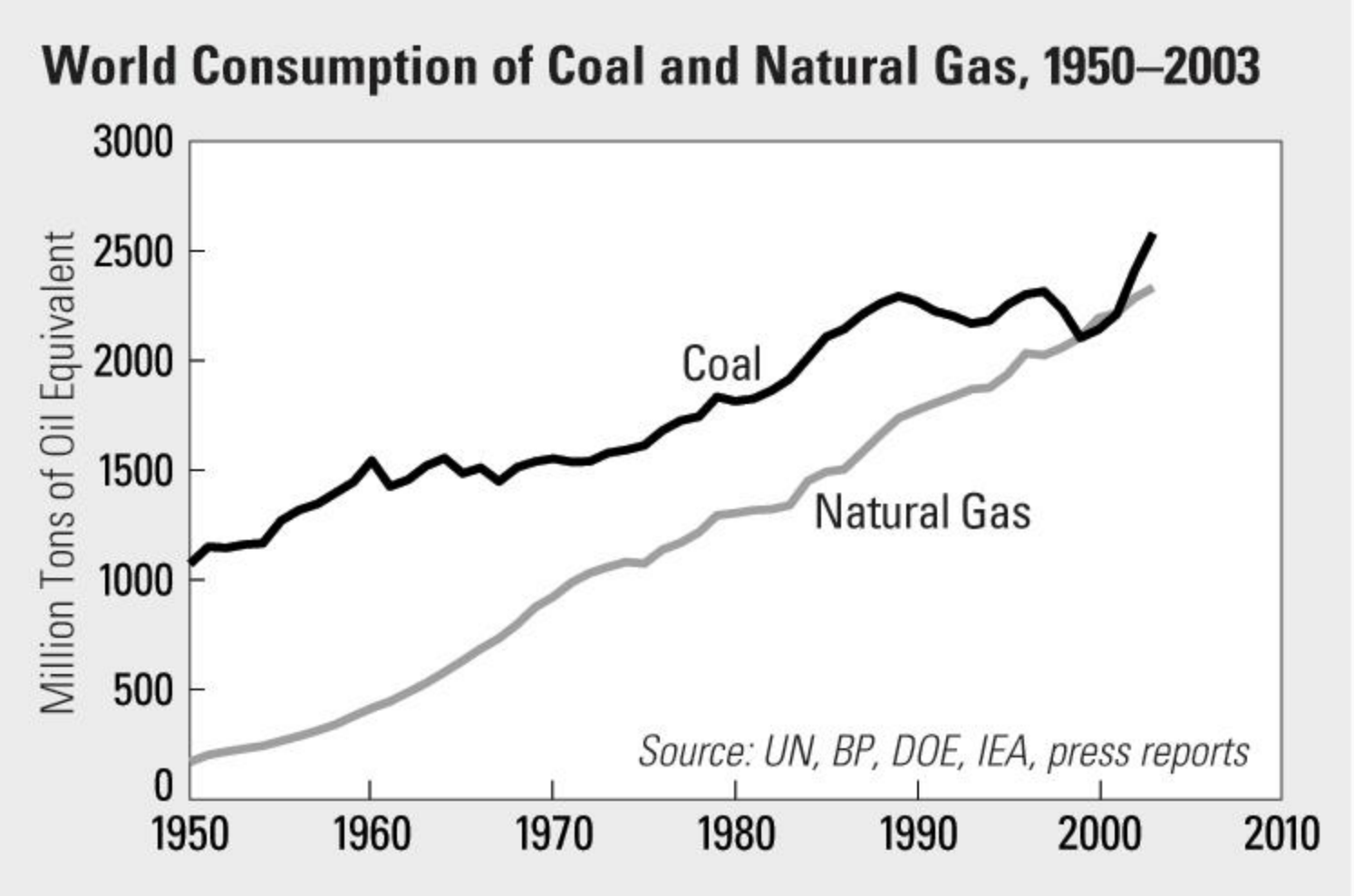
Air Pollution from Fossil Fuel Burning

Fossil Fuel: Coal



- Because of its high carbon content, coal emits more CO_2 than any other fossil fuel when its burns.
- It is also the main source of fuel for electricity worldwide and number one human caused contributor to greenhouse gas emissions in the atmosphere.
- Coal-fired power plants represent one of the largest sources of greenhouse gases.
- Coal causes asthma and other health problems, destroys the environment, and releases toxic mercury into communities.

Pollution from Fossil Fuel



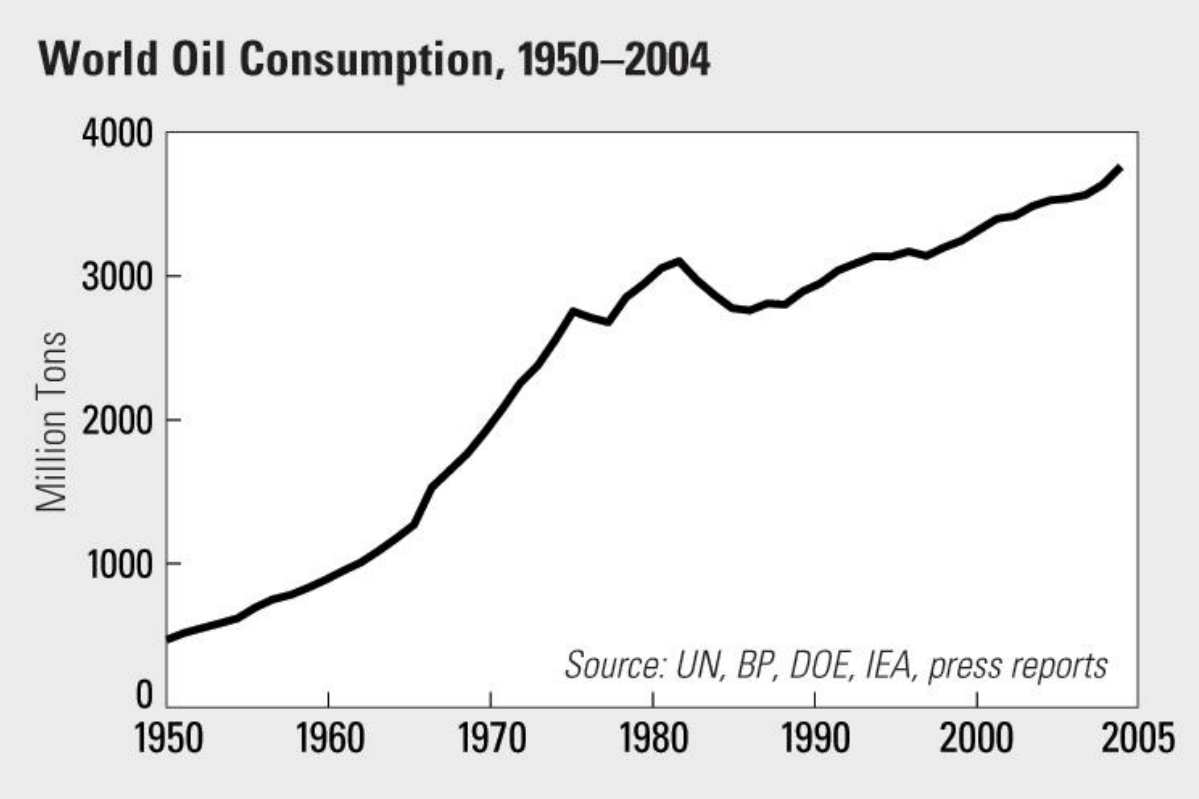
With the increase of consumption of coal and gas, pollution also increases over time

Air Pollution from Fossil Fuel Burning

Fossil Fuel: Oil and Gas

- The most obvious environmental impact from the oil and gas industry is the burning of oil.
- This releases several smog (smoke + fog) - causing pollutants and greenhouse gases that contribute to global warming.
- Besides, the act of exploration and drilling for oil and gas also poses a major threat to fragile ecosystems throughout the world.
- In recent years, we have seen oil spills destroy communities, soil beaches, and kill countless numbers of birds, marine mammals, fish, and other wildlife.

Pollution from Fossil Fuel

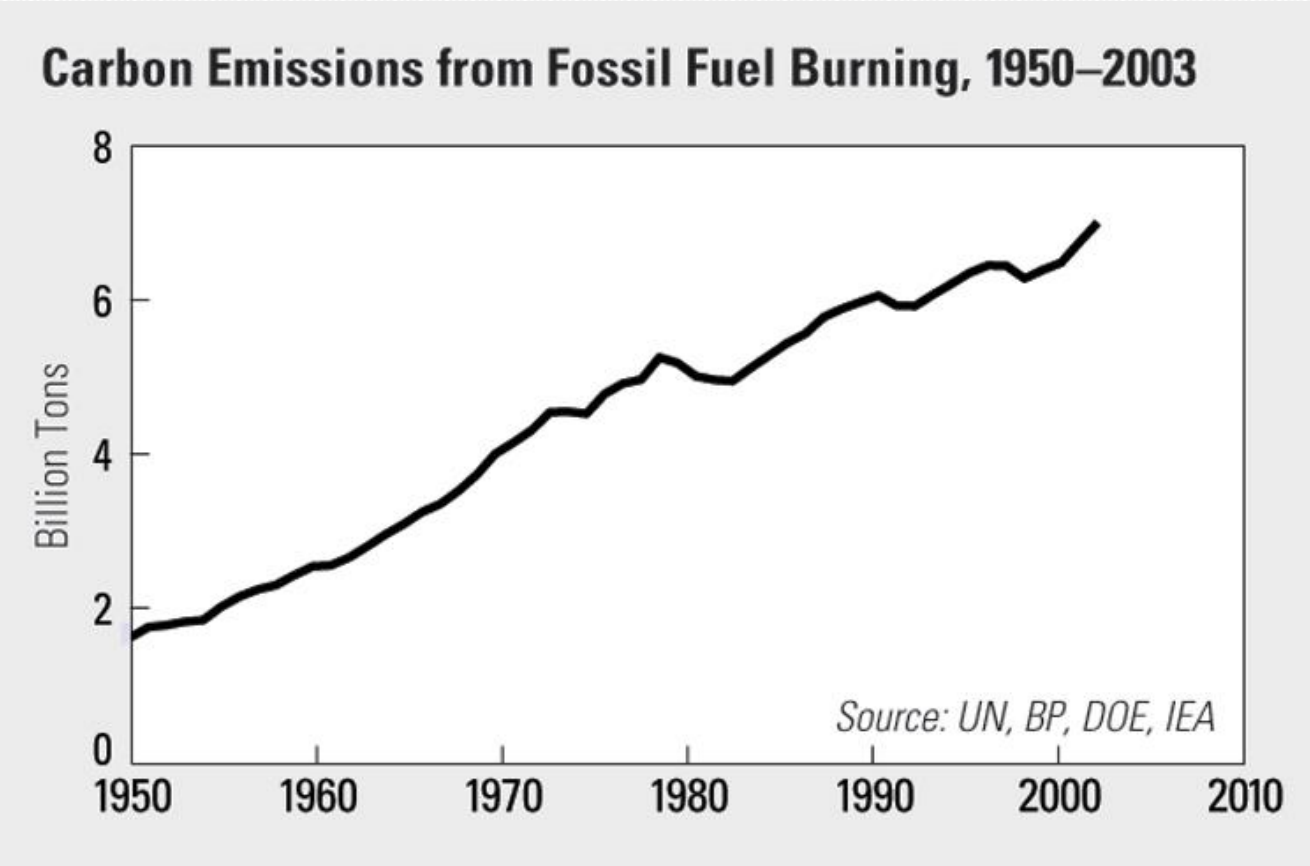


With the increase of consumption of oil, pollution also increases over time





Air Pollution from Fossil Fuel Burning

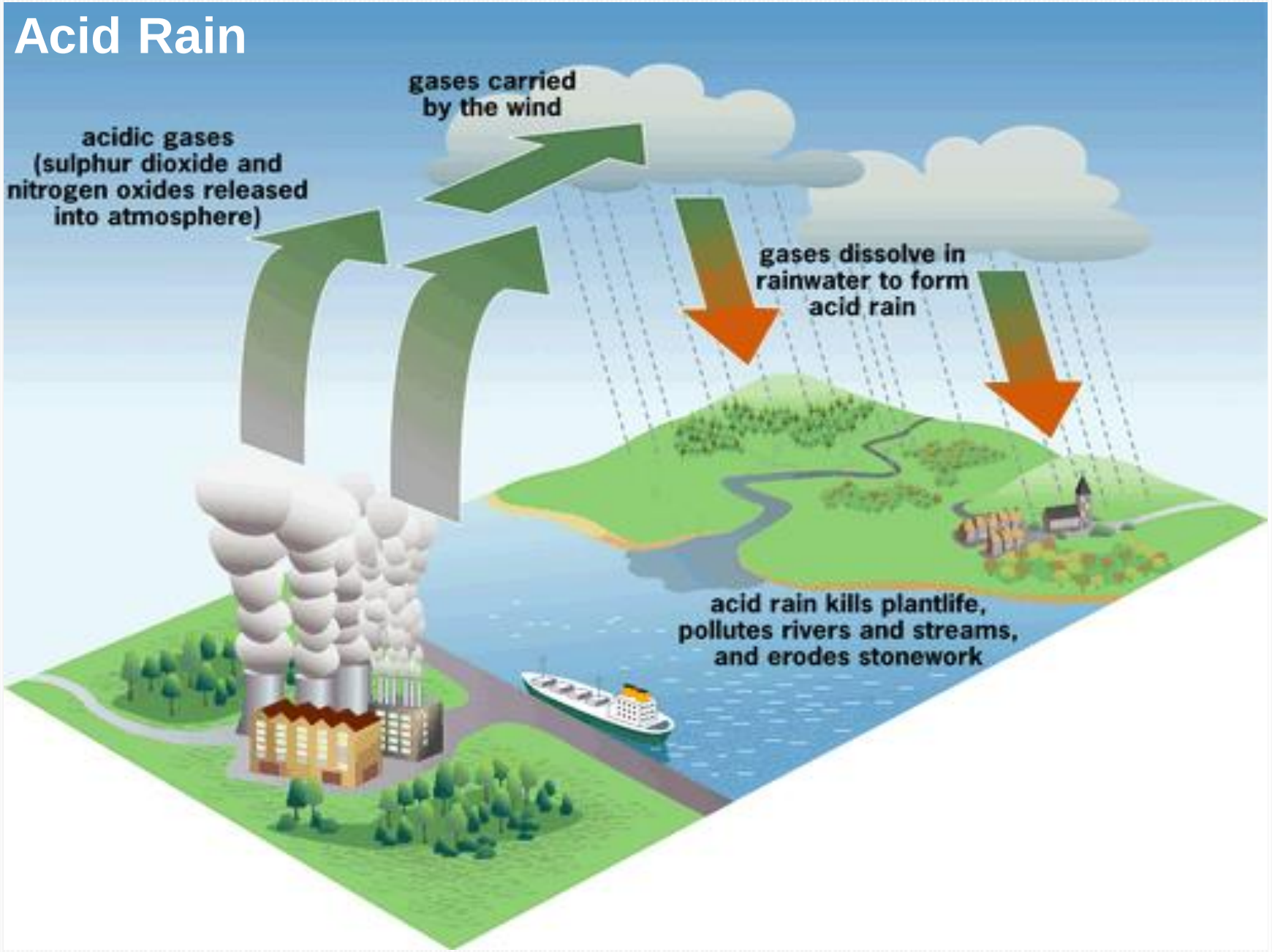


Global Scenario of Carbon Emission from fossil Fuel Burning

Fossil Fuel Burning – Adverse Effects

- Reduces visual range and atmospheric clarity, less contrast, less visibility
- CO (carbon monoxide), 90% natural, 10% from incomplete combustion, cigarettes, combines with hemoglobin and reduces bloods ability to carry oxygen. Causes 150,000-350,000 deaths/yr
- Cause damage to vegetation, including leaves, needles, fruit, growth rate, reproduction, hardiness.
- Cause degradation of vertebrate health, aquatic life, with impacts on respiration, bones, teeth, reproduction; increase lake acidity,

Air Pollution from Fossil Fuel Burning



Fossil Fuel Burning – Adverse Effects

Short term effects:

- Irritation to the eyes, nose and throat.
- Upper respiratory infections.
- Headache, nausea, and allergic reactions
- Asthma and emphysema

Long term effects:

- Chronic respiratory diseases.
- Lung cancer.
- Heart diseases.
- Damage to the brain, nerves, liver or kidneys.

Fossil Fuel Burning – Adverse Effects

- Taj Mahal is changing color (from white to brown) due to deposition of dust and carbon-containing particles emitted due to burning of fossil fuels.



