AGS 2110

Lecture Notes 1

1. **Definition & Concepts of Soil**

Soil Science: also known as Pedology
Science: The study of the laws of nature
Layman's definition of Soil: The loose surface of the earth in which plants grow

In the early days soil was defined as the uppermost loose layer of the earth suitable for plant growth.

Raman in 1917 defined soil as the uppermost layer of the solid crust of the earth; it consists of rocks that have been reduced to small fragments and have been more or less changed chemically, together with the remains of plants and animals that live on it and us it. This definition does not distinguish between soil and loose rock material. It does not limit the depth of the soil. It also fails to bring out the inherent characteristics of the soil as an independent body in nature.

Hilgard (1892) defined soil as: The more or less loose and friable material in which plants may or do find a foothold and nourishment as well as other conditions of growth. This is purely an agronomic and plant physiological definition.

Western European soil scientists defined soil as a mixture of pulverized solid particles, water, air which may serve as a carrier of available plant food materials for growth.

All these definitions advance the concept that soil is simply a medium for plant growth.

Dokuchaev (1887) and his students gave a better definition of soil. He stated that soil is the surface and adjoining horizons of parent material which have undergone more or less a natural change under the influence of water, air, various species of microorganisms-living or dead; this change is reflected to a certain degree in the composition, structure and color of the products of weathering. This definition excludes the soil from the geological system of mantle rock and gives it an independent status. It designates the soil body in terms of soil forming processes instead of soil body characteristics which are a result of these processes.

Marbut made a definite step forward in defining soil in terms of soil characteristics instead of soil forming processes. Marbut definition: Soil is a natural body of mineral

and organic material differentiated into horizons of variable depth which differ from the material below in morphology, chemical, physical and biological properties and composition. This was revolutionary concept important in soil science ie recognition of soil as a natural body comprising mineral and organic constituents.

Vernadski defines a natural body as any object in nature which attains the status of individuality, endowed with a independent existence, capable of being distinguished and isolated from its environment, with an internal constitution and controlled by specific laws of nature.

This means that any individual soil is a 3-dimentional body with recognizable boundaries. The earth's surface is the soil's upper boundary. The depth to which the biological activity and weathering occurs approximates the lower boundary. And laterally it is bounded by other soils which possess different properties. Thus, it can be seen that an individual soil body will occupy a certain definite section of the landscape.

Soil Profile

A1 horizon
A2 horizon
B2 horizon
B3 horizon
C horizon
Parent material

2. History of soil science: A world perspective

The word "soil" is derived from the Latin word "Solum" which means floor or ground. With the beginning of agriculture about 10,000 years ago mankind came to view the soil as a medium of plant growth. The oldest classification of soil is believed to have developed in China 4,000 to 5,000 years ago. It was based on the ability of the soil to produce crops. This concept of soil is still of basic value today.

About 2,400 years ago, soil was considered as one of the four basic components of all matter along with fire, water and air. As knowledge of soils increased, people became more aware of the components making up the soil.

In this respect, soil is considered to be a 3-phase system consisting of solids, liquids and gases. In most soils the solid phase consists of mineral particles that form a skeletal framework on to which humus and organic particles are adsorbed. Pore space exists between the particles of the solid phase. The pore space is jointly filled with the liquid and gas phases. The liquid phase is mainly water from rainfall which exists as films surrounding particles of the solid phase and occupies the smaller pore spaces. The larger pore spaces are filled with gases unless if the soil is saturated with water.

In the 19^{th} century around 1870, Dokuchaev; a Russian scientist who is widely considered as the father of soil science observed many different soils and recognized for the first time that soil is a natural body made up of several layers (horizons). Dokuchaev saw each kind of soil was the result of a combination of climate, vegetation, parent material and age. The soil was the product of evolution and changed over time.

As an independent science-Soil science or pedology originates from Russia led by Dokuchaev (1887) and his students. Dokuchaev is internationally recognized as the father of soil science. However, World War I and the subsequent revolution in Russia restricted the movement of this knowledge to Western Europe.

Classification of soils developed in Russia around 1888 and was based on factors of soil formation, processes of soil formation and properties.

Soil genesis was the principle basis of the soil classification system in Russia.

Marbut was the first in USA to appreciate the far reaching possibilities in the study of soils as presented by Dokuchaev after he became acquated with the view of Glinka-the most prominent student of Dokuchaev.

The Russians made it known the principles applied in natural sciences, such as zoology and Botany are applicable to soil science. The soil is viewed as a distinct organism with definite morphology and physiological features with specific physical, chemical and biological properties in its various parts.

The Russians later developed a system of classification of soils which was based on major soil forming factors, processes and properties. Soil genesis was the principle basis of the soil classification system in Russia.

In the United States, Hilgard (1892) emphasized the relationship between soil and climate which was known as the climatic zone concept. Between 1912 and 1960, the soil classification system in The USA used generic approach. Hilgard is recognized for the development of soil genesis & classification system in the USA. He emphasized the relationship between soil and climate which was known as the climate zone concept. From 1912 and 1960, the soil classification system in the USA used a generic approach. Generic means: Grouping soils into classes of similar characteristics.

In 1959, Simonson stressed that many generic processes are simultaneously and sequentially active in any soil.

It was generally accepted that soil genesis is very important for soil classification but cannot alone be used as a basis for soil classification because generic processes can rarely be quantified or observed in the field.

The current situation is that the wealth of knowledge about soils which has evolved since the 19th century to now has culminated into the development of soil classification systems around the world.

3. History of soil science in Zambia

- Pre-independence era- The work of Trapnell
- Post-independence era: The work of the Soil Survey Unit under Norad support 1975-1980s
- Current situation

The most recognized and widely used systems of soil classification in the world including Zambia are:

1. USDA 2014: Keys to Soil Taxonomy
2. World Reference Base for Soil Resources 2014 (FAO): International Soil Classification System for naming soils and creating legends for soil maps.

Scientific definition of soil: A 3-dimentional natural body differentiated into horizons which differ among themselves in their morphological, chemical, physical and biological properties.

3. Soil science and man's evolution

Soil is the foundation of human existence

Man gradually acquired knowledge of soils and plants as a result of the struggle for survival.

Medicine is as a consequence one of the early disciplines of science

Similarly Botany: the study of plants is also one of the early disciplines of science because plants provide ingredients for formulating medicines.

From the time man transformed from nomadic way of life to settlements, he had been confronted with soil problems. As his food needs increased land became exhausted and yields started to decline.

As there was enough land, there was no pressing need to soil studies.

However, as population increased, land had to be managed to produce more food and scientific investigation of soils became increasingly important.

Systems of soil management have developed all through recorded human history. Such systems include:

- Fallowing the land
- Use of legumes in farming
- Growing improved pastures
- Involving crop rotations in farming
- Alley cropping
- Conservation farming