STUDY MATERIAL

VIVEKANANDA COLLEGE

THAKURPUKUR

ENVIRONMENTAL SCIENCE

Topic: Soil Order Classification

Dr. Sakuntala Chakrabarti

Dept. of Environmental Science

Soil Orders

USDA (United States Department of Agriculture) and National Cooperative Soil Survey dept. of United States provides a system of Soil Taxonomy or the classification of Soil Order. The classification was originally developed by Guy Donald Smith, former director of the U. S. Department of Agriculture's soil survey investigation. All of the soils in the world can be assigned to one of just 12 orders (Table 1). These Soil orders are frequently defined by a single dominant characteristic affecting soils in that location, e.g., the prevalent vegetation (Alfisols, Mollisols), the type of parent material (Andisols, Vertisols), or the climate variables such as lack of precipitation (Aridisols) or the presence of permafrost (Gelisols). Also significant in several soil orders is the amount of physical and chemical weathering present (Oxisols, Ultisols), and/or the relative amount of Soil Profile development that has taken place (Entisols). The 12 soil orders are Entisols, Inceptisols, Andisols, Mollisols, Alfisols, Spodosols, Ultisols, Oxisols, Gelisols, Histosols, Aridisols, and Vertisols.

Table 1 - Soil Orders and General Descriptions

Soil order	characteristics	Soil order	characteristics
Entisols	Little, if any horizon development	Inceptisols	Beginning of horizon development
Aridisols	Soils located in arid climates	Mollisols	Soft, grassland soils
Alfisols	Deciduous forest soils	Spodosols	Acidic, coniferous forest soils
Ultisols	Extensively weathered soils	Oxisols	Extremely weathered, tropical soils
Gelisols	Soils containing permafrost	Histosols	Soils formed in organic material
Andisols	Soil formed in volcanic material	Vertisols	Shrinking and swelling clay soils

Name and Important Properties of soil orders

Alfisols -Mineral soils relatively low in organic matter with relatively high base saturation. Contains horizon of illuvial clay (clay minerals deposited from one soil horizon to another by rain water etc). Moisture is available for plant crop. Must have argillic, natric, or kandic horizon; High-to-medium base saturation; Moderately weathered; Commonly form under boreal or broadleaf forests; Rich in iron and aluminum; Commonly in humid areas, semi-tropics, and mediterranean climates. Alfisols generally show extensive profile development, with distinct argillic (clay) accumulations in the subsoil. Extensive leaching often produces a light-colored E horizon below the topsoil. Generally fertile and productive, these soils typically have a high concentration of nutrient cations (Ca, Mg, K, and Na) and form in regions with sufficient moisture for plants for at least part of the year. Natural fertility and productive capacity of Alfisols is considered to be greater than that of Ultisols, but less than that of Mollisols.

Andisol- Form from volcanic ejecta, dominated by allophane (Allophane is an amorphous to poorly crystalline hydrous aluminium silicate clay mineraloid. Must have andic soil properties: high in poorly crystalline Fe and Al minerals, high in Phosphorous, low bulk density, and high proportions of glass and amorphous colloidal materials, such as allophane, imogolite (Imogolite is an aluminium silicate clay mineral with formula: $Al_2SiO_3(OH)_4$. It occurs in soils formed from volcanic ash and ferrihydrite (Ferrihydrite is a widespread hydrous ferric oxyhydroxide mineral at the Earth's surface, $5Fe_2O_3.9H_2O$); High Organic Matter content, sometimes melanic epipedon. Soils form in volcanic ash and cinders near or downwind from volcanic activity. Generally lacking in development, they are not extensively weathered. Usually of high natural fertility, they tend to accumulate organic matter readily and are of low bulk density that is easily tilled. These soils generally have a high productivity potential. Limited geographic distribution.

Aridisols -Mineral soils relatively low in organic matter. Contain developed soil horizons. Moisture is inadequate to mature a crop without irrigation in most years. Dry soil; Ochric epipedon is common; Sometimes argillic or natric horizon; Commonly in deserts; Soils of arid, desert climates. Varied parent materials; Often have accumulations of lime ($CaCO_3$), sodium, or salts. Can be made productive if irrigation water is available. Found extensively in tropical latitudes, rainshadows and arid climates.

Entisols- Mineral soils lacking developed soil horizons. Moisture content varies. Least soil profile development; Ochric epipedon is common; No B horizons; This is a very diverse group of soils with one thing in common, little profile development. Includes the soils of unstable environments, such as floodplains, sand dunes, or those found on steep slopes. Entisols are commonly found at the site of recently deposited materials (e.g., alluvium), or in parent materials resistant to weathering (e.g. sand). Entisol soils also occur in areas where a very dry or cold climate limits soil profile development. Productivity potential of Entisols varies widely, from very productive alluvial soils found on floodplains, to low fertility/productivity soils found on steep slopes or in sandy areas.

Histosols- Soils composed mostly of organic matter. Moisture content varies. Must have histic epipedon; Usually moisture content high; Rapid decomposition when aerated; Peat or bog; >20% organic matter; Organic soil materials extending down to an impermeable layer or with an organic layer that is more than 40 cm thick; Commonly in wetlands (swamps, marshes, etc.); Organic Peat Lands or Boggy soils; Consist of layered organic materials (more than 20% organic materials by mass); Form in cool, wetland environments; Do not contain permafrost. Found mainly in geographically high latitude areas or other marshy wetlands.

Inceptisols -Mineral soils containing some developed horizons other than one of illuvial clay. Moisture is available to mature a crop. Similar to Entisol, but beginning of a B horizon is evident; On landscapes continuously eroded or young deposits; Cambic, sulfuric, calcic, gypsic, petrocalcic, or petrogypsic horizon, or with a mollic, umbric, or histic epipedon, These soils are in the beginning stages of soil profile development. The beginnings of a B horizon may be seen with the accumulation of small amounts of clay, salts, and organic material. These soils show more profile development than Entisols, but have not developed the horizons or properties that characterize other soil orders. Inceptisols are commonly found throughout the world, and are prominent in mountainous regions. The natural productivity of these soils varies widely, and is dependent upon clay and organic matter content, and other edaphic (eg. plant-related) factors.

Mollisols -Mineral soils with thick, dark surface horizons relatively high in organic matter and with high base saturation. Must have mollic epipedon; High base saturation of >50%; Dark soils; Some with argillic or natric horizons; Common in grasslands; Mineral soils developed under grassland vegetation; Thick, dark-colored 'A' horizon, rich in organic matter; Dominant soil order of the North American Great Plains region; Large areas of Mollisols are also found in Eastern Europe, Russia, China, and South America; Generally very fertile for plant growth due to clay and organic matter content; Considered to be very fertile soils. These soils are typically well saturated with basic cations (Ca^{2+}, Mg^{2+}, Na^{+}, and K^{+}) that are essential plant nutrients.

Oxisols- Mineral soils with no weatherable minerals. High in iron and aluminum oxides. Contain no illuvial horizons. Most soil profile development; Must have oxic horizon within 150 cm of soil surface; Low nutrient availability; No argillic horizon; Highly weathered; Dominated by end-member clays, Al and Fe oxides; Commonly in old landscapes in tropics; Form in hot, humid climates with high annual rainfall. Commonly occur in equatorial latitudes. Highly weathered and leached, dominated by iron and aluminum oxides. Low in natural fertility (basic cations, Ca^{2+}, Mg^{2+}, K^{+}) and high in soil acidity (H^{+}, Al^{3+}) Physically stable soils, with low shrink-swell properties.

Spodosols - Soils that contain an illuvial horizon of amorphous aluminum and organic matter, with or without amorphous iron. Usually moist or well leached. Must have spodic horizon within 2 m of soil surface and without andic properties; Usually have albic horizon; High in Fe, Al oxides and humus accumulation; Acidic soils; Common in coniferous or boreal forests; Spodosols commonly form in sandy parent materials under coniferous forest vegetation. As a consequence of their coarse texture, they have a high leaching potential. Spodosols are characterized by high acidity, and have a subsoil accumulation of organic matter, along with aluminum and iron oxides, called a spodic horizon. Typically low in natural fertility (basic cations, Ca^{2+}, Mg^{2+}, and K^{+}) and high in soil acidity (H^{+}, Al^{3+}), Al, Fe oxides, these soils require extensive inputs of lime and fertilizers to be agriculturally productive. Spodosols are most commonly associated with a cool and wet climate. Large areas of Spodosol are found in northern Europe, Russia, and northeastern North America .

Ultisols- mineral soils with an illuvial clay horizon. Has low base saturation. Generally found in humid climates. Must have argillic or kandic horizon; Low base saturation of <35%; Common in subtropical regions; often known as red clay soils; Ultisols are intensely weathered soils of warm and humid climates. They are typically formed on older geologic locations in parent material that is already extensively weathered. Ultisols have accumulated clay minerals in the B horizon. While generally low in natural fertility (basic cations, Ca^{2+}, Mg^{2+}, and K^{+}) and high in soil acidity (H^{+}, Al^{3+}) the clay content of Ultisols gives them a nutrient retention capacity greater than that of Oxisols, but less than Alfisols or Mollisols. Ultisol soils can be agriculturally productive with inputs of lime and fertilizers. Large areas of Ultisol are found in the southeastern USA, China, Indonesia, South America, and equatorial regions of Africa.

Vertisols - Clayey soils with deep wide cracks at some time in most years. Moisture content varies. Usually mollic epipedon; High in shrinking and swelling clays; >30% clay to a depth of 50 cm; Deep cracks form when soil dries; Form from parent material high in clay (e.g., shales, basins, exposed Bt horizons of old soils); Vertisols are soils with a high content of clay minerals that shrink and swell as they change water content. The clay minerals adsorb water and increase in volume (swell) when wet and then shrink as they dry, forming large, deep cracks. Surface materials fall into these cracks and are incorporated into the lower horizons when the soil becomes wet again. As this process is repeated, the soil experiences a mixing of surface materials into the subsoil that promotes a more uniform soil profile. Vertisols are usually very dark in color, with widely variable organic matter content (1 – 6%). They typically form in Ca and Mg rich materials such as limestone, basalt, or in areas of topographic depressions that collect these elements leached from uplands. Vertisols are most commonly formed in warm, subhumid or semi-arid climates, where the natural vegetation is predominantly grass, savanna, open forest, or desert shrub. Large areas of Vertisols are found in Northeastern Africa, India, and Australia , with smaller areas scattered worldwide.

Gelisol- Soils with permafrost (frozen subsoil) within 100 cm or cryoturbation (frost churning) within 100 cm plus permafrost within 200 cm; Commonly at high latitudes and elevations; These soils generally have limited profile development. Most of the soil forming processes in these soils occur near the surface, sometimes resulting in significant accumulation of organic matter. Large areas of this soil occur in the Northern regions of Russia, Canada, and Alaska. These areas become boggy wetlands in the summer, and support large numbers of migratory birds and grazing mammals. The permafrost of Gelisols tends to become unstable (melt) if disturbed, leading to a waterlogged soil condition..