Problematic Soils and their Management
SOL 202

Dr. Pradeep Kumar srivastava

Associate Professor (Soil Science)

Department of Agriculture , MMU, Sadopur, Ambala, India

Problematic Soils and their Management
SOL 202

SECTION A

- Soil quality and health, Distribution of Waste land and problem soils in India. Their
- categorization based on properties.

SECTION B

- Reclamation and management of Saline and sodic soils, Acid soils, Acid Sulphate soils, Eroded and Compacted soils, Flooded soils, Polluted soils.

SECTION C

- Irrigation water – quality and standards, utilization of saline water in agriculture. Remote sensing and GIS in diagnosis and management of problem soils.

SECTION D

Multipurpose tree species, bio remediation through MPTs of soils, land capability and classification, land suitability classification. Problematic soils under different Agro-ecosystems.

Assignment

- ✓ Discuss the soil fertility & Productivity.
- ✓ Discuss the brief history of Waste land and problem soils in India.
- ✓ Discuss the reclamation and management of Saline and sodic soils.
- ✓ Irrigation water – quality and standards.
- ✓ Discuss the LCC.
- ✓ Discuss the brief history agro-climatic zone of India.
- ✓ Discuss bio-remediation .
- ✓ Land Suitability Classification.

SOIL QUALITY: It is a capacity of a soil to function within a ecosystem and land use to sustain biological productivity maintain environmental quality and sustain plant, animal, human health. –by Doran & Parkin(1994)

ASSESSMENT OF SOIL QUALITY: Ecosystem concept such as function, processes, attributes & indicators is a useful framework to describe soil quality. It has 2 aspects i. intrinsic part ii. Dynamic part

i. Inherent Soil Quality

- This type of Soil Quality depends upon geological & topographical features.
- Attributes of inherent Soil Quality are mineralogy and particle size distribution.
- There is no universally applicable set of inherent Soil Quality criteria and optimum values.
- It can be assessed by soil survey.

ii. Dynamic Soil Quality

- It encompasses that properties that can change over a short period of time i.e. SOM, SOC
- It is influenced by the human activities and agronomic practices.
- Soil Quality Indicator is used to determine the dynamic soil Quality.

PARAMETERS OF SOIL QUALITY

- **Nutrient status & Organic matter**- Quality soil should have sufficient available nutrient support the crop production. By intensive cultivation the nutrient status depletes day to day. Quality soil should have minimum gap between nutrient demand & supply .It is possible to optimize the nutrient status by taking proper nutrient management as well as adding optimum amount of org. matter.

- **Soil Texture**- Relative proportion of sand, silt & clay. Most suitable texture for agricultural purpose is sandy loam to clay loam soil.
- **Soil Structure**- Arrangement of primary & secondary particles. For argil. Purpose crumby and granular structure is most suitable.
- **Particle Density**-Ratio of total mass of soil solid & volume of soil solid. Quality soil should have P.D of 2.60g/cc-2.70g/cc
- **Bulk Density (B.D)** - Ratio of soil solid and total volume of soil. Optimum B.D should be 1.3g/cc to 1.5g/cc. The compact sub soil have the value 2g/cc. If B.D is less than 1g/cc then puddling cannot be done.
- **Porosity**- There are two types of pore space in the soil. i.e. macropores and micropores.
  - ✓ Macropores- It contains mainly soil air,which is responsible for root respiration. Puddling operations destroys the macropores as well as soil structure which affect the soil quality.
  - ✓ Micropores- It mainly contains the soil water.
  - Quality soil should have optimum macropores as well as micropores.
- **Soil Temperature**- Soil temperature influences
  - Germination of seeds
  - Physical properties of soil
  - Microbial activity- optimum temp is 25°-35°c
  - Availability of nutrients
  - Plant diseases
  - Root growth- optimum temp. for root growth is 20°-25°c
- **Cation Exchange Capacity (CEC)** – It is the amount of exchangeable cations per unit of dry soil. It helps to maintain soil pH and nutrient status

Mineral	CEC{C mol(p+)/kg}
Kaolinite	3-15
Illite	15-40
Montmorillonite	80-100
Vermiculite	100-150
Organic matter	>200

- **pH**- It is the negative logarithm of active [H^+] and [OH^+].It is an important parameter of quality soil because it influences
  - ✓ Nutrient availability

Nutrients	pH Range
N	6-8
P	6-6.5
K	6-7.5
S	6 and above
Ca, Mg	7-8.5
Fe	6 and below
Mn	5-6.5
B,Cu,Zn	5-7.5
Mo	7 and above

Source-fundamentals of soil science, ISSS

  - ✓ Microbial Activity- In high pH and low pH the microbial population get hampered.

The quality soil should have neutral pH i.e. 6.5-7.4 in which enhances the plant growth, microbial activity, org. matter decomposition and mineralization.

MAJOR FACTORS AFFECTING SOIL QUALITY

- Wide gap between nutrient demand & supply
- High nutrient turnover in soil plant system coupled with low and imbalanced fertilizer use.
- Emerging deficiency of secondary and micronutrients due to improper use of inputs such as water, fertilizer, pesticides, etc.
- Insufficient use of organic inputs.

- Acidifications and Al & Fe toxicity
- Development of heavy metal toxicity.
- Disproportional growth of microbial population
- Natural and man-made calamities such as erosion, deforestation due to rapid industrialization and urbanization.
- Development of salinity and alkalinity in soils.

TYPES OF SOIL	EC	ESP	PH
SALINE	>4	<15	<8.5
ALKALINE	<4	>15	>8.5
AKALI-SALINE	>4	>15	>8.5

Source - fundamentals of soil science, ISSS

MANGEMENT FOR QUALITY SOIL

➢ ENHANCE ORGANIC MATTER

- Whether the soil is naturally high or low in organic matter, adding new organic matter every year is perhaps the most important way to improve and maintain soil quality.
- Regular additions of organic matter improve soil structure, enhance water and nutrient holding capacity, protect soil from erosion and compaction, and support a healthy community of soil organisms.

➢ AVOID EXCESSIVE TILLAGE

- Reducing tillage minimizes the loss of organic matter & protects the soil surface with plant residue.
- Minimize the destruction of soil structure.

- Decrease the threat of erosion, enhance the habitat of helpful organisms, and reduce compaction

➢ MANAGE PESTS AND NUTRIENTS EFFICIENTLY

- Application of proper amount of chemical fertilizer and pesticide to maintain the helpful soil microorganism.
- IPM and INM helps to maintain the optimum soil quality
- C:N ratio should be 10:1
- Apply recommended fertilizers on the basis of soil test value.

➢ MANAGEMENT OF THE PROBLEM SOIL

- **Acid Soil Reclamation**
  - ✔ Application of liming material like Calcium Carbonate($CaCo_3$),Dolomite($CaCo_3.MgCO_3$),Calcium hydroxide[$Ca(OH)_2$],Basic slag
  - ✔ Minimize the use of acid forming fertilizers like Urea, Ammonium Sulphate, and Ammonium nitrate.
  - ✔ Rice, minor millet, finger millet can be successfully grown in acid soil. Many fruits and veg can be cultivated in acid soils. Ex- apples, blueberries, tomato, potatoes etc.
- **Salinity and Alkalinity reclamation**
  - ✔ Physical amelioration-It can be controlled by deep ploughing, subsoiling, sanding, profile inversion etc.
  - ✔ Hydro-technical amelioration-It is done by leaching, salts by dissolving with water.
  - ✔ Chemical amelioration- Alkali and sodic soil can be reclaimed by gypsum,$CaCl_2$,$CaCO_3$,lime sulpher etc.
  - ✔ For non-calcareous soil apply only solube sources of Ca (Ex-gypsum, calcium chloride)

LAND DEGRADATION

Land degradation may be define as the long term loss of ecosystem function and productivity caused by disturbance from which the land cannot recover without help.It occure slowly and cumulatively,and has long lasting impact on rural people who become increasingly vulnerable.

The term 'Soil Degradation' refers to processes that causes a reduction in its capacity to produce goods (e.g. crop, fodder for livestock production) and services (e.g. regulation of water and nutrients, below and above ground bio diversity) for needs and benefit
of current and future generations.

Land degradation generally signifies the temporary or permanent decline in the productive capacity of the land (UN/FAO definition).

LAND DEGRADATION IN INDIA

Land degradation	Type	mha	mha
Water Erosion	Loss of top soil	83.31	93.68
	Terrail deformation	10.37	
Wind Erosion	Loss of top soil	4.35	9.48
	Terrail deformation	3.24	
	Over Blowing	1.89	
Physical Deterioration	Water logging		14.29
Chemical Deterioration	Salinization	5.89	21.92
	Soil acidity	16.03	
Complex Problem			7.38
			TOTAL – 146.75

Types of soil degradation include:

1. SOIL EROSION BY WATER: the removal of soil particles by the action of water.

- **Splash** – results from the impact of raindrops on the soil surface. The bombardment causes the displacement/detachment of soil particles. The impact can dislodge particles as far as 3 feet. As they resettle elsewhere they block soil pores and lower infiltration capacity of the soil. Splash erosion also causes soil disintegration (destruction of soil structure). Maintenance of vegetative cover remedies this condition

Rain drop and Splash erosion

- **Sheet** – when rainfall intensity is greater than infiltration a layer of water moves across the soil surface, **transporting a uniform layer of soil**. This layer typically contains fine particles and a significant proportion of the nutrients and organic matter.

Sheet and rill erosion (Source: NRCS/USDA)

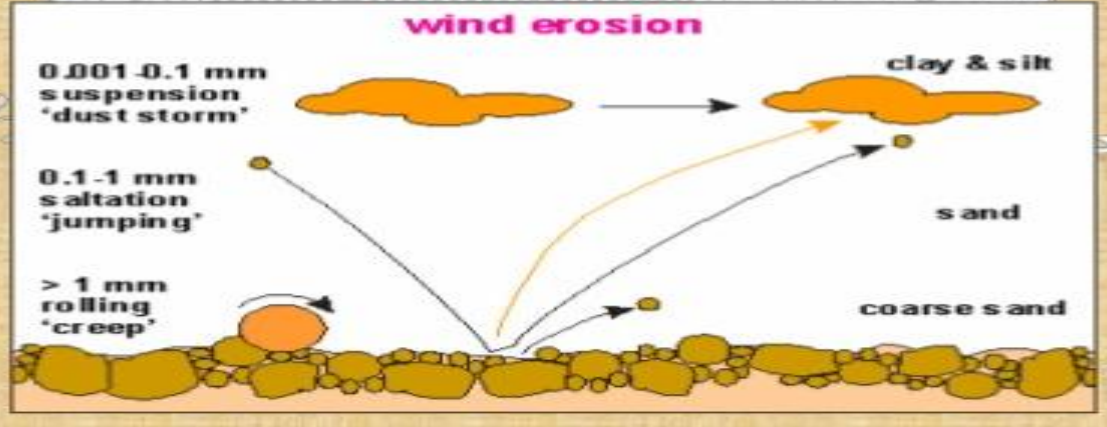
- **Rill** - deep, fast-flowing channels are formed into the ground from the concentration of surface (sheet) water, detaching and transporting soil particles. Flow velocity (and thus degree of erosion) may be reduced by a rough surface e.g. grass, ploughing or reduce in gradient. Alternatively the soil surface may be hardened to prevent movement.

- **Gully** – forms from the deepening and widening of rills, and cannot be repaired using tillage equipment. This occurs as water erodes the face or undercuts the head wall, causing upslope migration; or via undercutting and collapse or slumping of side walls. Once established gully erosion is difficult to mitigate and requires a combination of control measures e.g. re-vegetate gully floor and walls and the upstream catchment, divert surface drainage away from the gully.

2.WIND EROSION

Wind erosion is more common in arid and semi-arid climates, and in periods of drought. It removes the most fertile layer of soil, hence reducing soil productivity. Deposition of the soil onto plant surfaces reduces their capability for photosynthesis and respiration.

Airborne particles make visibility difficult, cause respiratory problems and can cause sedimentation of watercourses when they settle. Chemicals such as pesticides in the soil can also cause water pollution. Suspended particles can also cause erosion of solid surfaces (e.g. rock, walls) by abrasion.



3) SOIL FERTILITY DECLINE: the degradation of soil physical, biological and chemical properties. Erosion leads to reduced soil productivity, as do:
a) **Reduction in soil organic matter**, with associated decline in soil biological activity;
b**) Degradation of soil physical properties** as a result of reduced organic matter (structure, aeration and water-holding capacity may be affected);
c**) Changes in soil nutrient content leading to deficiencies, or toxic levels,** of nutrients essential for healthy plant growth;
d) **Build up of toxic substances** – e.g. pollution, incorrect application of fertilisers.

4) WATER LOGGING: caused by a rise in groundwater close to the soil surface or inadequate drainage of surface water, often resulting from poor irrigation management. As a result of water logging, water saturates the root zone leading to oxygen deficiency.

5) INCREASE IN SALTS: this could either be salinization, an increase in salt in the soil water solution, or sodication, an increase of sodium cations (Na+) on the soil particles. Salinization often occurs in conjunction with poor irrigation management. Mostly, sodication tends to occur naturally. Areas where the water table fluctuates may be prone to sodication.

SEVERE SALINISATION OF SOILS

6) SEDIMENTATION OR 'SOIL BURIAL': this may occur through flooding, where fertile soil is buried under less fertile sediments; or wind blows, where sand inundates grazing lands; or catastrophic events such as volcanic eruptions.

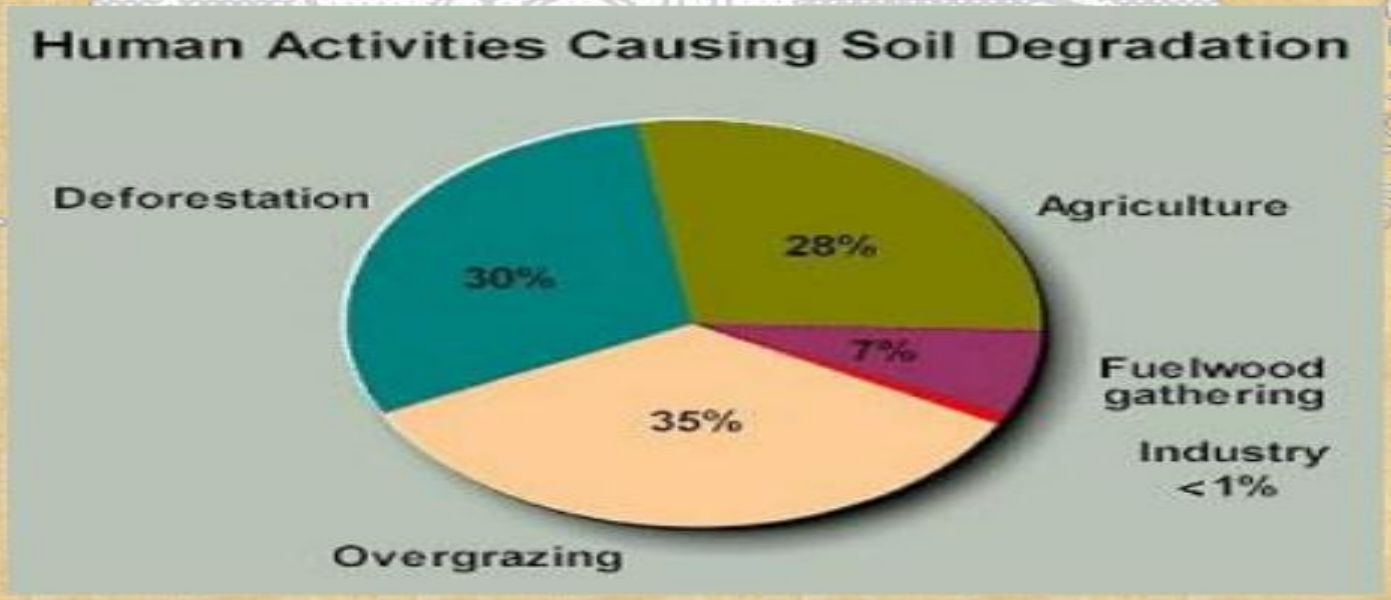
In addition to these principal types of soil degradation, other common types of land degradation include

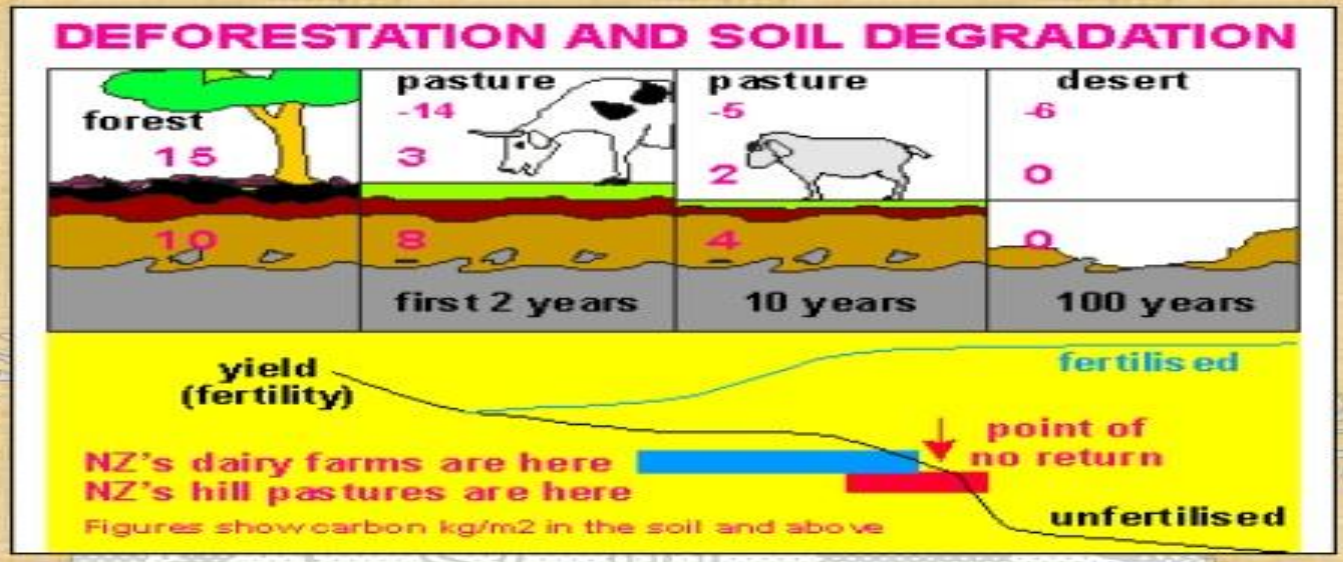
7) LOWERING OF THE WATER TABLE: this usually occurs where extraction of groundwater has exceeded the natural recharge capacity of the water table.

8) LOSS OF VEGETATION COVER: vegetation is important in many ways. It protects the soil from erosion by wind and water and it provides organic material to maintain levels of nutrients essential for healthy plant growth. Plant roots help to maintain soil structure and facilitate water infiltration.

9) INCREASED STONINESS AND ROCK COVER OF THE LAND: this would usually be associated with extreme levels of soil erosion causing exhumation of stones and rock.

10) HUMAN ACTIVITY: Mainly deforestation,agriculture,industry,fuel wood purpose etc. the pie chart is given below.





NEED FOR MANAGEMENT OF LAND DEGRADATION

Land degradation or soil loss is a major problem in India in present days. Soil degradation causes several losses by which plants, animal, human being and overall the eco system biodiversity are affected.

So sustainable land management is necessary. Sustainable land management innovation include measure to increase the productivity of agricultural and forestry land (for example soil quality, vegetative cover) to maintain the provisioning of ecosystem service (carbon sequestration, water availability, erosion and flood control, drought mitigation) and protect genetic resource.

Sustainable land management is defined as a knowledge based procedure that helps to integrate land water biodiversity and environmental management to meet rising food and fiber demands while sustaining ecosystem service and livelihood, sustainable land management, therefore embraces and integrated approach to natural resource management, taking into account the various factor influencing decision about land use at the local, regional and national level.

MANAGEMENT OF LAND DEGREDATION:

1. Permanent soil cover
2. Cover crop
3. Strip cropping

CONTOUR STRIP CROPPING AND TREES FOR WINDBREAKS

4. Crop residue
5. Crop rotation
6. Minimum tillage
7. Shelter belt
8. Wind breaks
9. Residue management
10. Terrace cultivation

TERRACES FOR RICE CULTIVATION

11. Conservation of natural resources
12. Control of grazing
13. Reforestation
14. Judicious application of irrigation water,fertilizer,and pesticide
15. Mainly use of drip and sprinkler irrigation

THE WASTELANDS IN INDIA

- About one fourth of the Earth's surface is covered by land.
- In many instances, the biological and physical makeup of the land contributes to how it is used.
- Some land areas which contain rich soils are the most suitable zones for farming. At the same time, some land areas which are prone to be affected by floods are less suitable for any activity including settlement. Land is a valuable natural resource. It is the home for all life.
- The needs of human population are met by the land for Food, Fiber, Medicine, Housing and settlement, Energy supply, Water supply, Material supply, Engineering construction and also for Congenial environment for all life to survive.
- Land is the most important ingredient for any ecological and economic development in the world. When it is good, a land can be used for several activities including cultivation, construction, grazing and for all other development works. Land is a terrestrial bio-productive eco system.
- It comprises of soil, water, plant and other biota.

Land systems are classified based on the ecological conditions

a) Cropland
b) Barren Land
c) Wet Land
d) Arid dry land
e) Range land
f) Grass land
g) Snowy land and
h) Wastelands. Wasteland is a major category by itself.

- **Cropland:** It is the land in which crops are regularly planted and harvested.
- It includes land in fallow or pasture as a part of a regular rotation system.
- **Barren Land** are areas characterized by exposed bed rocks, desert pavements scarps, talus, slides and other accumulations of rock without vegetative cones. It is considered to be a track of up productive land.
- **Wet Land** is an area of land whose soil is saturated with moisture either permanently or seasonally.

The type of wastelands

a) Degraded land

b) Stalinized soil

c) Water logging

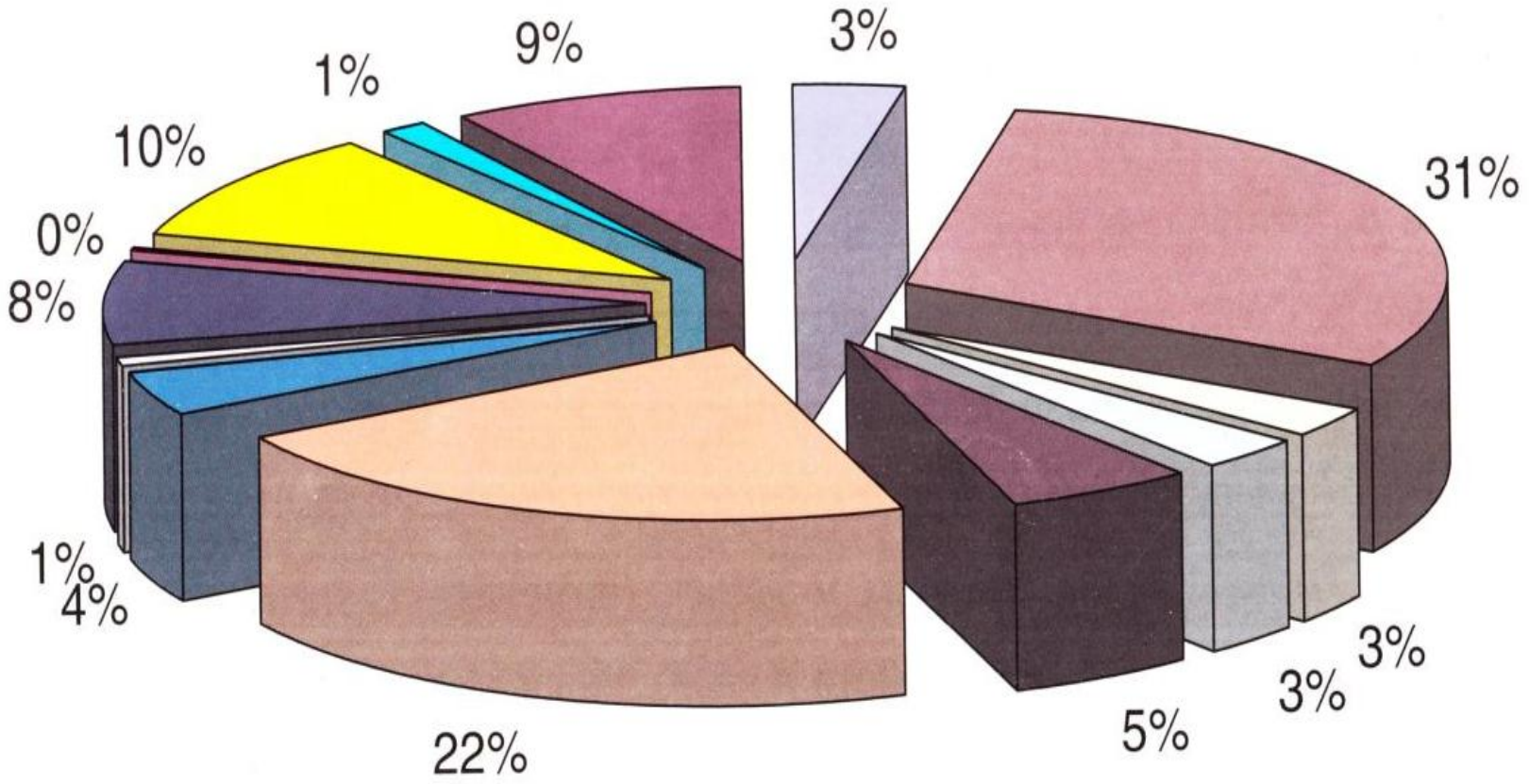
d) Desertification and

e) Soil erosion.

S. No.		Area (in M ha)	Area (in %)

1. Gullied or ravenous land
2. Land with or without scrub
3. Waterlogged land or Marsh land
4. Land of soil salinity/alkalinity
5. Land of shifting cultivation
6. Underutilized Degraded Notified Forestland
7. Degraded Pasture/ Grazing Land
8. Degraded Land of Plantation Crops
9. Desertic sands or Coastal sands
10. Mining or industrial waste lands
11. Barren land with rock/ stony wastes
12. Steep sloping lands
13. Snow covered lands

WASTELANDS OF INDIA CATEGORYWISE



Section B

- Reclamation and management of saliine and alkali/sodic soil, Acid soil, Acid sulphate soil, eroded soil and compacted soil, Flooded and polluted soils

Saline and Alkaline Soils

- In saline and alkaline soils there is presence an excess of sodium salts or predominance of sodium among exchangeable bases and pH is greater than 7.00.

Saline Soils

- These soil contain primarily the soluble salts of chlorides and sulphates of sodium, calcium and magnesium. The EC is greater than 4 dSm-1 and ESP is less than 15% and pH is less than 8.5. These soils correspond to Hilgards “White alkali soils”
- Predominantly Nacl, Na2 SO4 and Na2 CO3 is always absent in saline soils.

Alkali/ Sodic Soils

- ✓ These soils contain of sodium on the exchange complex. The ESP is greater than 15%, pH is greater than (8.5-10) and EC is less than 4 dSm-1.
- ✓ These soils were called black alkali/ Sodic soil/degraded alkali soil.
- ✓ Due to high pH and dominance of Na+ in this soils, SOM dissolves and comes into the soil solution.
- ✓ Alkali soils may be divided into following groups

a. Saline alkali Soils

- When they contain soluble salt in excess. The ESP is greater than 15%, pH is more than 8.5 and EC greater than 4 dSm-1, they are known as saline alkali soils.
- b. Non saline alkali soils (alkali soils) When they do not contain soluble salt they are known as non saline alkali soils.
- c. Degraded alkali soils: Under certain circumstances the clay clay complex of some alkali soils is broken down to give rise to degraded alkali soils. The ESP is greater than 15% and EC is less than 4 dSm-1.
- These soils absent CaCO3, horizon A and B acidic, Dark-coloured, compact soils, low infiltration

Area under Saline and Alkali soils

State	Area (Lakh ha)	State	Area (Lakh ha)
UP	12.95	Karnataka	4.04
Gujrat	12.14	MP	2.24
West Bengal	8.50	AP	0.42
Rajasthan	7.28	Delhi	0.16
Punjab	6.89	Kerala	0.04
Maharashtra	5.34	Bihar	0.04
Haryana	5.26	TN	0.04
Orissa	4.04	Total Area	69.49 (7 million ha)

Detrimental effects of soil salinity and alkanity

- Bad effect of saline soils:
- Absorption of water and nutrients
- Salt toxicity
- Bad effect of Alkali soils:
- Physical properties affected
- Availability of plant nutrients reduced

Reclamation of Alkali and saline Soils

- Principle for any reclamation technique to be permanent, three essential requirements have to be met with (Kelley 1951)
- The land must be prevented from reverting to original conditions
- Salt of alkali must be remove from red zones
- The repair of the damage, already done to the soil, should be substantial.

Reclamation of saline soils:

- 1. Mechanical Method:
- Construction of embankment to prevent tidal see water.
- Land leveling and contour bunding.
- Establishment of drainage network.
- Breaking of hardpan in the subsurface layer through boring auger hole

- 2. Hydrological :
- Flushing of salt
- Leaching of salt
- Drainage
- 3. Chemical Method:
- Use of amendments like Fe S2,Lime sulphur
- 4. Physical Methods:
- Scraping of salt crust.
- Deep tillage, subsoiling, profile inversion
- Use of soil conditioners e.g. sand,tanch, ash, manure and synthetic polymers like PVPC.

Saltwater and drainage is a continual problem for lowland agriculture near Puget Sound.

Solutions: Soil Conservation

- Biological Method:
- Use of manures
- Green manure
- Water hyacinth
- Selection of salt tolerant crops variety for partially reclaimed soil
- Ex. CSR 23, CSR89 and CSR 36
- KRL 210, KRL211 and KRL1-4

Water hyacinth in lakes and rivers due to pollution -chokes fish landing sites, e.t.c.

Reclamation of Alkali/ sodic soils

- **Chemical methods:**
- Application of Gypsum
- $Na_2CO_3 + CaSO_4 - CaCO_3 + Na_2SO_4$
- Use of Sulphur:
- $2S + 2H_2O + 3O_2 - 2H_2SO_4$
- $Na_2CO_3 + H_2SO_4 - CO_2 + H_2O + Na_2SO_4$
- Adding of OM:
- Use of Sulphuric acid :
- $Na_2CO_3 + H_2SO_4 - CO_2 + H_2O + Na_2SO_4$

Cultural method

- Mechanical Method:
- Construction of embankment to prevent tidal see water.
- Land leveling and contour bunding.
- Establishment of drainage network.
- Breaking of hardpan in the subsurface layer through boring auger hole

Hydrological :

- Flushing of salt
- Leaching of salt
- Drainage

Physical Methods:

- Scraping of salt crust.
- Deep tillage, subsoiling, profile inversion
- Use of soil conditioners e.g. sand,tanch, ash, manure and synthetic polymers like PVPC.
- Biological Method:
- Use of manures
- Green manure
- Water hyacinth
- Selection of salt tolerant crops variety for partially reclaimed soil
- Ex. CSR 23, CSR89 and CSR 36
- KRL 210, KRL211 and KRL1-4

Management of saline and Alkali soils

- Selection of crops varieties
- Tillage
- Layout
- Seed rate and spacing
- Irrigation and Dranage
- Fertilizers

Acid and acid sulphate soils

- Out of 157 million hectares of cultivated land of India, approximately 49 million hectares of land are acidic, in which 26 million hectare of land pH value less than 5.6 and the rest 23 million hectare of land having pH range 5.6-6.5.

Acid Soils

- Acid soil is a base unsaturated soil which has got enough of adsorbed exchangeable hydrogen ions (H+) so that to give soil a pH of lower than7.0.
- In acid soil most of the plant nutrients become unavailable form and consequently plant growth is affected.

Source of hydrogen Ions

- Soil acidity is caused by ion able hydrogen ions. The sources of H ions are moderately acid soil, Strongly acid soils and acid sulphate soils.
- Nature of acidity : Active acidity (H+ remains freely present in soil sulphate soil)
- Exchangeable acidity
- Residual acidity

Development and Formation of Acid Soils

- Leading due to heavy rainfall.
- Microbiological action.
- Acid parent rock material.
- Removal of bases by crops.
- Application of acid-forming fertilizer.
- Ca (Colloid) + $(NH_4)_2 SO_4$ – $2NH_4$ (Colloid) + $CaSO_4$.

- $2NH_4$ (Colloid) +$3O_2$ - Nitrification 2H (Colloid) +$2HNO_3$.

Effects of Soil Acidity on plants

- Toxic effect of H on root tissues
- Effect on permeability of plant membrane
- Adverse effect on the availability of nutrients i.e. P, Cu, Zn etc.
- Al, Mn and Fe become available in toxic amount
- Activities of soil microorganisms adversely affected

Reclamation of acid soils or Management

- Addition of lime
- Use of basic fertilizer, e.g Sodium Nitrate
- Soil and water Management
- Growing of acid tolerant crop varieties
- **Lime requirement :**
- a. Laboratory b. Field method
- **Method of application :** Lime should be applied one or two months before the sowing of crop.
- Lime should be well-mixed in the soil.

- Increasing the efficiency of nitrogen and potassic fertilizers in acid soils
- Water management
- Lime materials :
- Lime stone (CaCO3)
- Quick lime (CaO)
- Hydrated lime (Ca(OH)2)
- Basic slag (CaSiO)3)
- Dolomitic lime stone (CaMg(CO3)2)
- Miscellaneous sources, such as wood ash etc.

Efficiency of liming material

- a. Chemical composition e.g., oxide or hydroxide
- b. Fineness of liming material.
- **Effect of lime on acid soil.**
- Lime makes P more available
- Increases availability of N, K, Ca, Mg etc.
- Encourages the activities of soil microorganisms
- Renders Al, Fe and Mn insoluble and harmless
- Improves physical condition of soil.
- Checks soil erosion
- Increases fertilizer effectiveness
- Decreases plant diseases.

Area of acid soils in India

Soil Groups	pH Range	Area (mha)	States
Laterites soils	4.8-7.0	12.65	Mysore,MP, Orissa, WB,Maharashtra, Kerala, Assam and Bihar
Laterite and laterite red soils	5.0-7.0	11.80	Kerala, Orissa, WB, and Assam in Bihar, MP and UP
Mixed red and black/yellow soils	5.5-6.5	23.66	Mysore, Bihar, MP and UP

Acid sulphate soil

- These soils are extremely acid soils (pH below 4)
- The acidity is due to the presence of sulphuric acid and iron (Fe) and Aluminium sulphates.
- **Management of Acid sulphate Soils**
- When submerged, these soils are nearly natural in reaction. In order to keep these soils normal, the soils are keep flooded or saturated.
- Liming of soils are also effective in keeping soil normal.

Eroded Soils

- It is process of detachment and transportation of soil by natural agencies like water, wind etc. that affected soils known as eroded soils.

Nearly 5.5 mha area is affected by soil erosion. Area affected by wind erosion is estimated to be 0.90 mha, 0.15 mha by glacial erosion, 2.92 mha by sheet and rill erosion and 1.53 mha area is under gullies erosion.

- Development of eroded soils
- Water erosion:
- Rainfall
- Slope of the land
- Vegetation
- Tillage
- Nature of the soil like texture, structure, OM, presence of hard pan and high water table.

Type of water erosion

- Splash erosion
- Sheet erosion
- Rill erosion
- Gully erosion
- Slip erosion
- Stream bank erosion
- Sea-shore erosion
- **Soil and water conservation**

Type of wind erosion

- **Saltation**
- **Soil creep**
- **Soil suspension**

✓Tillage

✓Soil structure

✓Organic matter

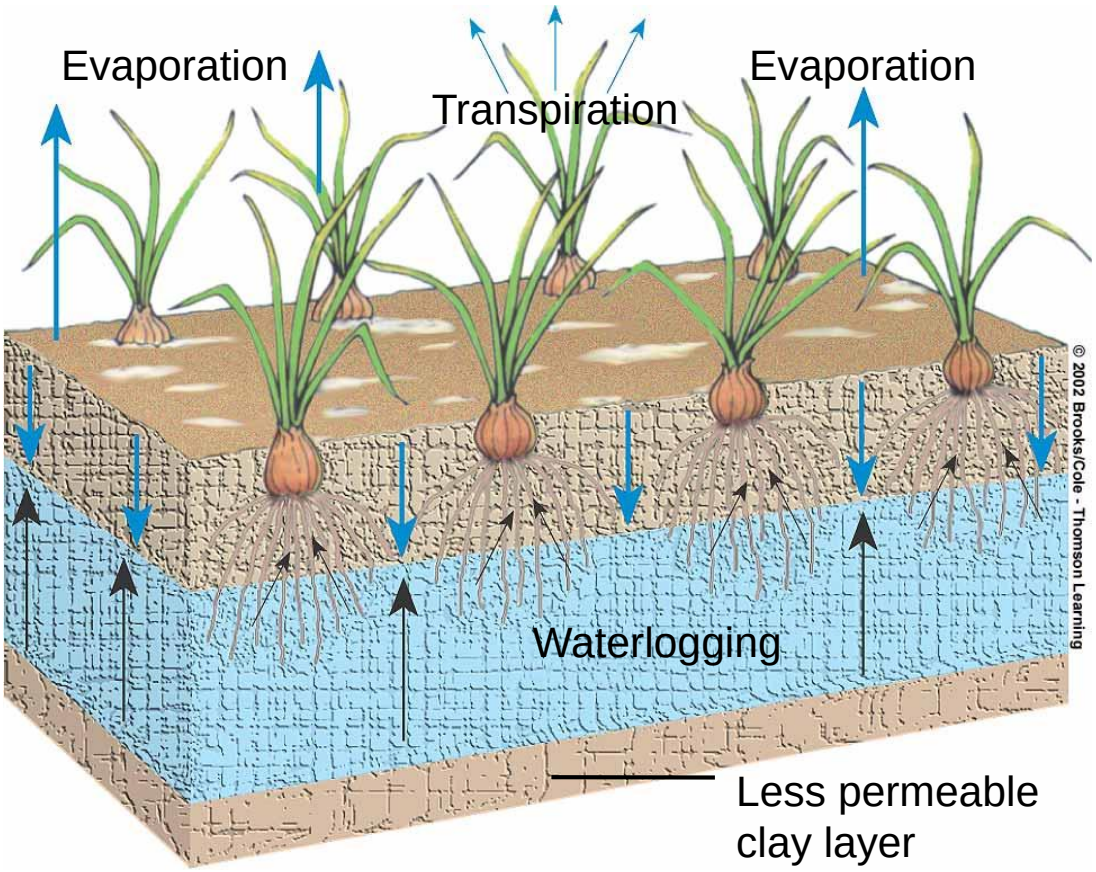
✓Barren surface

✓Continuous dry weather

✓Wind velocity and turbulence.

Soil Degradation on Irrigated Land

- **Salinization**
- **Water logging**



Control of eroded soils formation

- **Reduce the erodibility of the soil**
- **Reduce wind velocity at ground level.**

✓ Conservation of soil moisture
✓ Vegetative cover
✓ Mulching
✓ Trash tillage
✓ Increasing SOM
✓ Regulating grazing
✓ Strip cropping
✓ Wind break and shelterbelt
✓ Vegetative barriers

Traditional

Plantation

Industrialized

Causes of eroded soils

- Deforestation and overgrazing of pastures

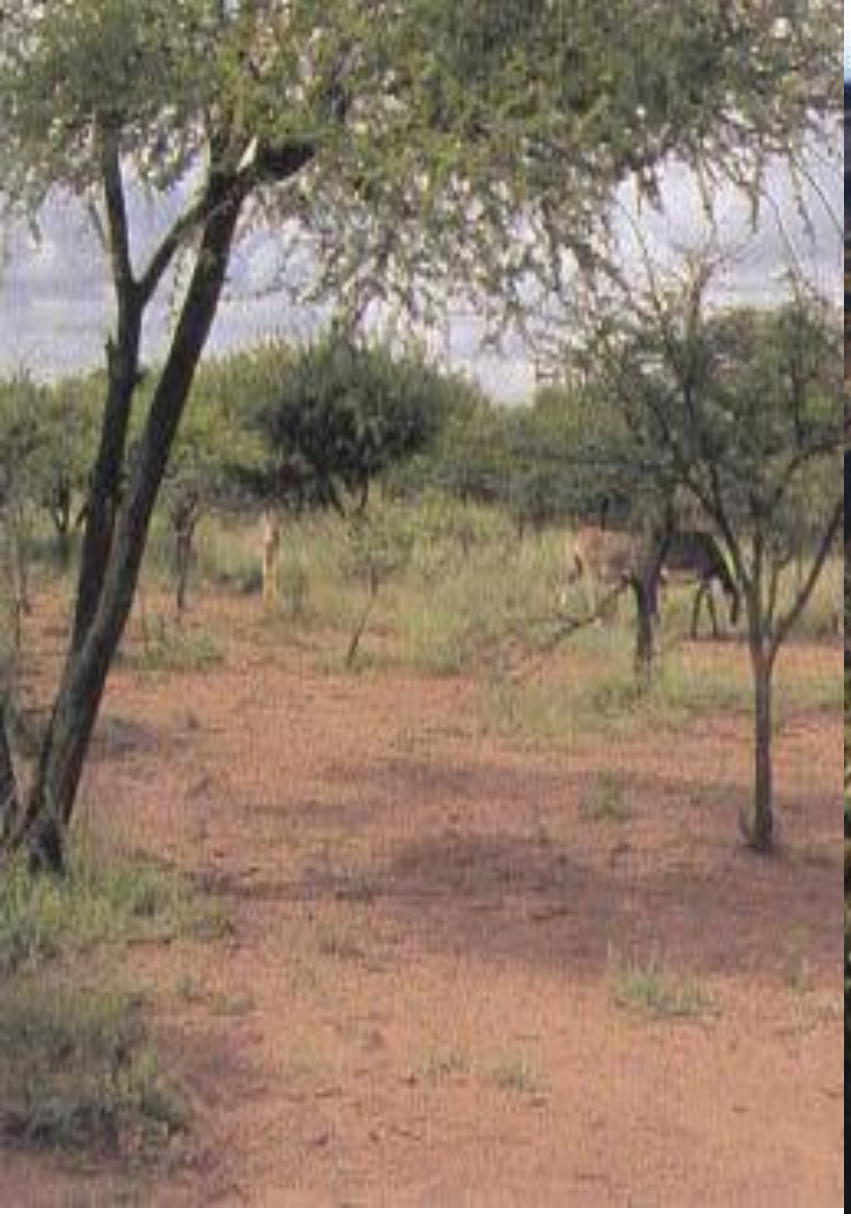
✓Loss of soil moisture

✓No Vegetative cover

✓Decreasing SOM

✓No wind break and shelterbelt

✓No Vegetative barriers



Overgrazing typically strips the land of any natural protection and leaves the soil very susceptible to erosion

Polluted Soil

- The term of pollution is derived from *Latin* word
- Pollution comes from Polluere word.

"Soil pollution is defined as the build-up in soils of persistent toxic compounds, chemicals, salts, radioactive materials, or disease causing agents, which have adverse effect on plant growth, animal health and human health".

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 Pollution

- 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 sewage.
- Seepage from a landfill.
- Discharge of industrial waste into the soil.
- Percolation of contaminated water into the soil.

The most chemicals involved in causing soil pollution are :

- **Petroleum hydrocarbons.**
- **Heavy metals.**
- **Pesticides.**
- **Solvents.**

Type of soil pollution

1. **Agricultural soil pollution**
   i) Pollution of surface soil.
   ii) Pollution of underground soil.
2. **Soil pollution by Industrial materials**
   i) Pollution of surface soil.
   ii) Disturbances in soil profile.
3. **Soil pollution by Urban activities**
   i) Pollution of surface soil.
   ii) Pollution of underground soil.

Sources of soil pollution

a. **Agrochemicals :** 1. Pesticides 2. Insecticides 3. Herbicides 4. Fungicides 5. Fertilizers
b. **Industrial wastes :** 1. Effluents 2. Dust and others wastes 3. Radioactive wastes 4. Heavy Metals 5. Acid precipitation.
c. **Urban wastes :** Municipal solid wastes 2. Municipal sewage 3. Vehicular exhaust
d. **Rural wastes :** 1. Home wastes 2.Litter 3. Livestock wastes 4. Plant residues 5. Sediments

Result of soil pollution

- A soil pollutant is any factor which deteriorates the quality, texture and minerals contents of the soil or which disturb the biological balance of the organisms in the soil.
- Pollution in soil has adverse effect on plant growth.

Effects of soil pollution

- **Agricultural**
- Reduced soil fertility
- Reduced nitrogen fixation
- Increased erodibility
- Larger loss of soil and nutrients
- Deposition of silt in tanks and reservoirs
- Reduced crop yield
- Imbalance in soil fauna and flora

Industrial

- Dangerous chemicals entering underground water
- Ecological imbalance
- Release of pollutant gases
- Release of radioactive rays causing health problems
- Increased salinity
- Reduced vegetation

Urban

- Clogging of drains
- Inundation of area
- Public health problems
- Pollution of drinking water sources
- Foul smell and release of gases
- Wastes management problems.

Control of soil pollution

- To help prevent of soil erosion.
- We can limit construction in sensitive area. In general we would need less fertilizers and fewer pesticides if we could all adopt the three R's: **Reduce**, **Reuse** and **Recycle**

- **Reducing chemical fertilizer and pesticide use.**

Applying bio-fertilizers and manure can reduce chemical fertilizers and pesticides use. Biological methods of pest control can also reduce the use of pesticides and thereby minimize soil pollution.

- **Reusing of materials :** Materials such as glass containers, plastic bags, paper, cloth etc. can be reused at domestic levels rather than being disposed, reducing solid waste pollution.

Recycling and recovery materials

- This is the reasonable solution for reducing soil pollution. Materials such as paper, some kind of plastics and glass can and are being recycled. This decreases the volume of refuse and help in the conservation of natural resources. For Example recovery of one tonne of paper can save 17 trees.

Reforesting

- Control of land loss and soil erosion can be attempted through restoring forest and grass cover to check wastelands. Soil erosion and floods. Crop rotation and mixed cropping can improve the fertility of the land.
- **Solid waste treatments :**Proper methods should be adopted for management of solid waste disposal.
- Industrial waste can be treated by physically, Chemically and biologically until they are less hazardous.
- Acidic and Alkaline waste should be first neutralized etc.

Flooded Soil

“Flooded soil are a condition in which an area of soil is oversaturated with water, often due natural occurrence or with intended purpose for agricultural reasons”.

Flood reclamation : The impact of land reclamation coastal environment and marine ecology is well recognized and widely studied. It has not been recognized yet that reclamation may change the regional ground water regime, which may in turn modify the coastal environment, flooding pattern and stability of slopes and foundations.

Flood control

- Some methods of flood control have been practiced are following
- These methods include planting vegetation to retain extra water, terracing hillsides to slow flow downhill and the construction of floodways, other techniques include the construction of levees, lakes, dams, reservoirs, retention ponds to hold extra water during times of flooding.

Management of flooded soil

- Dams
- Diversion canals
- Floodplains and ground water replenishment
- River defenses
- Coastal defenses
- Self-closing flood barrier
- Temporary perimeter barriers

Compacted Soil

- Soil liners have traditionally been compacted in the field to a minimum dry weight over a specified range in water content. This approach evolved from the practice for structural fills for which strength and compressibility are of primary concern. With soil liners, hydraulic pressure etc.

Management of compacted soil

- Deep tillage
- Sub-soiling
- Profile inversion
- Breaking of hardpan in the subsurface layer through boring auger hole etc.

THANKS