POLLUTION oF SOIL ECOSYSTEM– A HIDDEN REALITY

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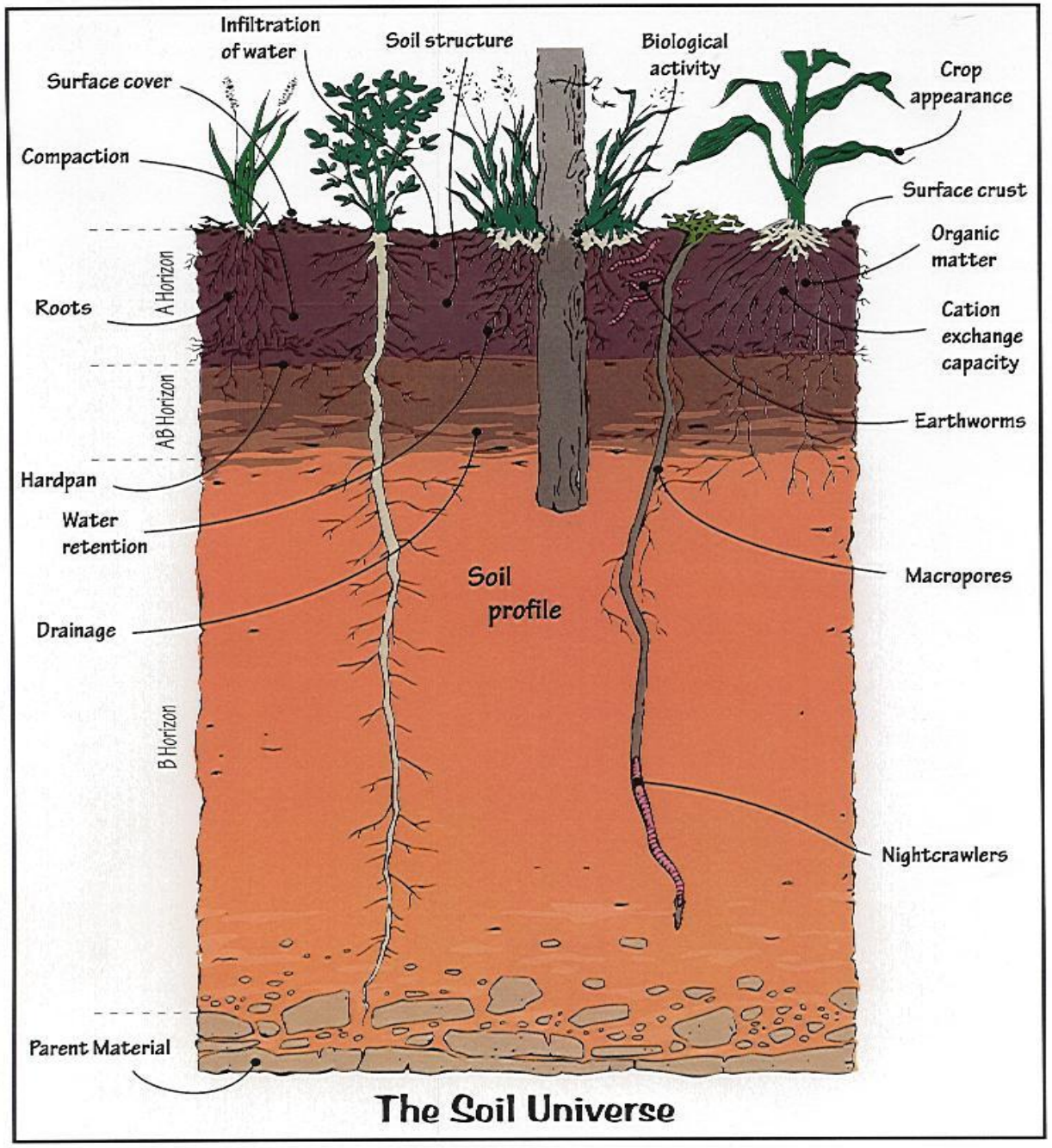
Soil definition

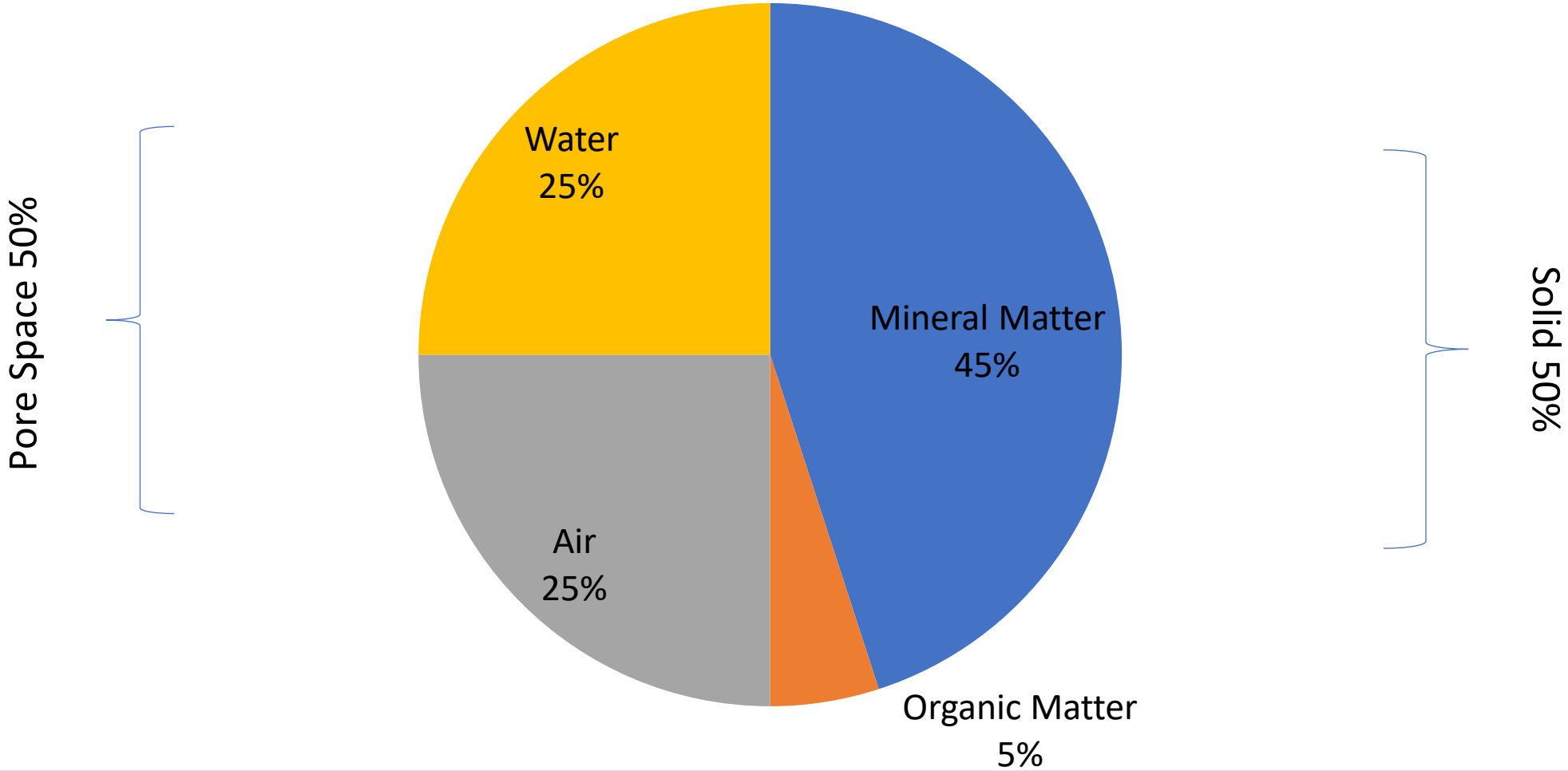
Soil is the thin layer of organic and inorganic materials at covers the Earth's rocky surface. The organic portion, which is derived from the decayed remains of plants and animals, is concentrated in the dark upper most topsoil.

The inorganic portion made up of rock fragments, was formed over thousands of years by physical and chemical weathering of bedrock. Productive soils are necessary for agriculture to supply the world with sufficient food.

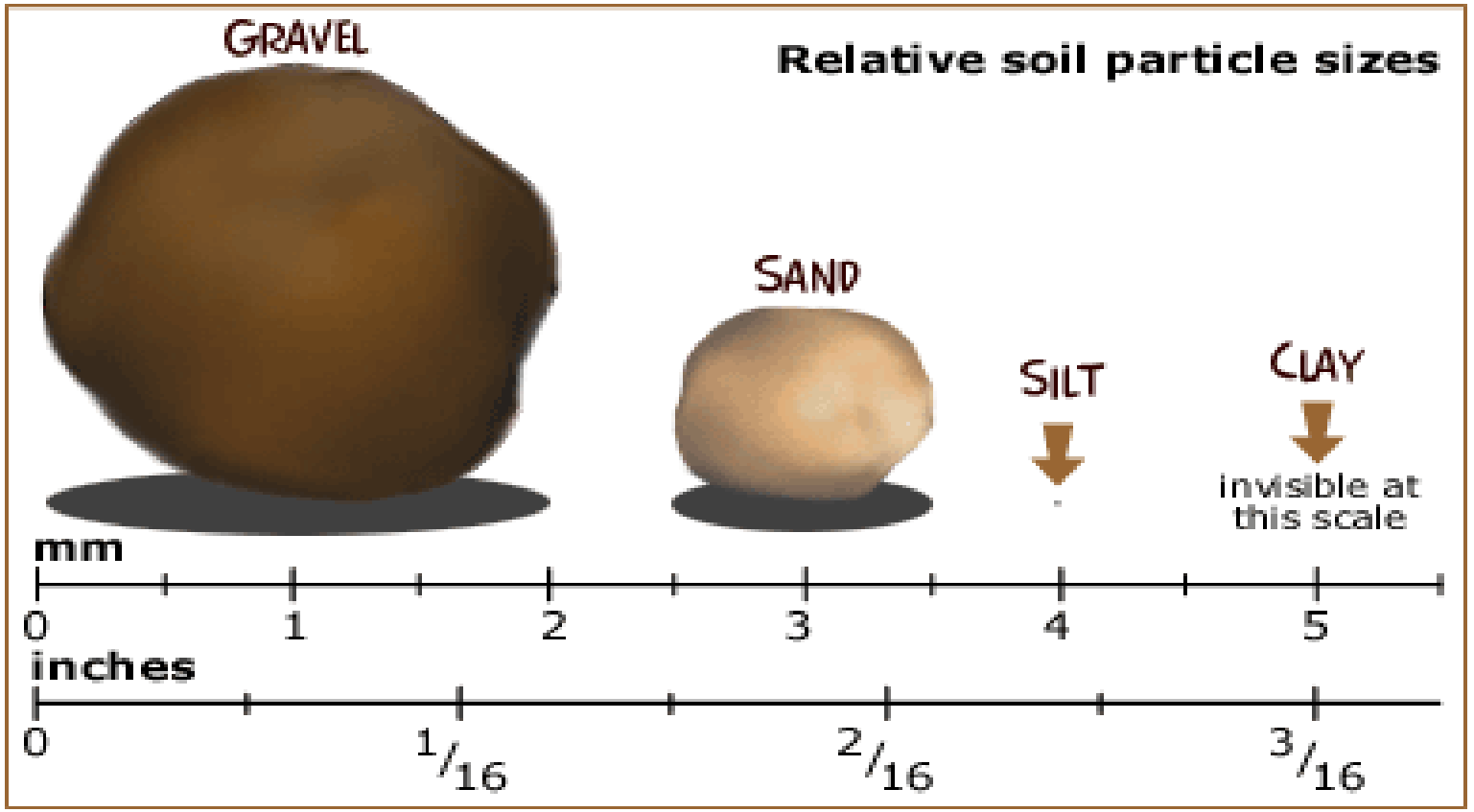
Soil Profile



Four Components of Soil



Fractions of mineral matter



Vital functions of soil

- Sustains plant and animal life below and above the surface
- Regulating and partitioning water and solute flow
- Filtering, buffering, degrading, immobilizing, and detoxifying
- Storing and cycling nutrients
- Providing support to structures

FAO has Sounded – RED ALERT

- **Generating three centimeters of top soil takes 1,000 years, and if current rates of degradation continue all of the world's top soil could be gone within 60 years**

Soil Degradation

- **Is the natural inability of a soil to support growth of crops**
- **It is the decline in soil quality caused by improper use of land for agriculture, industrial or urban purposes**
- **It is a serious environmental problem**
- **Minimising or avoiding soil degradation is crucial for our well being**
- **Soil pollution is one form of soil degradation**

Soil Pollution- Definition

- Defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effects on plant growth and animal health.

- A soil pollutant is any factor which deteriorates the quality, texture and mineral content of the soil or which disturbs the biological balance of the organisms in the soil with adverse effect on plant growth.

Soil Contamination

- **Soil pollution is also synonymous with soil contamination, micro analysis of the problem will have to take into consideration the variety of pollutants that become entrained in the soil and also the complex nature of the soil ecosystem.**
- **Phenomenon correlated with the degree of industrialization and intensities of chemical usage**
- **Includes surface & sub surface layers of soil profile**

- The nature and intensity of the damage to the soil eco system is dependent on the physicochemical characteristics of the soil like
    - **Texture ranging from gravel, sand, silt to clay**
    - **Porosity**
    - **Cation exchange capacity**
    - **Buffering capacity**

Pollution of Agricultural ecosystems

Sources of Contamination

- Direct discharge of industrial effluents and dumping of solid wastes
- Pollution due to urban activities
- Rupture of underground storage tanks
- Indiscriminate application of pesticides, herbicides and fertilizers
- Percolation of contaminated surface water to subsurface strata
- Oil and fuel dumping
- Leaching of wastes from landfills
- Deforestation and soil erosion

Indiscriminate use of Pesticides and Herbicides

- Widespread use of pesticides and herbicides are used to combat pests ,diseases and weeds which drastically affects production of crops.
- The first insecticide use began at the end of World War II and included DDT (dichloro-diphenyl trichloro ethane) and gammaxene (Benzene hexa chloride)
- Insects soon became resistant to DDT.
- DDT does not decompose readily, and persisted in the environment.
- Being fat soluble it caused biomagnification and a host of metabolic disorders
- Pesticides like organophosphates get adsorbed on the soil particles, and residues persist in soil, crops and enter human biological systems, with adverse effects
- Causes several neuro diseases and cancer

Indiscriminate use of manures and fertilizers

- **Fertilizers are used to correct soil deficiencies but contaminate the soil with impurities, which come from the raw materials used for their manufacture.**
- **Arsenic, lead and cadmium present in traces in rock phosphate mineral get transferred to super phosphate fertilizer.**
- **Excessive use of Phosphatic fertilizers cause accumulation of these metals in the soil.**
- **Fertilizers added to the soil are held adsorbed in the colloidal complex or absorbed by the plant and stored in the biomass.**

- Excess over this is washed out into the ground water or contaminates the surface water bodies
- Deterioration of the balance in the composition of soil
- Decrease/increase in soil pH
- Soil structure deterioration
- Limit the activities of nitrifying bacteria
- Dangerously elevated levels of nitrogen in drinking water. (blue baby disease or Methemoglobinemia of young babies and cancer due to nitrate ingestion in food and water)

- Destroy critical soil microbes.
- Eutrophication (enrichment with nutrients) of dams and waterways, algal blooms.
- Reducing depth of water body and reduce dissolved oxygen, critically affect aquatic life.
- Organic manures especially those obtained from animal faeces can cause offensive odour or add pathogenic organisms to the soil system.
- Poultry manures are often contaminated with heavy metals .

Dumping of solid wastes

- **Solid waste includes garbage, domestic refuse and discarded solid materials such as those from commercial, industrial and agricultural operations.**

- **Hazardous such as oils, battery metals, heavy metals from smelting industries and organic solvents get deposited to the soils of the surrounding area and pollute them by altering their chemical and biological properties.**

- **Contaminate drinking water aquifer sources.**

Deforestation and Erosion

- **Deforestation, agricultural development, temperature extremes, precipitation including acid rain, and human activities contribute to erosion.**
- **Human activities speed up this process by construction, mining, cutting of timber, over cropping and overgrazing.**
- **Consequent floods cause soil erosion. and associated problems**
- **Threaten food chains and the survival of many species.**
- **Hasten desertification**

Pollution due to Urbanization

Surface soils

- **Clogging of drains causing serious drainage problems including the burst or leakage of drainage lines leading to health problems.**
- **Barrier to movement of water by solid wastes have seriously damaged the normal movement of water thus causing inundation, damage to foundation of buildings as well as public health hazards.**
- **Foul smell generated by dumping the wastes.**
- **Increased microbial activities: causing decomposition of organic wastes generate large quantities of methane and many chemicals to pollute the soil and water flowing on its surface.**
- **Hospital wastes create many health problems being carriers of dangerous pathogen, and harmful drugs.**

Underground Soil Pollution

- **Chemicals released by industrial wastes and industrial wastes**
- **Decomposed and partially decomposed materials of sanitary wastes.**
- **Dangerous chemicals like cadmium, chromium, lead arsenic, selenium products are deposited in underground soil.**
- **Underground soil polluted by sanitary wastes generate many harmful chemicals can damage the normal activities and ecological balance in the underground soil.**

Impact of Pollution

- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility
- Larger loss of nutrients
- Greater deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in flora and fauna and loss of biodiversity
- Fish kills and loss of flora and fauna from wetlands due to runoff of toxic constituents

Controlling Pollution- Three R's

- Reducing the use of fertilizers and pesticides
- Reuse of material
- Recycling and recovery of materials
- Afforestation
- Solid waste management

Monitoring System for Soil Pollution in Kerala

- Indentified hot spots
- Industrial areas and surroundings
- Crop production Systems

1. **Rice Based Production System**

- **Kuttanad**
- **Kole Regions**
- **Palakkad Rice areas**

2. Coconut based Cropping Systems

- **Mono cropped coconut areas in midland laterite region.**
- **Mono cropped coconut areas in coastal sandy belt.**
- **Coconut based mixed farming system.**

3. Other Cropped Areas

- **Rubber**
- **Cashew**
- **Pepper**
- **Cardamom**
- **Small holdings and home steads in the midland laterite region**
- **Coffee and tea plantations**

Monitoring system to be followed

- **Monitor residues of agricultural chemicals and heavy metals in the surface and subsurface soils and plants and water bodies**
- **Characterize physical, chemical and biological indicators of soil quality and soil health parameters that provide clues on how well a soil can perform as a medium for plant growth.**
- **Soil sample collection to be GPS enabled.**
- **Monitoring emission of Green House Gases from rice ecosystems and wetlands**
- **Soil Health parameters to be monitored at specific intervals**

- **In industrial areas and surroundings soil samples to be collected to find out the extent and spread of the pollutant to non target areas**
- **Especially important in the undulating laterite areas where soils are porous and lateral and vertical spread possible**

Reference

Alan Wild, 1993. Soils and the Environment, Cambridge University Press, 40 West 20th Street, New York, pp 287

Snap shots of pollution damage in Kerala- Astamudi lake

Erosion siltation, chemical fertilizers and pesticides causing eutrophication of the lake. Small scale industries coconut husk retting also contribute heavily to organic pollution

Soild Waste Dumping in Vilappilssala

Environmental impact

- Visible: Air pollution, Food insecurity (crop damage), Loss of landscape/aesthetic degradation, Soil contamination, Waste overtflow Deforestation and loss of vegetation cover, Surface water pollution / Decreasing water (physico-chemical, biological) quality, Groundwater pollution or depletion, Biodiversity loss

Health Impact

- Visible: Exposure to unknown or uncertain complex risks (radiation, etc…), Infectious diseases, Other environmental related diseases
- Socioeconomic impact
- **Visible: Displacement, Loss of livelihood, Violations of human rights, Loss of landscape/sense of place, Land dispossession**

Plachimeda Coco cola plant

In 2003, the Central Pollution Control Board (CPCB) of India assessed the sludge at eight Coca-Cola bottling plants, and found them all to contain excessive levels of lead, cadmium or chromium.

Kerala Minerals and Metals- Chavara

KMML Pollution. pools of brownish yellow, pungent smelling water, highly acidic and reactive. The colour change was noticed in the wells and ponds also. Chemical analysis of surface and ground water samples showed trace elements of chromium, copper, lead, cobalt, cadmium, nickel, zinc, iron, and manganese. Fish and other species had deserted the area and coconut trees were barren. Various skin diseases were noticed in adults and children residing in the region

KMML-Chavara – Polluted ground water and surface water

Air Pollution in Delhi

- Caused by factors, including vehicular emissions, burning of waste and crop residue, and industrial activities
- Stubble burning after harvest of rice crop in Haryana and Punjab coupled with north-westerly winds affects Delhi's air quality since the 1980s
- Air quality drastically deteriorated in October, the season of crop burning in Punjab and Haryana
- Practice can account for up to 45% of Delhi's pollution
- Primary gases released in stubble burning are Carbon dioxide (CO2), carbon monoxide (CO), nitrogen oxides (NO2), methane (CH4), and sulfur oxides (SO2),
- Particulate matter (PM2.5 and PM10), contribute to the city's air pollution, particularly during the winter months when weather conditions trap these emissions.
- Fog is a naturally occurring weather phenomenon consisting of tiny water droplets suspended in air, while smog is a type of air pollution where harmful pollutants mix with fog, creating a hazardous haze,
- Pusa Bio-decomposer will help farmers harvest crops to prevent burning
- Use of Straw bailing machinery for manufacture of card board/hardboards
- https://youtu.be/m4yU18Log2I

Upon this handful of soil our survival depends. Husband it and it will grow our food, our fuel, and our shelter and surround us with beauty. Abuse it and the soil will collapse and die, taking humanity with it"

(Vedas Sanskrit Scripture – 1500 BC)


Thank You