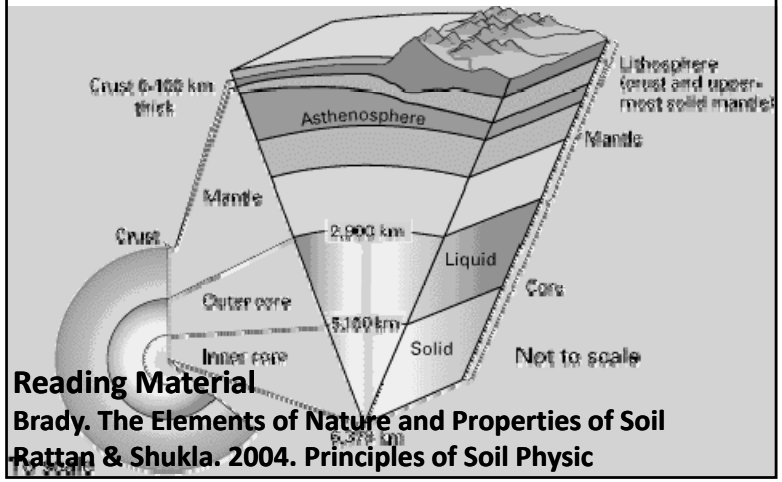
Soil Fertility

Dwi Priyo Ariyanto
http://www.ariyanto.staff.uns.ac.id
http://www.ilmutanahuns.wordpress.com

Email: dp_ariyanto@yahoo.com *Facebook: Dwi Priyo Ariyanto*

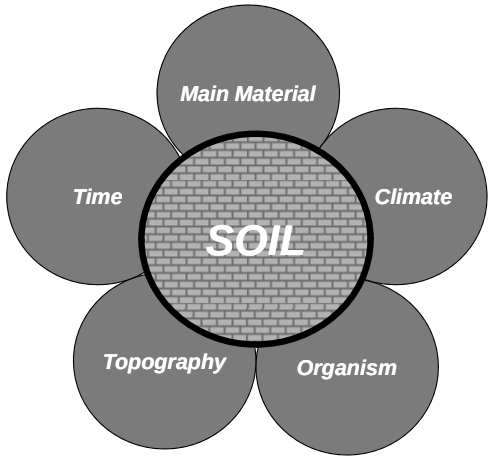
SOIL PHYSIC

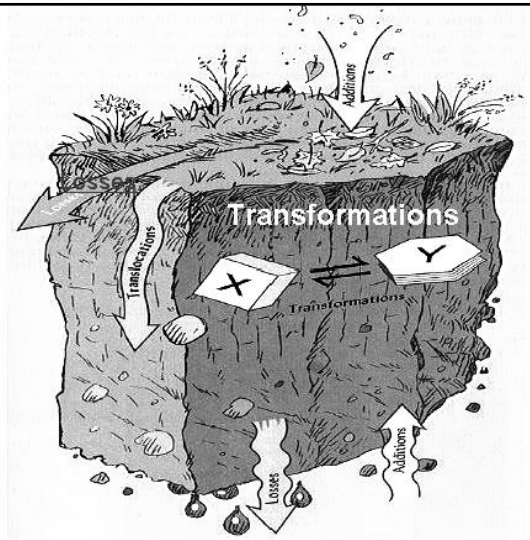


Reading Material

Brady. The Elements of Nature and Properties of Soil

Rattan & Shukla. 2004. Principles of Soil Physic





Soil Horizon Forming Processes

Soil

Solid ***Liquid*** ***Gas***

Solid

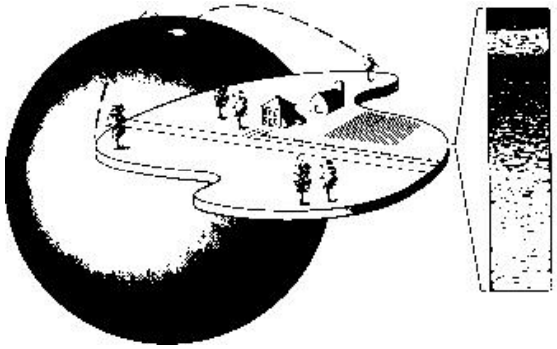
- ***Mineral → weathering***
- ***Organic matter → decomposition***

Liquid

- ***Capillary water →*** **micro/capillary pore**
- ***Crystal water***
- ***Gravitation water***

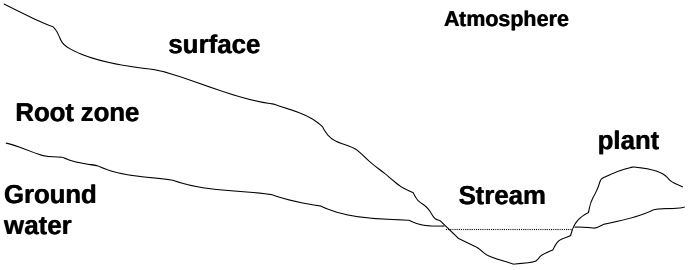
Gas

- **Gas in the soil → macro pore**
- **Boil in the soil**



SOIL PHYSICS

→ Science that learn conditions and transformation (changing) about all material and energy in the soil

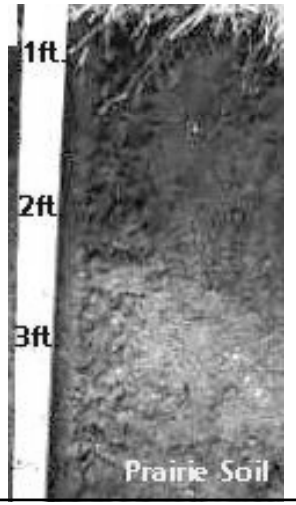


7

Why Soil Physics must be learn **?**

Soil

- **→ Source of nutrient and water for plant**
- **→ Channel between soil surface and water**
- **→ Filter and buffering**



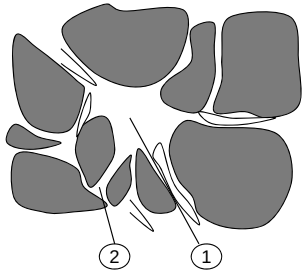
8

Tanah complex➔ need to learn and known about soil physical, *e.g.*:

- **Soil particle common ball**
- **Soil pore is combine of capillary pipe**
- **Soil is heterogenic**

Soil solid dipengaruhi by:

- **Soil texture**
- **Chemistry and mineralogy**
- **Form and surface area of soil particle**
- **Soil structure**



Between solid there are spaces ➔ pore:

1. Macro pore ➔ gas

2. Micro pore ➔ water (moist)

10

Soil fertility

1. Chemistry ➔ nutrient suffient

2. Biology ➔ organism suffient

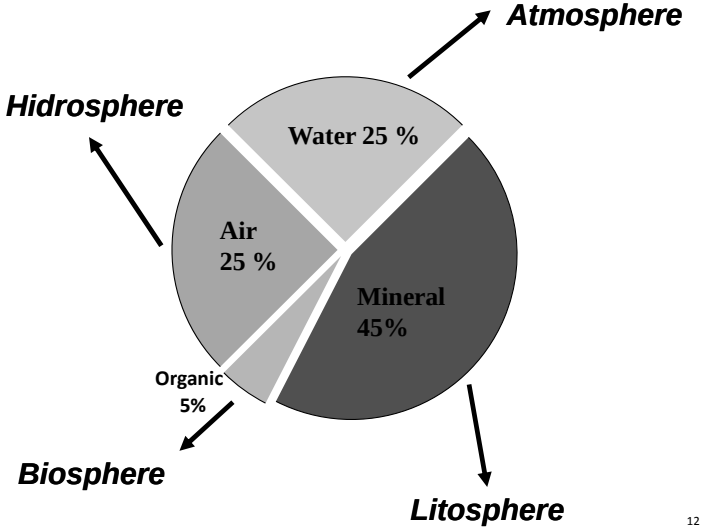
3. Physic ➔ suffient and balancing between water and air in the soil

Plant can be embedded (by physical/ mechanic) → *CRUMB*

on solid

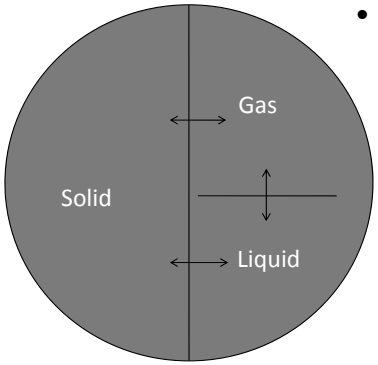
- **Water ➔ as dissolver and transponder of nutrients**
- **Air ➔ root breathing**

11



12

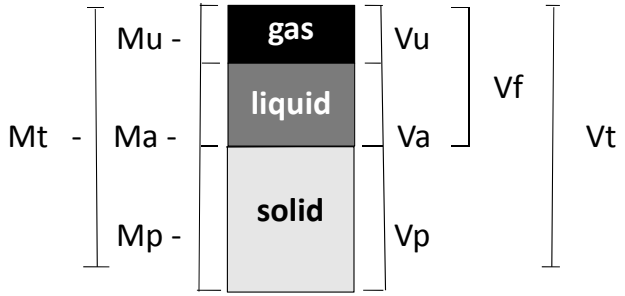
Density and volume relationship of soil components



- **Soil is something that complex and heterogonous**

13

Picture: Schema of interaction between third soil phase in density and volume



14

- **Vu = gas volume**
- **Vla= liquid volume**
- **Vp = particle volume (solid)**
- **Vf = pore volume (gas + liquid)**
- **Vt = total volume (Vg+Vl+Vs)**
- **Mu = gas density (rate 0)**
- **Ma = liquid density**
- **Mp = solid density (soil particle)**
- **Mt = total density (Mg+Ml+Ms)**

15

Soil Particle Density (ρ_p)

- **Particle Density (ρ_p), is solid density divided solid volume from soil**

$$\rho_p = \frac{Mp}{Vp} ..... \quad g.cm^{-3}$$

- **PD : 2,6 – 2,7 g.cm^{-3}, if OM content increases, PD decreases**

16

Bulk Density (ρ_b)

- Is solid (particle) density or called dry soil density divided total volume, including particle volume and pore volume
- ρb smaller than ρp, loam soil: 1,1 g.cm^{-3} and sandy soil: 1,6 g.cm^{-3}
- Soil structure influences bulk density

17

$$\rho_b = \frac{Mp}{Vp + Vu + Va}\, g.cm^{-3}$$

Factors that influence Bulk Density (ρ_b) :

1. Soil tillage
2. Compaction
3. Texture
4. Structure
5. Water content

- This is used for calculation : irigation needs, fertilizing, soil tillage etc

19

Soil Porosity

In soil, there are space between particles, commonly called soil pores

Soil pores are generally partly filled with water and partially filled with gas

Water availability, air for the plants and water moving in the soil have related with number and size of soil pores

20

- **Jumlah dan komposisi ruang pori dalam tanah berbeda-beda dari suatu tempat dengan tempat lainnya.**
- **Demikian pula akan berbeda antara satu horizon dengan horizon lainnya.**
- **Jumlah dan komposisi ruang pori tanah dipengaruhi oleh tekstur dan struktur tanah.**

21

Soil Porosity (n)

$$n = \frac{Vu + Va}{Vp + Vu + Va} = \frac{Vf}{Vt}$$

or

$$n = \left(1{,}0 - \frac{\text{Bulk Density } (\rho_b)}{\text{Particle Density } (\rho_p)}\right) \text{X } 100\%$$

Pore Size distribution

According to the total size of the pore space consists of:

1. Capillary pore, can hold water and its movement by capillary forces
2. Non-capillary pore, water within the pore space is movable as a percolation of water called drainage pore

TASK

1. If Bulk Density = 1,1 gr/cm3, soil depth = 20 cm. How much weight the land area of 1 hectare?
2. If Particle Density = 2,5 gr/cm3, how much is total porosity?
3. If a experiment about influence of urea fertilizer on chili yield needed 10 kg/pot (BD = 1,1 gr/cm3). Urea dose is 200 kg/ha. How many grams of urea fertilizer requirements for each pot?

Note: no 1, 2 and 3 are related

Any Question?

See You Next Class

Insya Allah