

# Soil and water interaction

## INTRODUCTION

- ❑ Successful aquaculture depends on providing animal with a satisfactory environment in which to grow.
- ❑ Good initial condition for aquaculture can be assured by a selecting a site with suitable soil and a high quality water supply.
- ❑ Soil is a key factor in aquaculture. Most of the pond is built from in a soil.
- ❑ Many dissolved and suspended substances are derived from contact with soil.
- ❑ Pond soil are store house for many substance that accumulate in the pond ecosystem and chemical and biological process occurring in the surface layer of pond soil influences water quality and aquaculture.
- ❑ Hence an understanding of soil properties and process in soil can be useful in pond aquaculture.

## INTRODUCTION

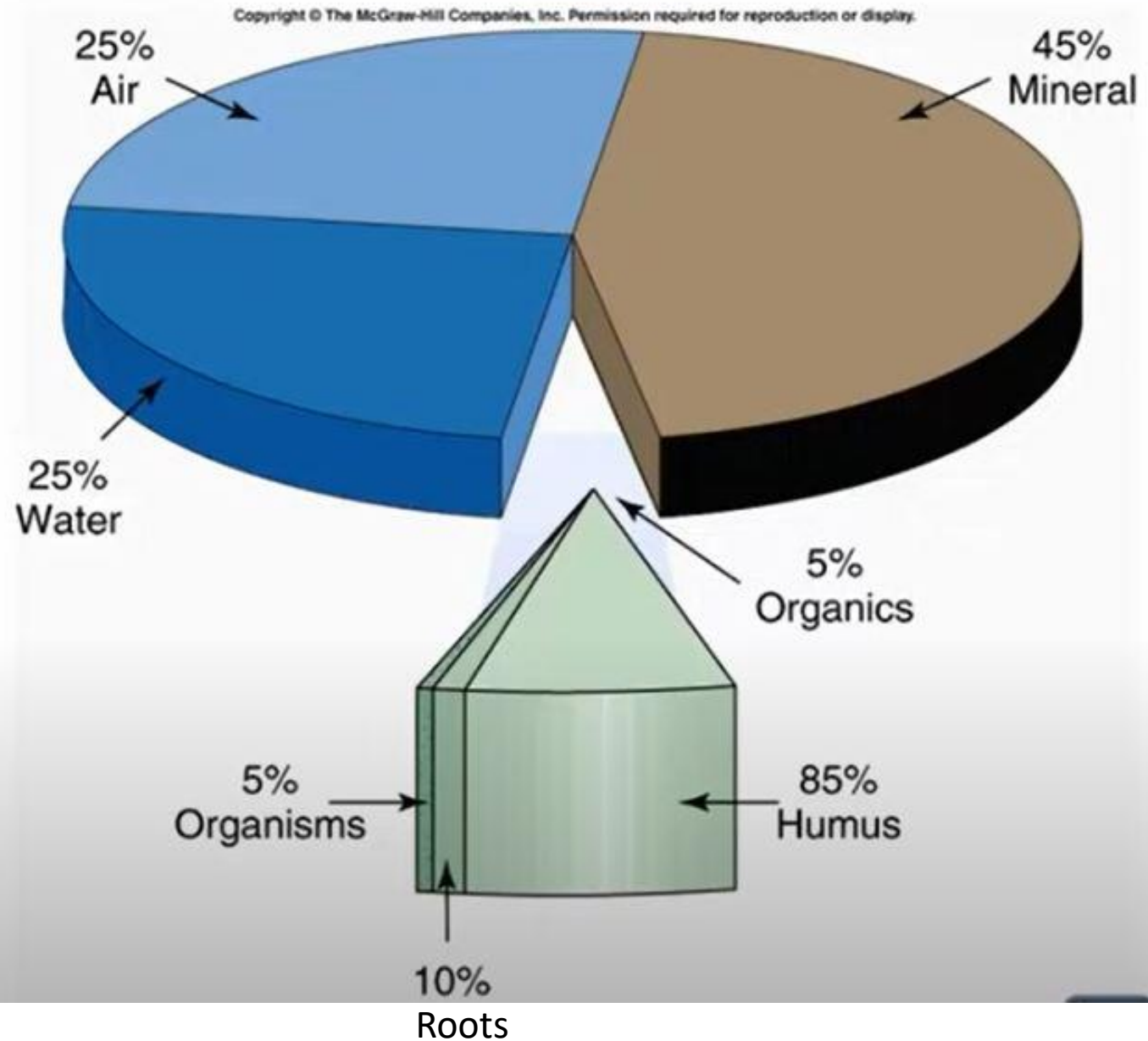
- Soils are the natural media that support the growth and activities of many kinds of plants, animals and micro-organisms which play a vital role for the existence of life on earth.

### SOIL COMPONENTS

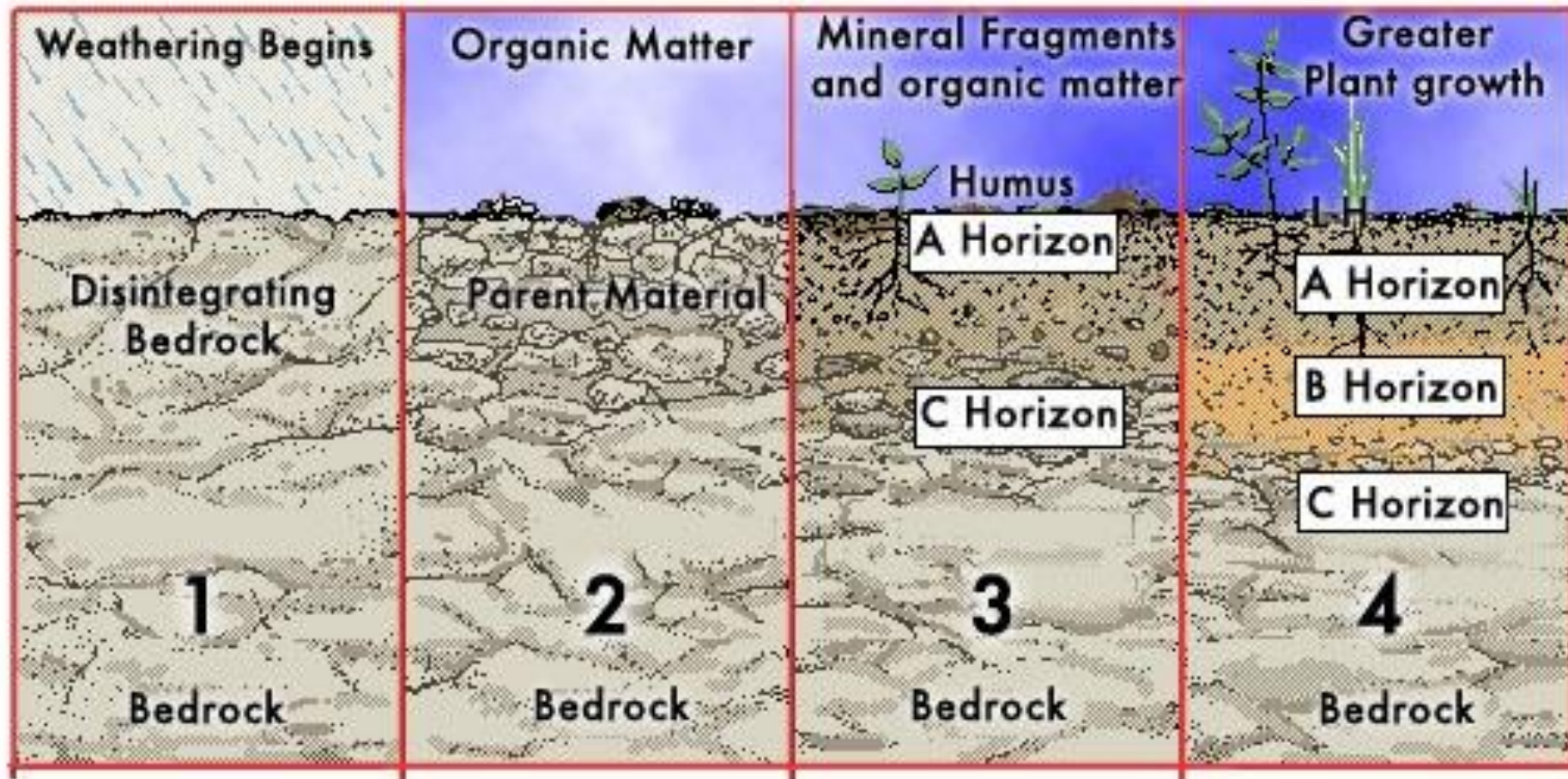


# Soil contents

## Soil contents



# Soil Formation



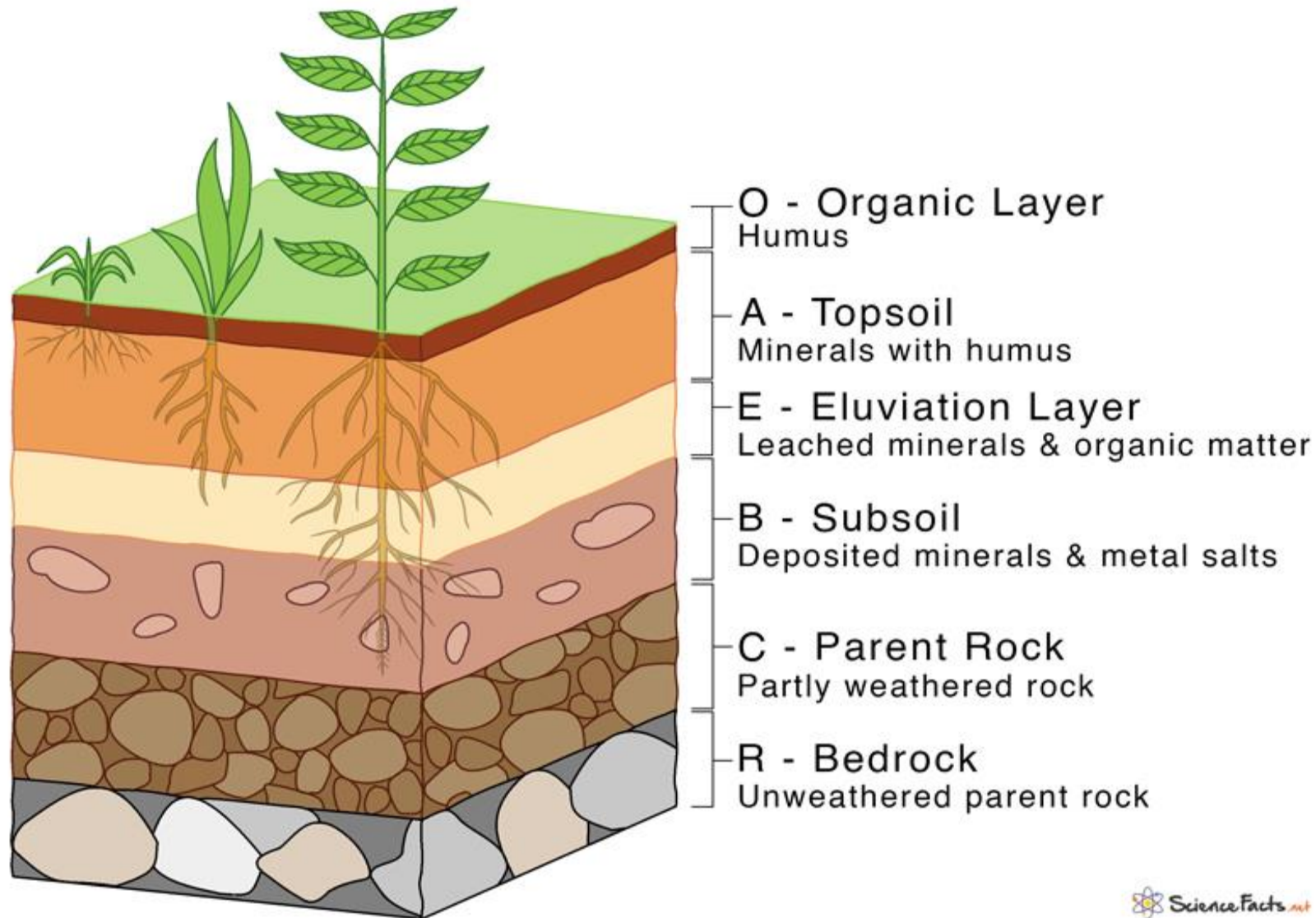
Bedrock begins to disintegrate

Organic matter facilitates further disintegration

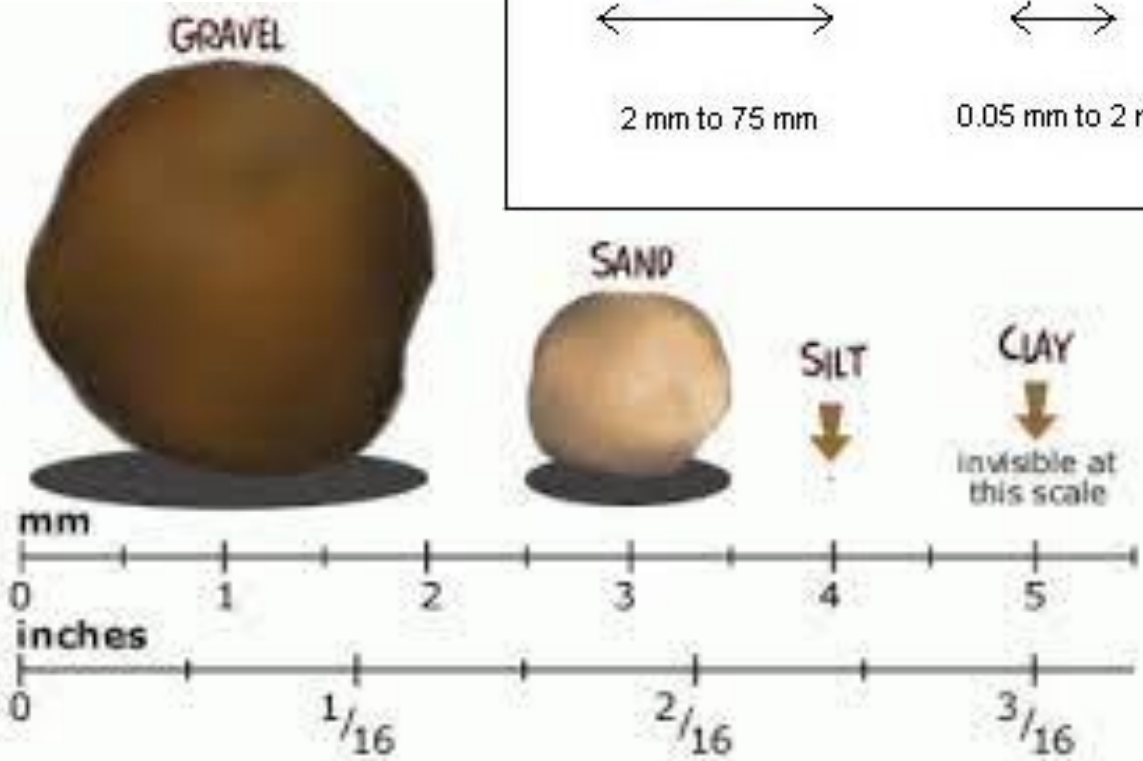
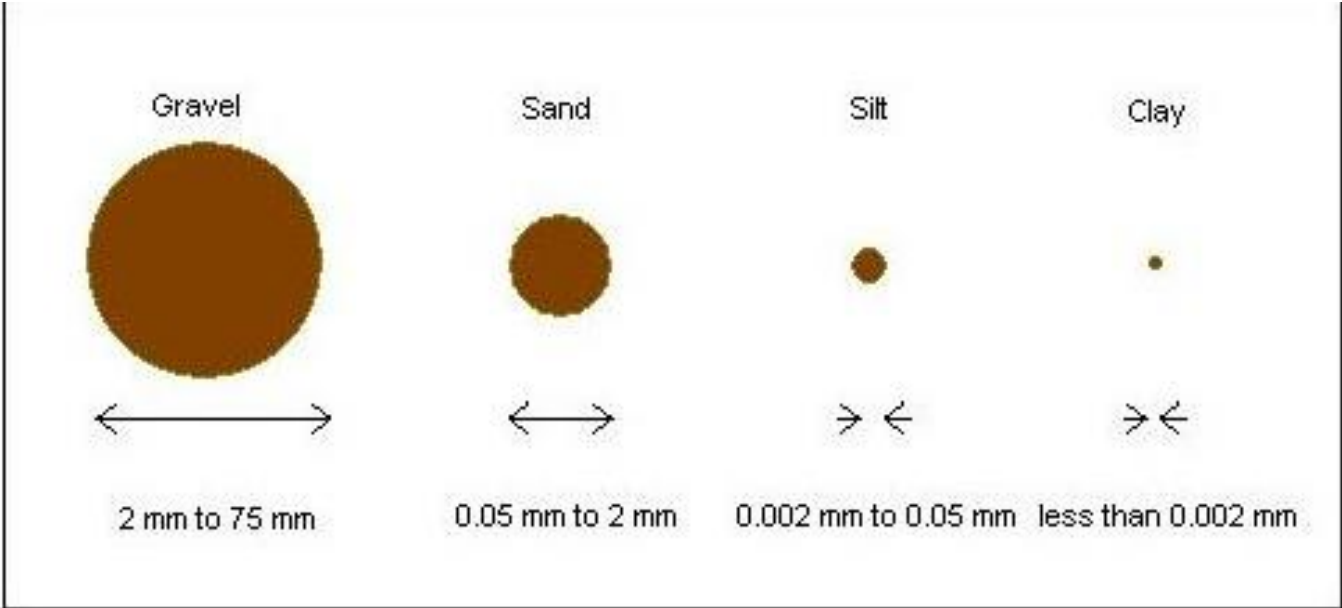
Water percolates. Horizons form

Deeper profile - more humus, thicker horizons

# Soil Horizons



# Sediment size



**Soil structure** describes the arrangement of the solid parts of the soil and of the pore space located between them. It is determined by how individual soil granules clump, bind together, and aggregate, resulting in the arrangement of soil pores between them.



Granular (high permeability)



Aggregated (high permeability)



Blocky (moderate permeability)



Columnar/prismatic (moderate permeability)



Platy (low permeability)



Massive (low permeability)



## PHYSICAL PROPERTIES OF SOIL

- |                   |                            |
|-------------------|----------------------------|
|                   |                            |
| 1. Soil Texture   | → <b>SANDY, CLAY, LOAM</b> |
| 2. Soil Structure |                            |
| 3. Soil Colour    |                            |
| 4. Soil Porosity  |                            |
| 5. Soil Colloids  |                            |

COLLOID – A two phase system in which one material in a finely divided state is dispersed into other.

## CHEMICAL PROPERTIES OF SOIL

- |  |  |
|--|--|
|  |  |
|  | <ol style="list-style-type: none"><li>1. Soil pH</li><li>2. Organic Matter</li><li>3. Calcium Carbonate</li><li>4. Soil Salinity</li><li>5. Redox Potential</li><li>6. C:N Ratio</li><li>7. Nutrients Status</li></ol> |

## PHYSICAL PROPERTIES OF WATER

- |  |  |
|--|--|
|  |  |
|  | <ol style="list-style-type: none"><li>1. Water Temperature</li><li>2. Turbidity</li><li>3. Water Colour</li><li>4. Light penetration</li></ol> |

## CHEMICAL PROPERTIES OF WATER

1. Dissolved Oxygen
2. Carbon Dioxide
3. pH
4. Alkalinity
5. Hardness
6. Salinity
7. Hydrogen Sulphide
8. Redox Potential
9. Ammonia

## How pond is considered as a model to understand Soil-water interaction??

- Successful aquaculture depends on providing animal with a satisfactory environment in which to grow.
- Good initial condition for aquaculture can be assured by selecting a site with suitable soil and a high quality water supply.
- Soil is a key factor in aquaculture. Most of the pond is built from soil.
- Many dissolved and suspended substances are derived from contact with soil.
- Pond soil are store house for many substance that accumulate in the pond ecosystem and chemical and biological process occurring in the surface layer of pond soil influences water quality and aquaculture.
- Hence an understanding of soil properties and process in soil can be useful in pond aquaculture.

## POND SOIL

- Material composing the bottom of streams, lake and ponds are known as sediment, mud or soil.
- The pond bottom is originally made of terrestrial soil and when the pond is filled with water the bottom becomes wet.
- Mixture of solid materials and with water is called 'mud'.
- Solids settle from the pond water and cover the pond bottom is 'sediment'.

# What is contribution of water to soil?

## ROLE OF WATER IN SOIL FUNCTIONING

- ✓ Soil Formation
- ✓ Soil Fertility
- ✓ Regulating soil temperature

**Soil formation** – The initial weathering process of rock is due to expansion of rock due to heat and contraction due to rain water. The flow of water causes a frictional force generated between rock and water.

**Soil fertility** – Water has several minerals, salts and essential elements That increases the fertility

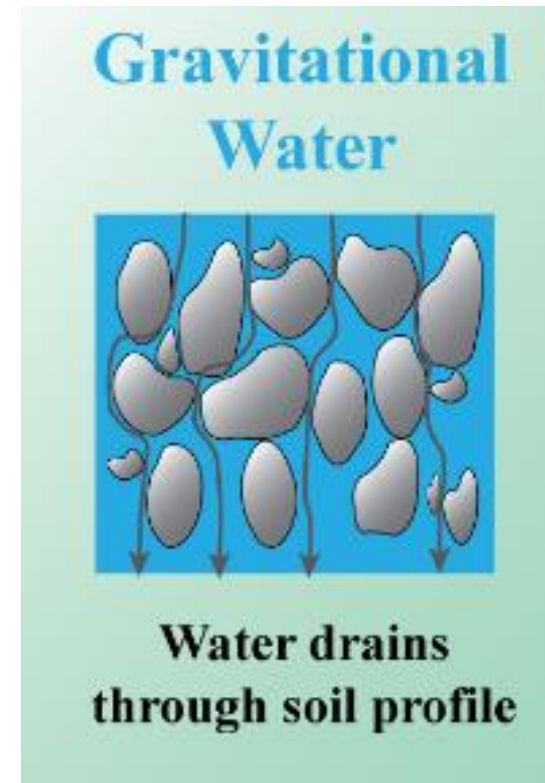
**Regulation of temperature** – Soil has no temp. of its own and its temp. is controlled by temp, of water.

# Types of Groundwater

## Gravitational water

- Gravitational – also called “free water.” –
- This is the water that drains out of the soil after it has been wetted. - This water moves downward through the soil because of the pull of gravity. - This water also feeds wells and springs.

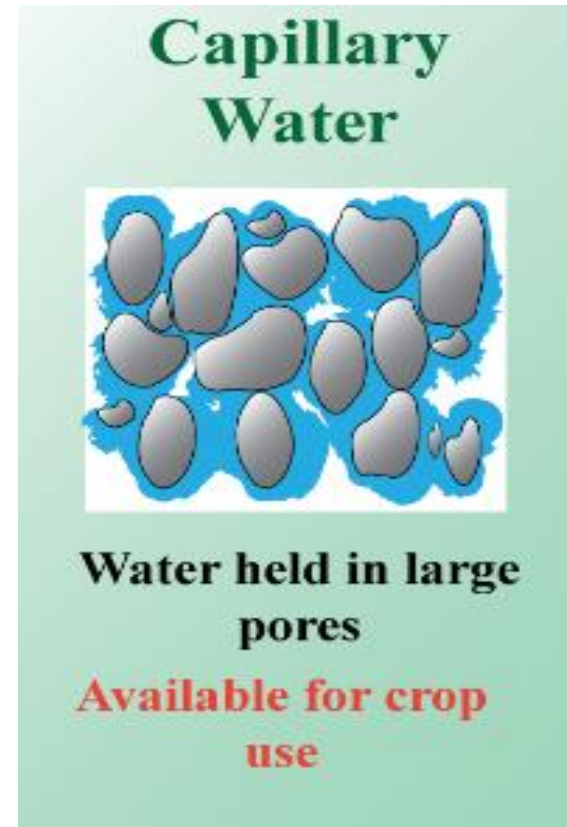
How soil water can be classified??





# Capillary water

- Capillary – water that moves into and is held in the soil by capillary forces (or pertaining to the attraction or repulsion between a solid and liquid and liquid

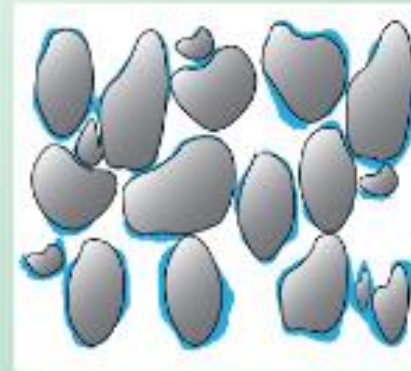


# Hygroscopic water

- Hygroscopic - very thin water films around the soil particles. - These films are held by extremely strong forces that cause the water molecules to be arranged in a semi-solid form. - This water is unavailable to plants.

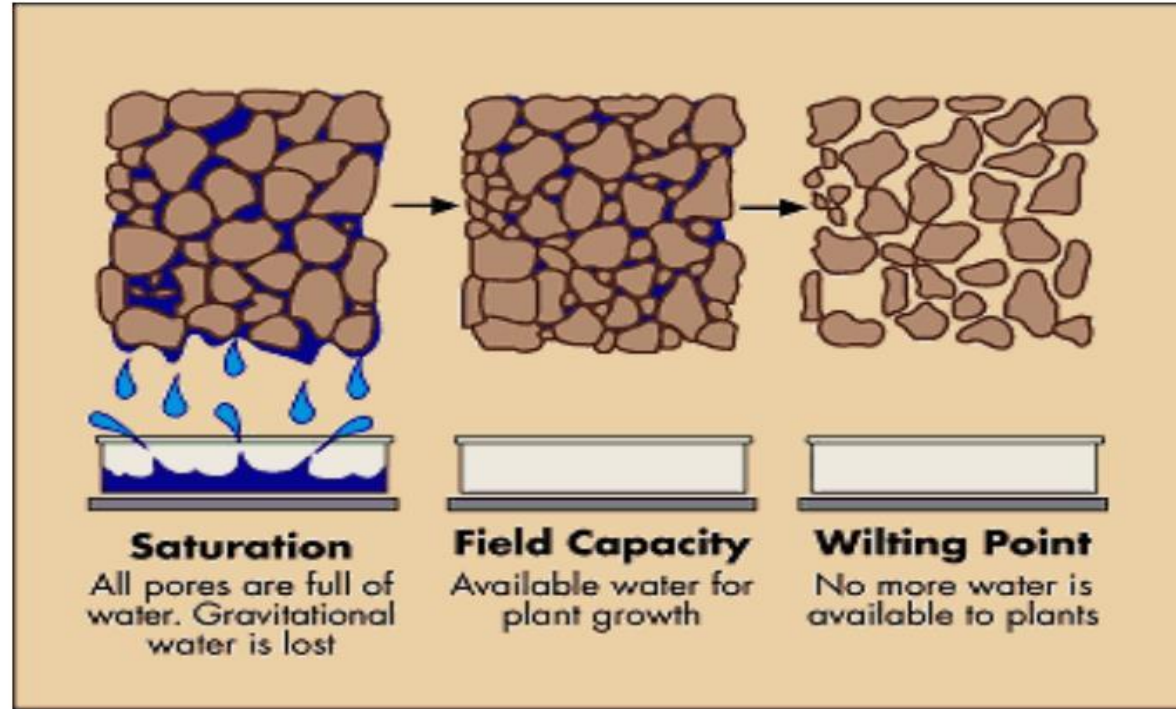
Hygroscopic water

**Hydroscopic  
Water**



**Water adheres to  
soil particles**

## Field Capacity and Wilting Point



- **Wilting Point** – the point at which the plant can no longer obtain sufficient water from the soil to meet its transpiration needs. - At this point the plant enters permanent wilt and dies.

## SOIL WATER ENERGY CONCEPT

- ✓ Retention and movement of water in soil, its uptake and translocation in plants as well as its loss to atmosphere all our energy related phenomenon. Soil water has two types of energy.
- 1. **Kinetic Energy:** It is the form of energy due to movement of water molecules within soil.
- 2. **Potential Energy:** It is the form of energy due to position of water in soil.
- ✓ Free energy of water is always expressed relative to energy condition of water in a standard reference state.

- ❑ Diffusion : Oxygen diffuses into bottom soil from water above.
- ❑ Seepage: Water carrying dissolved substance seeps downward into the pond soil.
- ❑ Erosion: Water current in pond erode the bottom soil.
- ❑ Suspension: Particulate matter eroded from the bottom is suspended in pond water.

# SOME IMPORTANT REACTION AND PROCESSES CONTROLLING POND-SOIL-WATER INTERACTION

- ❑ Dissociation:  $\text{CaCO}_3 + \text{CO}_2 + \text{H}_2\text{O} \longrightarrow \text{Ca}^{2+} + 2\text{HCO}_3^-$
- ❑ Precipitation:  $\text{Al}^{3+} + \text{H}_2\text{PO}_4 + 2\text{H}_2\text{O} \longrightarrow \text{Al}(\text{OH})_2\text{H}_2\text{PO}_4 + 2\text{H}^+$
- ❑ Hydrolysis:  $\text{Al}^{3+} + 3\text{H}_2\text{O} \longrightarrow \text{Al}(\text{OH})_3 + 3\text{H}^+$
- ❑ Neutralization:  $\text{HCO}_3^- + \text{H}^+ \longrightarrow \text{H}_2\text{O} + \text{CO}_2$
- ❑ Oxidation:  $\text{NH}_4^+ + 2\text{O}_2 \longrightarrow \text{NO}_3^- + 2\text{H}^+ + \text{H}_2\text{O}$
- ❑ Reduction:  $\text{SO}_4^{2-} + 4\text{H}_2 \longrightarrow \text{S}^{2-} + 4\text{H}_2\text{O}$
- ❑ Complex Formation:  $\text{Cu}^{2+} + \text{CO}_3^{2-} \longrightarrow \text{CuCO}_3$