#### Soil pollution

#### **BOT 346**

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- Formation of soil from the parent material (bedrock): mechanical weathering of rocks by temperature changes, abrasion, wind, moving water, glaciers, chemical weathering activities and lichens.
- Under ideal climatic conditions, soft parent material may develop into 1 cm of soil within 15 years.

- particles. darker & looser than the deeper • **O & A-horizon:** contain a large amount of
- bacteria, fungi, earthworms, small insects, forms complex food web in soil, recycles soil nutrients, & contribute to soil fertility.

• **O-horizon:** freshly-fallen & partially-

• A-horizon: humus/partially decomposed

organic matter & some inorganic mineral

black.

layers.

decomposed leaves, twigs, animal waste, fungi & organic materials. Colour: brown or

- B-horizon /(subsoil): less organic material & fewer organisms than A-horizon.
- **C-horizon:** consists of broken-up bedrock, does not contain any organic materials. Chemical composition helps to determine pH of soil & also influences soil's rate of water absorption & retention.
- R-horizon: The unweathered rock (bedrock) layer that is beneath all the other layers



# Soil Pollution

- **Soil pollution** is caused by the presence of chemicals or other alteration in the natural soil environment.
- Resulting in a change of the soil quality
- likely to affect the normal use of the soil or endangering public health and the living environment.





### CAUSES OF SOIL DEGRADATION



Soil erosion/degradation is the loss of top soil erodes fertility of soil & reduces its water-holding capacity.



Excessive farming, construction, overgrazing, burning of grass cover and deforestation



Excess salts and water (Salinization)



Excessive use of fertilizers & pesticides

Solid waste



## First effect of pollutants

- Washed away: might accumulates somewhere
- Evaporate: can be a source of air pollution
- Infiltrate through the unsaturated soil to the groundwater
- DDT: fat soluble, stored in fatty tissues
  - Interferes with calcium metabolism
  - Results in thin egg shells in birds
- Agent orange: code name for one of the herbicides and defoliants (results in leaf fall) used by the U.S. military as part of its herbicidal warfare program, During the Vietnam War, between 1962 and 1971, the United States military sprayed 20,000,000 US gallons (80,000,000 L) of chemical herbicides and defoliants in Vietnam
  - anti fertility, skin problems, cancer

### Control of soil pollution

Use of pesticides and fertilizers should be minimized.

Cropping techniques should be improved to prevent growth of weeds.

Special pits should be selected for dumping wastes.

Controlled grazing and forest management.

Wind breaks and wind shield in areas exposed to wind erosion

Afforestation and reforestation.

#### **3** Rs: reduce, reuse, recycle



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# Information needed to clean up materials added to soil

- ✓ Kind of material-organic or inorganic- is the material biodegradable/ dangerous to animals & humans
- ✓ How much material was added to the soil, will it overload the organisms in the soil
- $\checkmark$  C:N ratio of the pollutant material
- ✓ Nature of soil: will the soil be able to handle the material before groundwater is contaminated
- ✓ Growing conditions for the soil organisms: is it too cold, too wet etc.
- ✓ How long the material has been on site: is there evidence of environmental problems, is it undergoing decomposition.
- ✓ Immediate danger to people & environment: Urgency of the situation.

#### Bioremediation

- The use of naturally occuring microorganisms such as bacteria, fungi & plants to break down or degrade toxic chemical compounds that have accumulated in the environment
- It is a method that treats the soils and renders them non-hazardous, thus eliminating any future liability that may result from landfill problems or violations.





# Factors affecting bioremediation

- Microbial factors
- Temperature favorable for organisms
- Availability of water (Moisture content)
- Availability of nutrients (N,P,K)
- C: N (carbon: nitrogen) ratio of the contaminant material< 30:1
- pH
- Availability of Oxygen in sufficient quantity in soil.

### Two types for Bioremediation

*In situ* Bioremediation : The treatment in place without excavation of contaminated soils or sediments.

*Ex situ* bioremediation: requires pumping of the groundwater or excavation of contaminated soil prior to remediation treatments.

### Types of In situ Bioremediation

- Biostimulation: To stimulate the activity of microorganisms by adding nutrients and electron acceptors (*e.g.* O<sub>2</sub>)
- **Bioventing:** Injecting air through soil to stimulate microbe growth in unsaturated zone
- **Biosparging:** Injection of air/nutrients into unsaturated and saturated zones
- **Bioaugmentation:** inoculation of soil with microbes or adding exogenous microbes to the subsurface



#### **In-situ-Bioremediation**

- Good for large volumes
- Slower
- Doesn't work well in clays or highly layered subsurfaces

## *Biostimulation* (stimulates biological activity)

- <u>Bioventing</u> (Inject air/nutrients into unsaturated zone – good for midweight petroleum, jet fuel)
- <u>Biosparging</u> (Inject air/nutrients into unsaturated and saturated zones)

### *Bioaugmentation* (inoculates soil with microbes)

- Less expensive
- Creates less dust
- Less possibility of contaminant release into environment



### Biostimulation





### **Ex-situ -Bioremediation**

- Slurry-phase-Soil combined with water/additives in tank, microorganisms, nutrients, oxygen added
- Solid-phase
  - Land-farming: soil put on pad, leachate collected
  - Soil biopiles: soil heaped, air added
  - Composting: biodegradable waste mixed with bulking agent
  - Land Applied –waste added directly to soil which is later planted to a crop.

- Easier to control
- Used to treat wider range of contaminants and soil types
- ·Costly





#### Advantages of Using Bioremediation Processes Compared With Other Remediation Technologies

- biologically-based remediation detoxifies hazardous substances instead of merely transferring contaminants from on environmental medium to another.
- (2) bioremediation is generally less disruptive to the environment than excavation-based processes.
- (3) The cost of treating a hazardous waste site using bioremediation technologies can be considerably lower than that for conventional treatment methods: vacuuming, absorbing, burning, dispersing, or moving the material.