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Healthy soils are fundamental to life on Earth, and this precious resource faces multiple challenges, including soil sealing, over-grazing, and intensive agriculture. Celebrated on 5 December, World Soil Day emphasises the critical role soil plays in supporting diverse ecosystems, mitigating climate change and sustaining human societies. The Copernicus Land Monitoring Service (CLMS) offers a wealth of data to monitor and analyse soil and its impact on our environment. This information is crucial for decision-making, allowing us to better manage and protect this vital natural resource for future generations.Each year on 5 December the international community celebrates World Soil Day. Born out of an official endorsement by the Food and Agriculture Organization of the United Nations in 2013, the day aims to raise awareness about the crucial role of this precious resource.This years theme, Soil and water, a source of life highlights the way the two things come together to form the fundamental basis for nearly every terrestrial ecosystem on the planet.It is hard to imagine, but for most of Earths history, soil as we know it did not exist. Researchers estimate its genesis occurred roughly 500 million years ago, when plants first colonised the land. Since then, its relatively thin layer has come to cover nearly the entire planets land surface.Unfortunately, a host of human activities are directly contributing to a reduction in the health and availability of soil worldwide. Over-grazing of livestock, deforestation, intensive agriculture, and urban sprawl are among the most destructive and most widespread forces.Healthy soil is teeming with lifeIt is not uncommon for people, when thinking about nature, to imagine a forest full of lush greenery, colourful birds, and scurrying mammals. What often goes overlooked is that there is more biodiversity in the ground than above it. To put it in perspective, a single gram of soil can contain more unique species than all mammals combined. Most of these are tiny organisms like bacteria, fungi, protozoa, nematode worms, and small arthropods. However, when you consider larger amounts of soil, you begin to find larger animals like ground beetles, mice, and moles. When people talk about protecting soil, it is ultimately this rich biodiversity they are talking about.Common organisms found in a gram of soil.All these organisms contribute to soil health in their own ways. Some help to break organic matter down into more bioavailable versions of key nutrients, some convert atmospheric nitrogen into a form that plants can use, and others are important for maintaining the very structure of the soil itself. Nutrient-rich soil supports diverse plant life, which in turn supports many herbivores, who then sustain their predators. This intricate web of interactions illustrates the fundamental principle that the health of all terrestrial ecosystems is ultimately reliant upon the health and quality of the soil.Soil and water: inseparable partnersSoil acts as an enormous sponge, absorbing and storing massive amounts of water. On the low end, a cubic metre of sandy soil can store around 100 litres of water while at the high end a cubic metre of rich organic soil can store upwards of 900 litres. In the upper layers, water is necessary for the organisms that live there. When it percolates deep enough, water becomes part of the groundwater system, which can feed into lakes and rivers, and is also a critical source of water for human use.Water is filtered as it travels through the soil by a variety of physical and chemical processes. Particulate matter, such as sediments and organic material, can be physically trapped by soil particles. Microorganisms living in the soil break down organic materialincluding pollutantsinto their constituent parts and can even convert harmful substances like certain pesticides into less harmful ones. Ions in the soil are exchanged with ions in the water in a process which can help remove heavy metals, certain nutrients, and other chemicals from the water. Soil as a carbon sink and climate changeSoil plays a vital role in the global carbon cycle. In fact, soil stores more carbon than the entirety of Earths atmosphere and all its plant life combined. Moreover, healthy soil sequesters and stores carbon better than unhealthy soil.The carbon cycle is the process by which carbon compounds are moves between Earths atmosphere, oceans, soil and living organisms. Disruptions and changes affecting this cycle, such as decreases in carbon sequestration and increases in carbon emissions, have direct impacts on climate change. Given this, tackling climate change entails both decreasing carbon emissions and increasing carbon sequestration and storage. One of the best ways to increase carbon sequestration and storage is to have as much healthy soil on Earths terrestrial surfaces as possible. Healthy soil, plus lots of it, equals less climate warming.What if the soil is sealed off?Soil sealing occurs when humans render surfaces impermeable by covering them with artificial materials such as asphalt or concrete. According to the European Environment Agency, artificial surfaces are the land cover category which has increased the most in recent decades, both in net area and in percent change.Increases in sealed areas (red) in an agricultural area in Germany between 2009 (left) and 2021 (right). The data derived from the Copernicus Land Monitoring Services High Resolution Layer Imperviousness product. Note the 2021 status layer represents unpublished preliminary data. When soil is sealed, the natural processes that sustain their rich biological network are disrupted. Oxygen and water, which are both critical for the survival of soil organisms, simply cannot penetrate the sealed surface. This causes a decline in microbial activity and diversity, which sets off a chain reaction as the effects ripple up the food chain. The loss of soil biodiversity is not just a loss for the organisms that live in the soil but also for the entire ecosystem that depends on it, including us humans.Water that is unable to get into the ground must go somewhere else instead. Usually, this leads to increased runoff, a problem which is especially problematic in urban areas where soil sealing is extensive, as it can overwhelm stormwater systems and result in flooding. And as if flooding were not bad enough on its own, runoff from sealed surfaces often carries pollutants like oils, heavy metals, and other contaminants. Since this water does not pass through the soil, where it would be filtered, these pollutants are often ferried directly into waterways, negatively impacting water quality and aquatic ecosystems.When soil is sealed, it loses its ability to sequester and store carbon. Most population centres around the world have grown larger over time, with the number and extent of impervious surfaces growing in parallel. Even in rare instances where urban expansion is halted, it is rarely reversed. Sealed surfaces tend to stay sealed.Excess runoff flowing along a sealed surface in an urban area (left) and rainwater in the process of being absorbed by unsealed soil after a rainstorm (right).How we can monitor soilCLMS Soil Moisture data products offer users detailed daily updates on soil hydration levels at the global level, whileCORINE Land Cover, High Resolution Layer Imperviousness, and Urban Atlas products can all be used to monitor soil sealing across Europe. The High Resolution Layer Vegetated Land Cover Characteristics product suite will be launched next year, combining several existing vegetation monitoring products with new agricultural datasets, thus opening new avenues for indirect monitoring of soil condition. To learn more about soil and the many services it provides, visit the European Environment Agencys Soil topics page. Share copy and redistribute the material in any medium or format for any purpose, even commercially. Adapt remix, transform, and build upon the material for any purpose, even commercially. The licensor cannot revoke these freedoms as long as you follow the license terms. Attribution You must give appropriate credit , provide a link to the license, and indicate if changes were made . You may do so in any reasonable manner, but not in any way that suggests the licensor endorses you or your use. ShareAlike If you remix, transform, or build upon the material, you must distribute your contributions under the same license as the original. No additional restrictions You may not apply legal terms or technological measures that legally restrict others from doing anything the license permits. You do not have to comply with the license for elements of the material in the public domain or where your use is permitted by an applicable exception or limitation . No warranties are given. The license may not give you all of the permissions necessary for your intended use. For example, other rights such as publicity, privacy, or moral rights may limit how you use the material. Water, air, and soil are three natural resources that we cannot live without. The Forest Service strives to protect, maintain, and restore these valuable assets now and into the future.Water is one of the most important natural resources flowing from forests. The Forest Service manages the largest single source of water in U.S., with about one-fifth originating from 193 million acres of land which provides drinking water to 180 million people every day.Soil provides nutrients, water, oxygen and heat to natural land areas. Understanding the ability and capacity of soil to support an ecosystem plays an important role in land management decisions. Air is a third critical resource for humans, plants, animals and all other organisms within a natural area. Air must be monitored in order to control and lower pollution levels, control smoke caused by wildland fires, and to monitor air quality. The Forest Service monitors the effects of air pollution that may impair visibility, harm human health, injure trees and other plants, acidify or cause unnatural fertilization of streams and lakes, leach nutrients from soils, and degrade cultural resources, like archeological sites and historical buildings. Forest activities that can affect air quality such as prescribed burning, ski areas, and mining are also monitored to ensure compliance with air regulations for human health and to monitor possible impacts to natural resources.What research is being conducted to protect these natural resources?Research on water, air and soil provides scientists with information about these critical natural resources, how they are changing, and what is affecting them. Forest Service Research and Development focuses on the following four focus areas involving water, air and soil:Basic ProcessesThis research focus area strives to understand the basic processes of water, air and soil and how they are affected by many disturbances including fire, drought, invasive species and more.Extreme Event EffectsThis research focus area examines how extreme events, including storms, fire, invasive species, and more, have on the water, air and soil in a natural area. Scientists also look at the effects of these events on watersheds located in the forest or grassland.Watershed Management ToolsThese tools help natural resource managers, planners, and landowners decide how to manage forest and grassland watersheds. Watershed Management Tools can also be used to educate the general public about ways to protect and improve watersheds.Current Research HighlightsEffects of Drought on Forests andRangelands in the United StatesIn simple terms, drought is a lack of water over a given temporal and spatial scale. Drought can be a severe natural disaster with substantial social and economic consequences. Historical and paleoclimatic evidence shows that drought has always impacted the physical environment and will continue to do so. Management actions can either mitigate or exacerbate the effects of drought. As drought regimes change, the ability to quantify and predict the impacts on forests and rangelands is critical to developing and implementing management actions to increase resiliency and adaptation.Nitrogen Deposition Effects in California and the Pacific NorthwestThis research study focuses on proposing strategies that will set limits on power plants, cars, farms and other industrial processes in order to slow down the effects and production of acid rain, algal blooms and mercury. The amount of mercury found in plants and animals is continuing to rise to toxic levels making it extremely dangerous to the infected plant or animal as well as any higher level food chain animals that may eat it. Scientists are proposing these levels based on scientific research they have been conducting involving observation of tree-inhabiting lichens and diatoms, a tiny single-cell algae that is very sensitive to changes in nitrogen levels. B. Rupini Structure 15.0 Objectives 15.1 Introduction 15.2 Definitions of soils 15.3 Composition of soil 15.4 Soil profile 15.5 Properties of soil 15.6 Soil as a resource 15.6.1 Resource for minerals 15.6.2 Resource for water 15.6.3 Resource for fossil fuels 15.6.4 Resource for raw materials 15.6.5 Resource for organic matter 15.6.6 Resource for biological habitat 15.6.7 Resource for archeological materials 15.7 SAQ 15.8 Conclusion 15.9 Key Words 15.10 References and Suggested Further Readings Dear learners this unit mainly focuses on why soil itself is a resource and a source for many other resources to the living community by explaining important concepts of soil. Accordingly the objectives have been framed. 15.0 OBJECTIVES After reading this unit you will be able todefine the soil;understand the composition and profile of the soil; describe the properties of soil; anddiscuss various resources of soil. 15.1 Introduction Soils are limited nonrenewable natural resources. Soils provide a base for food production, water and many ecosystem functions. Healthy soil is important for healthy life on earth. The word SOIL was originated from the Latin Word SOLUM which means FLOOR. The global scientific community recognized the significance of soil and observed International year of soils in 2015. The predicted global population by 2050 raised an alarm to protect the soil and its resources from degradation. The soil is a component of pedosphere existing in the interface between atmosphere and pedosphere. The concept of soil formation is explained by pedology and the influence of soil on plants and human beings is described by edaphology. Learn more Pedology (Derived from Greek word pedon which means soil or earth) is a branch of soil science that deals with soil genesis, classification and mapping where as Edaphology (Derived from Greek word edaphos that means soil or ground. 15.2 Definitions We have learnt in lower classes that the soil is a visible surface of the earth which is loose in structure and formed from rocks and minerals by weathering process. Some of the definitions given by scientists are as followsAccording to Whitney (1892) Soil is a basket of nutrient that supplies all the nutrients for plant growth. According to Hilgard (1892) Soil is more or less a loose and friable material in which plants, by means of their roots, find a foothold for nourishment as well as for other conditions of growth. According to Dokuchaiev (1900) Russian scientist, Father of soil science Soil is a natural body composed of mineral and organic constituents, having a definite genesis and a distinct nature of its own. According to Joffe (1936) Soil is a natural body of mineral and organic constituents differentiated into horizons usually unconsolidated of variable depth which differs among themselves as well as from the underlying parent material in morphology, physical makeup, chemical properties and composition and biological characteristics. According to Jenny (1941) Soil is a naturally occurring body that has been formed due to combined influence of climate and living organisms acting on parent material as conditioned by relief over a period of time.According to Soil Science Society of America (1970) Soil is the unconsolidated mineral matter on the surface of the earth that transformed by eugenic and environmental factors of parent material, climate (including moisture and temperature effects), macro and microorganisms and topography, all affecting over a period of time and producing a product, that is SOIL that differs from the material from which it is derived in many, physical, chemical, biological and morphological properties and characteristics.According to Dr. W.E.H. Blum Soils not only serve for agriculture and forestry, but also for filtering, buffering and transformation activities between the atmosphere and the ground water, protecting the food chain and drinking water against pollution and biodiversity. As soil provides nutrients, water, air and anchorage and supports life on Earth, it can be called as Soul of Infinite Life (SOIL). By observing definitions of different scientific community we can understand that the soils are four dimensional open systems with time and space which connect to the atmosphere, biosphere, hydrosphere and lithosphere that are formed from mineral and organic substances on the earths crust by the effect of various environmental factors administered for long time.15.3 Composition of SoilSoil is a major component of the environment and essential for existence of life on earth. Soil is formed by the process weathering of rocks and by erosion. The soil forming factors and processes which influence the formation of soil is depicted in fig.15.1 Fig-15.1 Soil formation The soil is made up of four major components like minerals (45%), water (25%), air (25%) and organic matter (5%).These will be discussed in detail in the proceeding sections. These components influence the properties of soils. To understand the properties of soil first we will go through the soil profile. 15.4 Soil profile The soil has several layers beneath the earths crust. We will observe several layers in the vertical segment of the soil from the ground surface to parent material arranged in a sequential manner known as a soil profile. The main divisions in natural soil profile are known as horizons named as O, A, B, C & These natural layers or soil horizons are arranged parallel to the earths surface with non-uniform boundaries, different thickness and composition. These horizons provide information to pedologists to classify the soil in a particular location. The brief description of these horizons is here under. Horizon O: The O horizon represents soil layer which contains organic matter combined with minerals and clay. It is subdivided into two types.O1 It comprises of fallen leaves, twigs, lichens, and other decomposed plant and animal material which can be easily recognized. O2 It comprises of putrefied organic material that cannot be recognized.This horizon is observed in forest and wetland soils.Horizon A: It is the top most layer of the soil and contains major portion of the organic matter with significant biological activity and fertile in nature. Because of this reason it is known as the biomantle in which concentrations of all organisms of soil is more and bound to plant roots. This soil layer is suitable for cultivation. This layer is susceptible to leaching as the minerals and other soil constituents dissolve in rain water and percolates down wards. Horizon A is subdivided into A1, A2 & A3 on the basis of their components. A1 It is dark in color due to the presence of more organic matter. It is rich in humus which is a combination of decomposed organic matter, clay and a small portion of mineral content. A2 It is a lower part of the A1 horizon which is exhausted with reference to mineral oxides, clay and iron by leaching activity. Hence it is also known as eluvial horizon. It is rich in quartz and large size minerals.A3 It is an intermediate layer that connects A and B horizon with major characteristics of A1 & A2. Horizon B: The leached material like clay matter, oxides of iron, and aluminum from horizon A transported either by chemical or mechanical process and accumulated in this zone known as illuvial horizon and the soils accumulation is known as Alfisols. The presence of sesquioxides imparts dark red color to this layer. It is subdivided into B1, B2 & B3. B1 It is an intermediate layer between A & B.B2 In this zone accumulation of leached material is at maximum in addition to the formation of sesquioxides in the zone itself. Since the accumulation of different components is high, the color of the zone is darker than other zones. B3 It is an intermediate layer that connects B and C with more similar properties of B2.The horizon A and B are together known as SOLUM. Horizon C: This is the horizon of parent material from which the formation of soil starts. Along with the parent material the other soils from A, B horizons containing carbonates or sulphates, calcium and magnesium translocated by natural process. Those soils have mixed properties of B & C and known as BC horizon. Horizon R: It is the hardest layer in all horizons composed of bed rock by which all above layers are formed. 15.5 Properties of soil: The diverse nature of soil composition and its profile is not uniform on the earths crust. To understand its uses, affects on the environmental habitat, its resources and its health it is necessary to learn the properties of soil. Testing of soil suitability for particular use these properties provides ample information to the pedologists. These properties are governed by parent material, topography and soil formation factors.The properties are grouped under two categories. They are Physical propertiesChemical Properties Physical Properties: Physical properties of the soil mainly deal with the color, soil texture and structure. These properties depend on mineral composition, amount and size of the particles. Dear learner we will discuss about some of the important soil physical properties. They are 1.Color 2.Texture 3.Structure,4.Density,5.Porosity Color: It is an important and basic property to understand the classification of the soil. The change in the color of adjacent soils reveals about whether the soil formed from its parent material assigned as lithochromic or imparts the color in development process known as pedochromic color. Factors that influence the soil colour are presented in table 15.1.Ex: Lithochromic color: Red soil evolved from red sand stone Pedochromic color: Red soil developed from granite stone. Soil texture is a combination of sand, silt and clay particles in relative proportions that can be determined by quantitative analysis. It is a basic property of a soil that cannot be altered in a given sample area and collectively known as soil separates which can be defined by its size. There are several organizations that have established the size limits of these particles and classify the soil types in to different categories. For example :The American system developed by USDA, the English system or British system (BSI),The International system (ISSS) and the European system(table 15.2). When the soils are wet clay soils sense sticky, sand soil sense gritty and the silt sense smooth. The nature of soil separates presented in table 15.3. Soil texture is an important tool to guide for soil management methods and provides the value of the land. It also provides the information about percolation and water holding capacity. Soil Structure: The structure of the soil provides information about the condition of the soil and various activities like movement of quantity of air and water, bacterial activity that occur in a particular soil. Soil structure is defined as the systematic arrangement of primary particles of soil like sand, clay & silt and secondary particles like group of primary particles combined to form granules or aggregate particles is known as soil structure. The primary soil particles are solids and the secondary particles are porous, spongy and are not solids. Majority of soils are combination of individual single particles and aggregate particles. Primary soil particles are structure less in nature where as secondary particles are granulated structure. The aggregates or secondary soil particles are formed by the joining of individual primary particles with colloids of hydroxides of aluminium, oxides of iron, clay and decomposed organic matter by dehydration process under pressure.Significance: Soil structure plays important role in water infiltration, aeration, bearing moisture, fertility and also to resist the erosion. Density: The density of the soil is defined with reference to the solid particles is the weight per unit volume of the solid portion of soil is called particle density or true density. The bulk density of the soil is defined with reference to dry soil is the weight of dry soil per total unit volume. This total unit volume is the combination of solids and pores that contains air and water. The particle density of the soil may vary on the basis of the presence of the constituents. High density is observed in soils containing heavy minerals and decrease in soil density observed in soils with more organic matter. The bulk density decreases with increase in the fine texture of minerals in the soil. The bulk density provides the information about the porosity of the soil and useful to understand and estimate the physical behavior of the soil. Porosity: Porosity is the space between the primary particles and between or within the aggregates which will be filled with air and water. The larger pores are termed as macropores or non-capillary pores (> .05mm) and smaller pores are known as micropores or capillary pores (< .05mm). The soil air is inversely proportional to the soil water since water displaces air in the soil. The size of the pore space is depends on soil texture, soil structure and vegetation. Air movement and water percolation is high in the presence of macropores and low in case of micropores. Chemical Properties: pH: pH is the number of hydrogen ion concentration or the number of hydroxyl ion concentrations which is a measure of acidity and alkalinity of a particular compound. When the hydrogen ion concentration is more the soil is acidic. If the hydroxyl ion concentration is more the soil is basic or alkaline. A logarithmic pH scale ranges from 0-14 is used to measure it. The pH >7 indicates alkaline and the pH Ca > Mg > NH4 > K > NaAnion exchange is OH>H2PO4>SO4> NO3>ClSignificance: i.This is the only process for plants to take up the nutrients from the soil. It provides the information about the soil fertilityIt provides the information about availability of nutrients and need of the fertilizers.15.6 Soil as a resource: Soil is a non-renewable resource for land use, agricultural productivity and ecological services. In this chapter we are going to discuss about some important soil resources. 15.6.1 Resource for mineral: So far we have learnt that the major part of the soil composition is by minerals. Now we will discuss about the mineral resource in detail. Minerals are crystalline natural inorganic constituents of rocks with uniform chemical properties. The minerals are the product of the solidified liquefied magma. The fundamental unit in the mineral is silica (SiO2), since the high abundance of oxygen and silica on earth. The classification of minerals can be studied on the basis of their composition and crystal structure. They areSilicate mineralsNon-silicate minerals Silicate minerals: Silicate minerals are rock-forming minerals and consist of silicon and oxygen atoms bonded by tetrahedral geometry. The basic atomic structure of silicate mineral is [SiO4]4- and the silicon atom is placed at the centre of the tetrahedron and the four corners are occupied by oxygen atoms. The remaining negative charges on the tetrahedron are balanced by suitable cations like sodium (Na+), potassium (K+), magnesium (Mg2+), iron (Fe2+) aluminium (Al3+) and water molecules or with other oxygen atoms of another silicate unit to get the stability. The silicate minerals are subdivided into six groups on the basis of their structure and bonding of oxygen and silicon (table 15.4). Ortho/Neosilicate: These minerals are formed of either Mg or Fe cations. These are also described as Ferro magnesium minerals. Their color varies from dark brown, black and green due to the presence of Iron and Magnesium. The examples of Ferro magnesium minerals are Olivine, Pyroxene and Amphibole. These are categorized under different groups because of their structural differences. Olivine has a single tetrahedral structure in Ortho/Neo silicate structural group. Pyroxene and Amphibole are grouped under chain structural group. Pyroxene has single chained structure in which two oxygen atoms shared in individual tetrahedron. Amphibole has double chain structure in which more than two oxygen atoms contribute to their structure. Augite is an important mineral found in soils and basic rocks as well under Pyroxene group which are basic in nature. The Amphibole minerals are found in acidic rocks. Sorosilicate: These silicate minerals have double silicate tetrahedron structure that is linked by single oxygen atom. Epidote has the complex structure consists of chains of aluminium oxide tetrahedrons connected by single or double silicate tetrahedrons and generally exist in hour-glass shape. They are rare minerals with 2:7 silicon-oxygen ratio with chemical formula Ca2 (Al, Fe) Al2O (SiO4) (Si2O7) (OH). Cyclosilicate: These mineral tetrahedrons are connected in ring structures with 1:3 silicon-oxygen ratios. The important cyclo -minerals are beryl and tourmaline with chemical formulas (Be3Al2Si6O18) & NaFe2+3Al6 Si6O18 (BO3)3(OH) 4 Phyllosilicate: Silicate clays are important class under phyllosilicates which have (phyllon-leaf like structure) leaf like or sheet or layer like structure. Examples are Clay silicates. These clay silicates are formed by either alteration or weathering process of various mineral rocks. These are two types of cay silicates-silica tetrahedron and aluminium or magnesium octahedron that are arranged in horizontal manner. Both the silicate sheets are held together by sharing oxygen atomswithin the crystal structure. Depends on the arrangement of tetra and octahedral sheets they are classified in to 1:1type, 2:1 type and 2:1:1 or 2:2 type clay minerals. Clay minerals are extensively used in manufacture of ceramics and in construction.(Table 15.5).3-dimensional silicate minerals: Feldspar and quartz belong to tectosilicates that have three dimensional tetrahedral structures. Feldspars: The gaps of the tetrahedrons are filled by K+,Na+,Ca2+ or Al3+.Potassium feldspar also known as orthoclase, sodium feldspar known as albite and calcium feldspar anorthite are the important types which are rarely found in rocks. There are series of silicates observed in between albite and anorthite known as plagioclases. Feldspars are used in ceramic making. Quartz: It is the best known mineral of the silicate. It occupies 12% of the lithosphere by composition. The general formula and the simplest of all silicate minerals are SiO2.It is very hard and weathering resistant than their layer counterparts. The modified quartz is cristobalite, opal, tridimite.The pure quartz is used in the glass manufacture and in construction. Non-silicate minerals: Non silicate minerals are mostly recognized by their respective anions. Examples of carbonate minerals are calcite, that is calcium carbonate (CaCO3), dolomite, that is calcium magnesium carbonate (Ca Mg (CO3)2).The important and widely used sulphate mineral is gypsum CaSO4.2H2O.It is also known as plaster of paris used in plasters making. Minerals also available as sulfides like Pyrite (FeS2) is known mineral which is called fools gold due to its metallic golden color. Other examples are PbS and ZnS that are important sources of lead and zinc. Hematite (Fe2O3) & Magnetite (Fe3O4) are common iron ores. Halite, sylvite and Fluorite are the examples of halide mineral 15.6.2 Resource for water: One third of earths surface is covered with water in various bodies. Out of it 30% is ground water which includes soil moisture and wetlands. Now we will discuss different types of soil water in detail. The free water which found in large soil pores drained rapidly by gravitational force and is not available to plants and reduces the oxygen supply is known as gravitational water. The water in capillary soil pores which held by cohesion and adhesion forces against gravitational pull that is available for plants is known as capillary water. Some of the soil water found in the form of vapor on the surface of soil colloid particles is known as hygroscopic water. Significance: Soil water is responsible for plant growth and acts as solvent medium for transportation of plant nutrients. It regulates the soil temperature and assists the biochemical activities of the soil. 15.6.3 Resource for fossil fuels: Fossil fuels are energy sources like solid fuels (coal), natural gas and oil that are formed by the buried decayed organic material from plants and animals which were converted by physicochemical processes(anaerobic decomposition) over millions of years. Natural coal is considered as sedimentary rock which is formed in swamp soils. The anthracite is a harder form of the coal that is transformed at high temperature and pressure which is considered as metamorphic rock. It is composed mainly of carbon and other elements like oxygen, hydrogen, nitrogen and sulfur. Natural gas is a gaseous hydrocarbon mixture mainly contains methane and trace amounts of CO2, N2, H2S and He. The crude oil is a mixture of liquid hydrocarbons and sulfur compounds present in micropores of sedimentary rock. Bituminous and oil shales are other fossil fuels under the soil. 15.6.4 Resource for raw material: Soil is a main source for raw materials that are used in modern appliance manufacturing. For construction of brick walled houses requires clay and plinthite as a raw material for making bricks. Clay and loamy soils used for plastering, sand and gravel used to concrete by mixing with cement. Tin, asbestos concrete are used in construction of roof is obtained from soil. Pisolithic gravel is used for road construction. Rocky soil is used in final coating of dam walls. Raw material like soda lime and quartz are used to make glass window panes ad doors. The daily usage products like tooth paste, body creams & lotions and talcum powder requires clay minerals. Cooking gas, fuels are also the examples of the soil raw materials. In this way the life of the human community is highly depend on the raw materials acquired from the soil. 15.6.5 Resource for organic matter: Soil organic matter mainly composed of living soil organisms, decomposed plant and animal material that transformed into new organic substances and humus. It occupies 1-5% of solid portion of the soil and plays a major role in its structure and physico chemical and morphological properties. It is the main source of soil nitrogen and other nutrients like sulfur and phosphorous. It is an important source of energy for microorganisms. It controls the nutrient cycling, provides food for soil organisms. Soils with high organic matter have more water holding capacity with decrease in leaching of nutrients and erosion than the low organic matter containing soils. Along with the organic matter humus helps in adsorbing nutrients and water that available for plants and also to improve the soil structure. 15.6.6 Resource for biological habitat: Physico chemical process of soil was affected by the number of microbes and vertebrates present in the soil. They directly influence the soil fertility. Soil animals like mice and mile burrow the soil and redistribute the material of the soil from deeper layers to the surface. Earthworms, termites and ants also burrow and provide soil nutrients. Fungi help in decomposition of organic material and the formation of humus. Microbes like bacteria, algae, nematodes actinomycetes provides a gene pool in which actinomycetes provides earthy aroma when its rain and contains antibiotics for human consumption. The other antibiotics isolated from the gene pool are glycopeptides, tetracycline and cephalosporin. These microbes also help in developing the genetically modified crops. Rhizobium, nitrogen fixing bacteria in legumes and cyanobacteria or actinomycetes in non-leguminous plants is useful in nitrogen fixation. 15.6.7 Resource for archeological materials Soil is a natural physical and cultural heritage in terms of human revolution by storing archaeological remains. Soil properties are important in deciding the buried objects. Wooden objects decay due to the organic nature of the soil but can sustain in dry environment or under water. Metal objects like weapons, ornaments and coins sustain for a longer periods under aerated environment. Acid soils vigorously decompose iron artifacts. Objects like ceramics, pottery and glass sustain in all soil types. Fossils under the layers of soil provide the information about climate, agriculture and cultural variation of that particular region and time. The archeological evidences like bones, tools, metal sculptures and remains of pottery, utensils under the soil indicates about the environmental quality, paleontological characters of human civilization and soil age as well. These evidences provide the information to understand the culture of human civilization. For example, the existence of Indus Valley Civilization is evident at Mohenjo-Daro and Harappa by excavations. 15.8 Conclusion Soil is an important non replenishable natural resource which provides life support, food production, recycling of essential nutrients on earth. Soil profile and soil structure shows the soils ability of self purification and neutralization. It is an interface between atmosphere and lithosphere that connects various organic, inorganic and biotic components. Soil is an important natural resource for minerals, organic matter, and raw material for industries that provides a flow of ecosystem services which are key factors to support human life and economic well-being. It is the human responsibility to conserve the soil in order to pass on to the next generation for their food, fodder and fuel security. 15.10 References and Suggested Further Readings Brady, N and Weil, R 1999, The nature and properties of soils, 12th Edition, Prentice-Hall Inc, Sydney.Fertilizer Industry Federation of Australia Inc. and CSIRO, 2006, Australian Soil Fertility Manual, CSIRO publishing and FIFA, Collingwood.Hans, J 1980, The Soil Resource Origin and Behaviour, Springer-Verlag, New York, pg. 10.McDonald, R, Isbell, R, Speight, J, Walker, J and Hopkins, M 1998, Australian soil and landsurvey field handbook, 2nd ed. CSIRO, Canberra.Twenhofel. 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Explore our latest gallery of EditorsPicks.Browse Editors' FavoritesHow can financial brands set themselves apart through visual storytelling? Our experts explainhow.Learn MoreThe Motorsport Images Collections captures events from 1895 to todays most recentcoverage.Discover The CollectionCurated, compelling, and worth your time. Explore our latest gallery of EditorsPicks.Browse Editors' Favorites The Earths natural resources play a vital role in sustaining life and maintaining ecological balance. Among these resources, land, soil, water, natural vegetation, and wildlife are crucial components that contribute to the overall well-being of our planet. In this comprehensive article, we will explore the significance of each of these elements, discuss land use, address the conservation of land resources, and delve into the intricate details of soil composition. Lets embark on a journey through the heart of our planets ecosystems.Land is a fundamental natural resource that encompasses vast terrains, from mountains to plains, forests to deserts. The usage of land varies across different regions and is essential for human habitation, agriculture, and industrial activities.Land use patterns have a direct impact on the environment. Sustainable land management is crucial to ensure the longevity of ecosystems.Soil, often referred to as the skin of the Earth, is a complex mixture of minerals, organic matter, water, and air. It serves as a foundation for plant growth, providing essential nutrients.List of Points:Soil Erosion Prevention Techniques:Contour Plowing Cover Cropping TerracingImportance of Soil Conservation:Maintaining Agricultural Productivity Preventing Nutrient Depletion Protecting Water QualityTable 2: Soil Types and CharacteristicsSoil TypeCompositionIdeal UseSandy SoilDrains quickly, low fertilitySuitable for certain cropsClayey SoilRetains water, high fertilityIdeal for moisture-loving plantsLoamy SoilBalanced drainage and fertilityExcellent for most cropsWater is a precious resource that sustains all forms of life on Earth. Its availability and quality are crucial factors that impact ecosystems and human societies.Table 3: Global Water DistributionWater SourcePercentage of Total WaterOceans97.5%Freshwater2.5%Ice Caps/Glaciers1.75%Groundwater0.69%Surface Water0.009%The sustainable use of water resources is essential to ensure a balance between human needs and the preservation of aquatic ecosystems.Natural vegetation, comprising plants and trees, plays a crucial role in maintaining ecological balance. It contributes to oxygen production, carbon sequestration, and habitat provision for diverse wildlife.List of Points:Oxygen Production Biodiversity Conservation Carbon Sink FunctionDeforestation and Its Impact:Loss of Biodiversity Climate Change Consequences Soil ErosionTable 4: Major Types of Natural VegetationVegetation TypeCharacteristicsGeographical DistributionTropical RainforestsHigh rainfall, rich biodiversityEquatorial regionsTemperate ForestsModerate climate, deciduous treesNorth America, EuropeGrasslandsDominated by grasses, varying climatesAfrica, North AmericaWildlife, comprising animals and other living organisms, forms an integral part of ecosystems. Conservation efforts are crucial to safeguard biodiversity and maintain a healthy balance.List of Points:Habitat Destruction Pollution Climate ChangeProtected Areas Wildlife Sanctuaries Sustainable PracticesTable 5: Endangered Species and Conservation StatusSpeciesConservation StatusThreatsBengal TigerEndangeredHabitat Loss, PoachingGiant PandaVulnerableHabitat DestructionAfrican ElephantVulnerablePoaching, Human-Wildlife ConflictIn conclusion, the interplay between land, soil, water, natural vegetation, and wildlife resources is crucial for the sustainability of our planet. Human activities, while providing essential resources, also pose threats to these delicate ecosystems. It is imperative to adopt responsible land use practices, prioritize soil conservation, ensure sustainable water management, protect natural vegetation, and actively engage in wildlife conservation efforts.Why is soil conservation important?Soil conservation is vital to prevent soil erosion, maintain fertility, and sustain agricultural productivity. It also helps in protecting water quality.How does deforestation affect natural vegetation?Deforestation leads to the loss of natural vegetation, disrupting ecosystems, causing habitat loss, and contributing to climate change.What are the major threats to wildlife?Wildlife faces threats such as habitat destruction, pollution, climate change, and illegal activities like poaching.How can individuals contribute to the conservation of land resources?Individuals can contribute by practicing sustainable agriculture, reducing waste, and supporting conservation initiatives.Why is water conservation essential?Water conservation is crucial to ensure a sustainable and equitable supply of freshwater, protect aquatic ecosystems, and mitigate the impacts of drought. Water is essential in soil ecosystems, influencing plant growth, nutrient cycling, and overall soil health. It affects various physical, chemical, and biological processes critical for maintaining soil fertility and sustainability.Molecular Interactions With Soil ParticlesWater molecules interact intricately with soil particles, forming hydrogen bonds with charged surfaces like clay and organic matter. This interaction is crucial for moisture and nutrient retention. The electrostatic attraction between water and negatively charged clay particles creates a thin film of water that adheres to the soil surface, maintaining moisture levels.Cations such as calcium, magnesium, and potassium enhance the soils capacity to retain water by bridging soil particles and water molecules. This cation exchange process affects soil fertility and nutrient supply to plants. Factors like soil pH, organic matter content, and mineral composition influence these interactions, determining water retention and release.Soil structure results from these interactions, with particles aggregating into larger structures, or peds, through the binding action of water and organic compounds. This porous network facilitates water and air movement, essential for root growth and microbial activity. The stability of aggregates depends on clay type, organic matter, and polyvalent cations, crucial for preventing erosion and maintaining a healthy root environment.Water-Holding Capacity And RetentionSoils water-holding capacity depends on texture, organic matter, and mineral composition. Its not just about how much water soil can hold but also how effectively it retains it against gravity and evaporation. Soil texture, determined by sand, silt, and clay proportions, is vital. Clay soils have a higher capacity due to their small particle size and large surface area, while sandy soils drain quickly.Organic matter, like decomposed plant and animal residues, acts like a sponge, absorbing and holding water. It enhances soil structure by promoting aggregate formation, increasing pore space, and improving water retention. Soils rich in organic matter can hold significant water, supporting plant growth even in arid conditions. Organic matter also improves fertility by providing nutrients and enhancing microbial activity.The mineral composition, especially clay minerals, affects water retention. Different clays have varying shrink-swell capacities. Smectite clays, for instance, absorb significant water and expand, increasing water-holding capacity. This property maintains moisture during dry periods but can challenge plant roots and infrastructure due to soil swelling and shrinking.Nutrient Dissolution And MobilityWater acts as a solvent for soil nutrients, facilitating their dissolution and mobility. Plants can only absorb dissolved nutrients, making this process essential. Nutrient solubility depends on soil pH, other ions, and temperature. For example, phosphorus is more soluble in slightly acidic soils, while calcium and magnesium dissolve better in alkaline conditions. Nutrient dissolution fluctuates with soil moisture, temperature, and biological activity, creating a dynamic environment for availability.Once dissolved, nutrients move through soil with water. This mobility depends on soil texture and structure, affecting water and nutrient percolation rates. Sandy soils may cause nutrients to leach quickly beyond plant roots, while clay-rich soils may retain nutrients near the surface. Balancing these extremes is crucial for optimal plant growth and soil health. Effective irrigation and drainage help manage this balance, keeping nutrients in the root zone for plant uptake.Soil microorganisms enhance nutrient availability by decomposing organic matter, releasing essential nutrients. Nitrogen-fixing bacteria convert atmospheric nitrogen into ammonia, enriching soil with nitrogen compounds. Mycorrhizal fungi extend plant root reach, enhancing phosphorus and nutrient uptake.Microbial Life And Soil FaunaWater in soil creates a habitat for microorganisms and soil fauna, maintaining soil health and fertility. Microbial populations, including bacteria and fungi, respond to soil moisture levels. Bacteria dominate in moist conditions, decomposing organic matter and releasing nutrients like nitrogen and phosphorus. Fungi, especially mycorrhizal fungi, form symbiotic relationships with plant roots, enhancing water and n