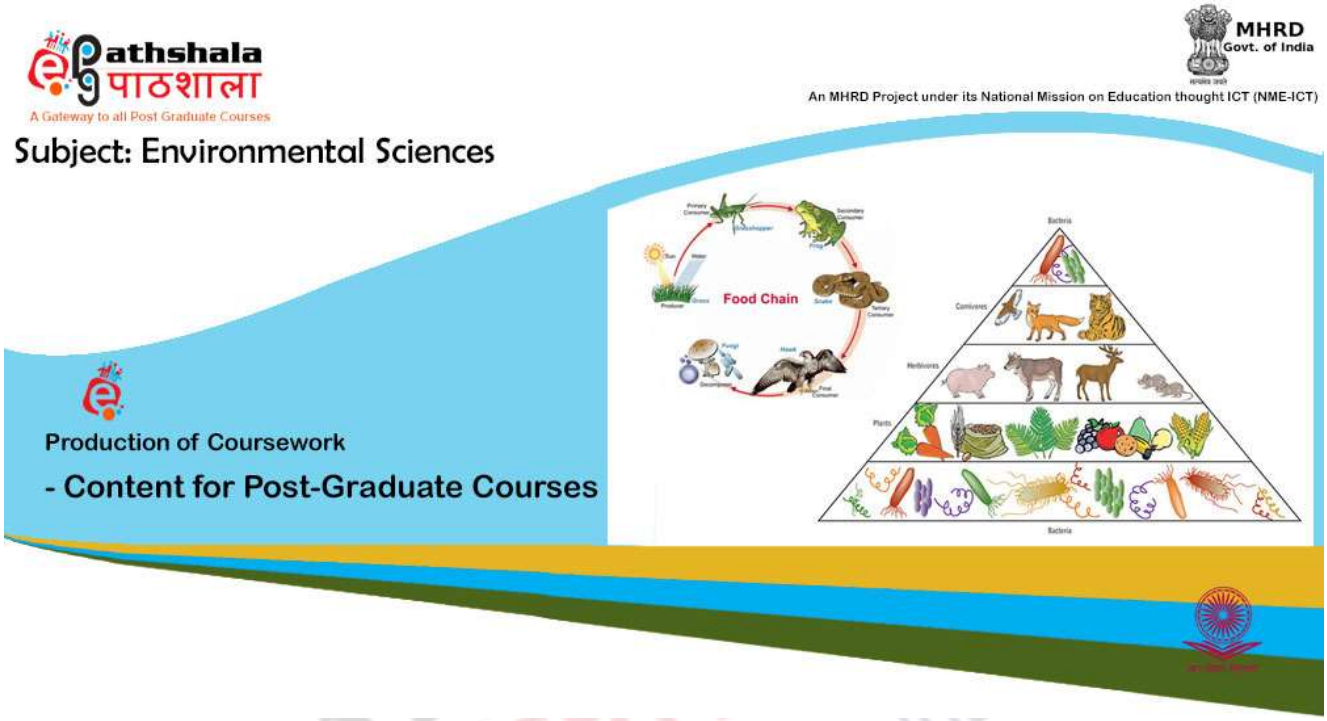

Paper No: 01 Ecosystem Structures & Functions

Module 24: Types of Ecosystem

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Description of Module	
Subject Name	**Environmental Sciences**
Paper Name	Ecosystem Structures & Functions
Module Name/Title	Types of Ecosystem
Module Id	EVS/ESF-I/24
Pre-requisites	
Objectives	To study the about Different Types of Ecosystem
Keywords	Ecosystem , Terrestrial Ecosystem, Aquatic Ecosystem, Forests, Grasslands, Deserts, Marine Ecosystem, Freshwater Ecosystem, Lentic Ecosystems, Lotic Ecosystems.

Module 24: Types of Ecosystems

Objectives:

1. Basic classification of ecosystems.
2. Brief introduction to different types of terrestrial and aquatic ecosystems including their location, climate, flora, fauna and other physical characteristics.
3. A brief overview to the threats imposed to these ecosystems.

24.1 Introduction

The biosphere is an intricate net of carefully mixed life forms. Complex interactions of many macro and microscopic species of plants and animals, together with the rich arrays of symbiotic fungi and lichens, are the base of every ecosystem, from forests to coral reefs and freshwater to soils. All ecosystems are not only sources of rich biodiversity, but also extremely productive areas, offering a lot of benefits to mankind. Ecosystem structure includes the spatial distribution of species, their architecture (size, shape, and pattern), organisation into communities or guilds, ecodiversity (multiple indices), seasonal and long term patterns, relationship to soil and climate characteristics and many other factors. Ecosystem function can be much harder to study and involves questions of nutrient cycling, productivity, decomposition, energy flow, water cycles, food webs, reproduction, predation, demographics (increasers and decresers), resilience, stability, and many other dynamic processes. All types of ecosystems fall into one of two categories: terrestrial or aquatic. Terrestrial ecosystems are land based, while aquatic are water based (Figure 1).

24.2 Terrestrial Ecosystems

The distribution of terrestrial ecosystems is primarily related to precipitation and temperature. Terrestrial ecosystems can be divided, mainly on the basis of the prevailing vegetation type, into three basic categories: forest, grassland and desert.

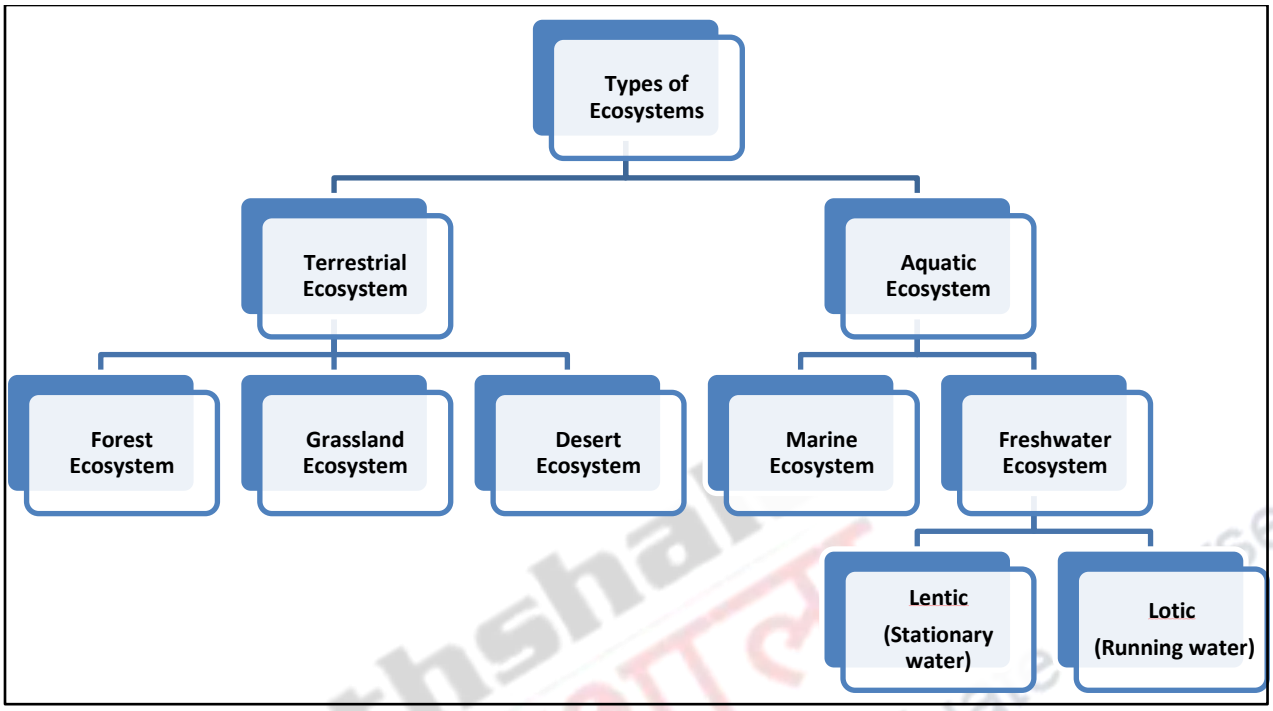

Figure 1: Different types of Ecosystems

24.2.1 Forest Ecosystem

Forests worldwide are known to be critically important habitats in terms of the biological diversity they contain and in terms of the ecological functions they serve. Forests are multi-functional: they provide an often complex array of goods and services (CBD, 2001). Forest ecosystems cover large parts of the terrestrial land surface and are major components of the terrestrial carbon cycle. Trees, the main component of forest ecosystems, contain the largest stock or absolute quantity of the living forest biomass. The total forest biomass is about 677 petagram (Pg), and trees constitute 80% of the world's biomass (Kindermann et al. 2008).

The forest is a complex and rich ecosystem as well as a valuable renewable natural resource. Its direct offerings include forest biomass, timber and a series of other forest products, storehouse of genetic material acting as genetic reservoir for future improvements of agricultural production and the most significant, along with the oceans, shelters of the planet's wildlife. The indirect offerings of forests are

perhaps even more important for man and include protection of drainage basins against erosion and the creation and preservation of soil, regulation and stabilization of the water cycle, global climate stabilization through binding and storing of atmospheric CO_2, regulation of the local climate through the increase of evapotranspiration and, consequently, of humidity, and reduction of the temperature variations amplitude, regulation of nutrients' circulation in the ecosystems, regulation of water and atmospheric air quality etc. Since the range of temperatures that allow forest development is exceptionally wide, a series of forest types succeed one another in different geographic latitudes. Forest ecosystems correspond also to a wide range of humidity values, from dry to very humid regions.

I. Tropical Rainforests

Tropical rainforests are restricted primarily to the equatorial zone between latitudes 10°N and 10°S in Central and South America, Africa, Southeast Asia, and some islands in the Caribbean Sea and Pacific Ocean. Climates where tropical rain forests develop are always warm and receive at least 200 cm of precipitation throughout the year, with no less than 10 cm during any single month. Their soils are typically old and deeply weathered oxisols. Because they are relatively devoid of humus and clay, they take on the reddish colour of aluminium and iron oxides and retain nutrients poorly. In spite of the low nutrient status of the soils, rain forest vegetation is dominated by a continuous canopy of tall evergreen trees rising to 30–40 m. Tropical rain forests are teeming with life and have increadible biological diversity. Nearly 90 percent of all non human primate species live in them. Tropical rainforests are under intense pressure from logging and agriculture.

II. Temperate Decidous Forest

Temperate decidous forest is typical of the eastern half of the United States, parts of south central and south eastern Canada, southern Africa, and many areas of Europe and Asia. These areas generally receive 75 to 100 cm (30 to 60 inches) of relatively evenly distributed precipitation per year. The winters are relatively mild, and plants are actively growing for about half the year. Temperate deciduous forests have fewer tree species than tropical rain forests. But the penetration of more sunlight supports a richer diversity of plant life at ground level. Most of the temperate deciduous forests have been heavily affected by human activity such as farming, periodic logging and

furthermore they are the major population centres. Some of these diverse forests have been cleared and replaced with tree plantations consisting of only one tree species.

III. Temperate Evergreen Forest

Temperate rainforests exist in the coastal areas of northern California, Oregon, Washington, British Columbia, southern Alaska, New Zealand and the southwest coast of Chile. They typically receive at least 130 cm (50 inches) of rain each year. Furthermore, rain occurs throughout the year and the cool climate slows evaporation, so thing are generally damp. This abundance of water, along with fertile soil and mild temperatures, results in a lush growth of plants. In warm temperate climates near the Pacific coast in north western North America, and in southern Chile, New Zealand, and Tasmania, mild winters, heavy winter rains, and summer fog create conditions that support extremely tall evergreen forests. In North America, these forests are dominated toward the south by coast redwood (*Sequoia sempervirens*) and toward the north by Douglas-fir (*Pseudotsuga* spp.). In contrast to rain forests in the tropics, temperate rain forests typically support few species. Because of the rich resource of trees, at least half of the original temperate rainforest has already been logged.

IV. Tropical Dry Forests

Tropical dry forests are found in parts of Central and South America, Australia, Africa, and Asia (particularly India and Myanmar). Many of the tropical dry forests have a monsoon climate in which several months of heavy rainfall are followed by extensive dry periods ranging from a few to as many as eight months. Since the rainfall is highly seasonal, many of the plants have special adaptations for enduring drought. Many of these forests occur in areas of very high human population. Therefore, the harvesting of wood for fuel and building materials has heavily affected these forests.

V. Taiga

Stretching in a broad belt centered at about 50°N in North America and about 60°N in Europe and Asia lies the evergreen coniferous forests or the boreal forest biome, often called taiga. In this subarctic climate, winters are long, dry, and extremely cold, with sunlight available only 6–8 hours a day. Summers are short, with mild to warm temperatures, and the sun typically shines 19 hours a day. Most boreal forests are dominated by a few species of coniferous (cone-bearing) evergreen trees such

as spruce, fir, cedar, hemlock, and pine that keep some of their narrow-pointed leaves (needles) all year long. Human impact is less severe than with many other biomes because population density is generally low in this region.

VI. Tundra

The tundra is an extremely cold region that lacks trees and has a permanently frozen subsurface soil. This frozen soil layer is known as permafrost. The amount of precipitation is less than 25 cm (10 inches) per year and the short summer is generally wet because the winter snows melt in the spring and summer temperatures are usually less than 10°C (50°F). Soils tend to be acidic because of their high organic matter content. Arctic tundra is an expansive biome that has low productivity because it has a short growing season. Plants hold their foliage for years. Most plants are dwarf, prostrate woody shrubs, which grow low to the ground to gain protection under the winter blanket of snow and ice. Tundra is essential for global biodiversity, especially for migratory birds.

24.2.2 Grassland Ecosystem

Grassland ecosystems are ecologically and economically important, and are of widespread occurrence. The potential distribution of grassland ecosystems to a large extent is determined by climatic variables, principally temperature and precipitation. Three factors including drought, fire, and grazing by large ungulate herbivores, distinguish grasslands from other ecosystem types. They are located in areas in which water availability is below the requirement for the forest at some time during the year but is sufficient to support grasses as the dominant plant type. Grasslands in the wider sense are among the largest ecosystems in the world; their area is estimated to be 40.5 percent of the terrestrial area excluding Greenland and Antarctica (White et al., 2000). Different types of grasslands include:

I. Tropical Grasslands

Tropical grasslands also called **savannas** are found in tropical parts of Africa, South America, and Australia and are characterized by extensive grasslands spotted with occasional trees or patches of trees. Although savannas receive 50 to 150 cm of rain per year, the rain is not distributed evenly throughout the year. Typically, a period of heavy rainfall is followed by a prolonged drought which

results in a very seasonally structured ecosystem. Fire and grazing undoubtedly play important roles in maintaining the character of the savanna biome, particularly in wetter regions, as grasses can persist better than other forms of vegetation under both influences. Savannas are characterized by a co-dominance of grasses and woody plants. Such vegetation is characteristic of regions with alternating wet and dry seasons. Savannas range from grass with occasional trees to shrubs to communities where trees form an almost continuous canopy as a function of precipitation and soil texture. Productivity and decomposition in savanna ecosystems are closely tied to the seasonality of precipitation. Savannas support a large and varied assemblage of both invertebrate and vertebrate herbivores. The African savanna is dominated by a large, diverse population of ungulate fauna and associated carnivores. Savannas have been heavily impacted by agriculture.

II. Temperate Grasslands

Temperate grasslands, also known as prairies or steppes, are widely distributed over temperate parts of the world. Temperate grasslands cover vast expanses of plains and gently rolling hills in the interiors of North and South America, Europe, and Asia. In these grasslands, winters are bitterly cold, summers are hot and dry, and annual precipitation is fairly sparse and falls unevenly through the year. In North America, grasslands develop within continental climate zones where rainfall ranges between 30 and 85 cm per year and winters are cold. The growing season increases from north to south from about 120 to 300 days. These grasslands are often called **prairies.** Extensive grasslands are also found in central Asia, where they are called **steppes.** Precipitation is infrequent, so organic detritus does not decompose rapidly, and the soils are rich in organic matter and nutrient content. The vegetation is dominated by grasses, which grow to heights over 2 m in the moister parts of these grasslands and to less than 0.2 m in more arid regions. Fires are infrequent in temperate deserts because the habitat produces little fuel.

III. Mediterranean Shrublands

The Mediterranean shrublands, also called chaparral, are located near oceans and are dominated by shrubby plants. Mediterranean shrublands have a climate with wet, cool winters and hot, dry summers. Rainfall is 40 to 100 cm (15 to 40 inches) per year. This biome is typical of the Mediterranean coast and is also found in coastal southern of Chile, and southern Australia. The vegetation is dominated by

woody shrubs that are adapted to withstand the hot, dry summer. Often the plants are dormant during the summer. Chaparral consists mostly of dense growths of low-growing evergreen shrubs and occasional small trees with leathery leaves that reduce evaporation. During the long, hot and dry summers, chaparral vegetation becomes very dry and highly flammable. Fire is a common feature of this biome, and the shrubs are adapted to withstand occasional fires.

24.2.3 Deserts

Deserts cover 17% of the world's land mass and harbour almost one-third of terrestrial global carbon stock. A desert often is defined as an area that receives less than 10 inches (25.4 cm) of unevenly distributed precipitation over the year. Much of this land lies between 15° and 30° latitude, where the air that is carried aloft along the Intertropical Convergence Zone subsides to form the semi-permanent high-pressure cells that dominate the climate of tropical deserts. Climatic conditions of aridity lead to high radiation and high evaporation. Lack of water by climate can be the main reason under all temperature regimes. Arid regions are defined as areas where potential evapotranspiration (ET) is higher than precipitation (P) (Figure 2). The most important factors that affect life in the desert biomes include radiation, heat and temperature, wind, water and nutrition. The radiant environment to which organisms in the desert environment are exposed is complex including, inter alia, direct solar radiation, diffuse radiation from clouds and the atmosphere, and considerable short wave radiation reflected from the soil's surface and other objects. The heat to which a desert organism is exposed comes not only from solar radiation but includes metabolic heat production, radiant heat transfer, conduction, convection and evaporative heat exchange, all of which are exacerbated in the desert environment. Wind and the role of limited water in the water balance of the organisms are also important influencing factors, together with nutritional stress.

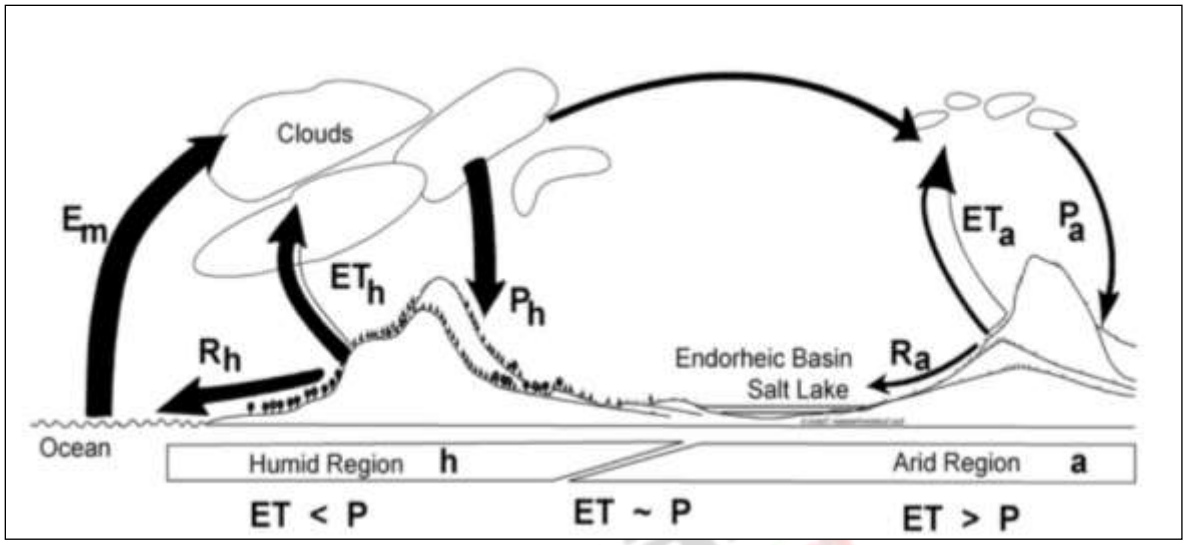

Figure.2: Global and regional water cycling in arid and humid areas. (E Evaporation; ET Evapotranspiration; P Precipitation; R Run-off; a arid; h humid; m marine) (Adapted from Breckle *et al.*, 2001)

The deserts are complex ecosystems with diverse and fragile groupings of sometimes bizarre plants, animals and fungi and little studied members of the Protista and Monera. The biomes may be influenced by their positions in coastal, inland or rain shadow deserts. Key characteristics of the biota are their adaptations to aridity, climate variability, scant summer and winter rainfall patterns and, most importantly, unpredictable rainfall. The adaptations fostering tolerance may take the form of morphological, physiological or behavioural. Some desert plants use deep roots to tap into groundwater. Others such as prickly pear and saguaro cacti use widely spread shallow roots to collect water after brief showers and store it in their spongy tissue. Evergreen plants conserve water by having wax coated leaves that minimize evapotranspiration. Others, such as annual wildflowers and grasses, store much of their biomass in seeds that remain inactive, sometimes for years, until they receive enough water to germinate. The hot deserts range from those lacking vegetation to ones with some combination of chenopods, dwarf shrubs, and succulents

DO YOU KNOW !

Hot During the Day, Cool at Night

Everyone knows that during the day many deserts are hot, very hot. Temperatures in excess of 100 degrees Fahrenheit are not uncommon. Yet at night, the same deserts can have temperatures fall into the 40s or 50s? Why?

Other biomes are insulated by their humidity (water vapor in the air). Temperate deciduous forests, for example, may have 80 percent humidity or more during the day. This water reflects and absorbs sunlight and the energy it brings. At night the water acts like a blanket, trapping heat inside the forest. Since deserts usually have only between 10 and 20 percent humidity to trap temperatures and have so few trees and other vegetation to retain heat, they cool down rapidly when the sun sets, and heat up quickly after the sun rises.

Despite their aridity, desert ecosystems support a surprising diversity of animal life, including a wide assortment of beetles, ants, locusts, lizards, snakes, birds, and mammals. The mammals are mostly herbivorous species. Desert rodents, particularly the family Heteromyidae, and ants feed largely on seeds and are important in the dynamics of desert ecosystems. Seed-eating herbivores can eat up to 90 percent of the available seeds. That consumption can distinctly affect plant composition and plant populations. Desert carnivores, such as foxes and coyotes, have mixed diets that include leaves and fruits; even insectivorous birds and rodents eat some plant material. Omnivory, rather than carnivory and complex food webs, seems to be the rule in desert ecosystems. The infrequent rainfall coupled with high rates of evaporation limit the availability of water to plants, so primary productivity is low. Ephemerality and micro-climate exploitation are found in many desert plants. Diapause, as exemplified by temporary pond inhabitants, is usually facultatively, not seasonally, controlled in desert ecosystems. Prolonged dormancy, or aestivation, is important for ectothermic vertebrates. Birds and large mammals may undergo seasonal migration to take advantage of temporary resource availability. Deserts tend to have relatively low biomass of plants and animals simply because of the arid environment. Nevertheless, most deserts have relatively high diversity with respect to reptiles and invertebrates and sometimes to succulent plants. Depending on the definition of the desert area, the degree of endemism of invertebrates, reptiles and some plants can be high.

Table 1: Different types of desert in the world.

TYPES OF DESERT IN WORLD					
HOT DESERTS			COLD DESERTS		
1	Arabian	Arabian Peninsula	1	Atacama	Coasts of Peru and Chile

2	Australian	(Great Sandy, Victoria, Simpson, Gibson, and Sturt) Australia	2	Gobi	Northern China and Southern Mongolia
3	Chihuahuan	North Central Mexico and South-western United States (Arizona, New Mexico, Texas)	3	Great Basin	Western United States (Idaho, Nevada, Oregon, and Utah)
4	Kalahari	South-western Africa	4	Iranian	Iran, Afghanistan, and Pakistan
5	Mojave	South-western United States (Arizona, California, Nevada)	5	Namib	Coasts of South-western Africa
6	Monte	Argentina	6	Takla Makan	Western China
7	Sahara	Northern Africa	7	Turkestan	Parts of the Middle East and South-western Russia
8	Sonoran	South-western United States (Arizona, California) and parts of Mexico (Baja Peninsula, Sonora)			
7	Thar	India and Pakistan			

Threats from water mismanagement, overgrazing, and over browsing by livestock, agricultural expansion, a lack of law enforcement, and introduced and exotic species are expected to result in loss of desert species and habitats. Human population growth and its distribution across the desert will be one of the most important issues that will be faced during the next century. Construction of large desert cities, soil destruction by off-road vehicles and urban development, soil salinization from irrigation, depletion of underground water supplies, land disturbance and pollution from mineral extraction and storage of toxic and radioactive wastes are some of such anthropogenic activities that are posing threat to desert ecology. Deserts take a long time to recover from disturbances because of their slow plant growth, low species diversity, slow nutrient cycling (because of little bacterial activity in their soils), and lack of water. Protection of seemingly barren desert areas for their undiscovered endemic plants and animals could be expected to yield valuable results.

24.3 Aquatic Ecosystems

An important determiner of the nature of aquatic ecosystems is the amount of salt dissolved in the water. Those that have little dissolved salt are called **freshwater ecosystems,** and those that have a high salt content are called **marine ecosystems.** Several other important factors include the ability of the sun's rays to penetrate the water, the depth of the water, the nature of the bottom substrate, and the water temperature.

24.3.1 Marine Ecosystems

Seawater covers approximately 71 per cent of the earth's surface, an area of about 361 million square kilometres (139 million square miles) comprising the major ocean areas. In the deepest parts the bottom lies more than 10000 m from the surface, and the average depth is about 3700 m. In oceans the surface area lighted by the sun is small compared to the total volume of water. This small volume of sunlit water and the dilute solution of nutrients limit primary production. All of the seas are interconnected by currents, influenced by wave actions and tides, and characterized by salinity. Vertical stratification is a key feature of aquatic ecosystems. Light decreases rapidly with depth, and communities below the photic zone (light zone, often reaching about 20 m deep) must rely on energy sources other than photosynthesis to persist. Temperature also decreases with depth. Warm, bright, near-surface communities, such as coral reefs and estuaries, are among the world's most biologically productive environments. Temperature also affects the amount of oxygen and other elements that can be absorbed in water. There are broadly two ways in which organisms live in the sea; they float or swim in the water, or they dwell on or within the sea bottom. Hence there are two major divisions of the environment, the *Pelagic* and the *Benthic*, the Pelagic Division comprising the whole body of water forming the seas and oceans, and the Benthic Division the entire sea bottom (Figure 3).

I. Pelagic Marine Ecosystem

The pelagic is divided into two provinces: the neritic province, water that overlies the continental shelf, and the oceanic province. Because conditions change with depth, the pelagic is divided into several distinct vertical layers or zones (Figure 3). The pelagic zone can be further subdivided into ecological zones based on depth: in the epipelagic or photic zone(0-200m) , there are sharp gradients

in illumination, temperature, and salinity; the mesopelagic (200-1000m), has little light to penetrate and the temperature gradient is more even and gradual, without much seasonal variation and this zone contains an oxygen-minimum layer and often the maximum concentration of nutrients (nitrate and phosphate);in the bathypelagic (1000-4000m), darkness is virtually complete, except for bioluminescent organisms; temperature is low; and water pressure is great; and the abyssopelagic region (4000 to 6000m) Areas deeper than 6000m are called hadalpelagicregions – which includes areas found in deep-sea trenches and canyons, while they account for the deepest regions on the planet's oceans, they compose a very small fraction of the total oceanic environment (for example, the Mariana trench is a hadal environment).

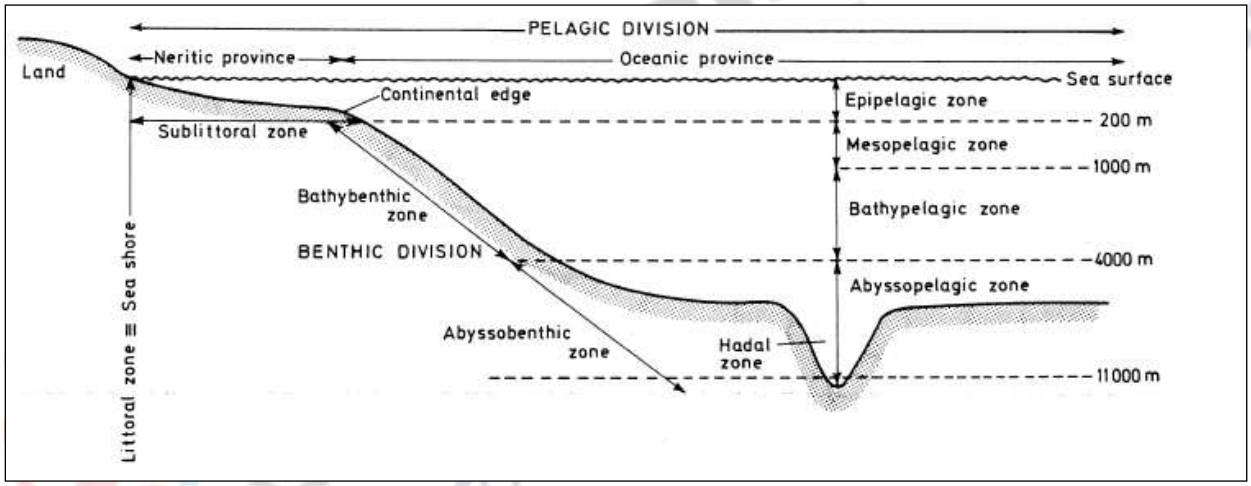

Figure 3: Ecological Divisions of the Marine Ecosystem (adapted from Miller & Spoolman, 2015)

The pelagic environment is home to two basic groups of marine organisms. The first group consists of the plankton (Greek for "wandering") which is appropriate because they possess little power to "swim" any significant distance, and are thus passively transported by ocean currents. Planktonic plants are known as phytoplankton, and planktonic animals are known as zooplankton (e.g. jellyfish, small crustaceans, pelagic snails, etc.). The second group of pelagic marine organisms are the free-swimming nekton, including marine mammals, fish, squid, and some larger crustaceans.

- **Coral reef ecosystems**

Coral reefs are among the best-known marine systems, because of their extraordinary biological productivity and their diverse and beautiful organisms. Reefs are colonies of minute, colonial animals (coral polyps) that live symbiotically with photosynthetic algae. Calcium-rich coral skeletons shelter the algae, and algae nourish the coral animals. They are a unique accumulation of dead skeletal material built up by carbonate secreting organisms, mostly living coral (Cnidaria, Anthozoa) but also coralline red algae (Rhodophyta, Corallinaceae),green calcerous algae (*Halimeda*), foraminifera, and mollusks. Although various types of corals can be found from the water's surface to depths of 6000 m, reef-building corals are generally found at depths of less than 45 m. Reefs are among the most endangered biological communities. Sediment from coastal development, farming, sewage, or other pollution can reduce water clarity and smother coral. Destructive fishing practices, including dynamite and cyanide poison, have destroyed many Asian reefs. Reefs can also be damaged or killed by changes in temperature, by invasive fish, and by diseases often lead to coral bleaching.

- **Mangrove swamp ecosystems**

Mangroves are the dominant ecosystems that line the coasts of subtropical and tropical coastlines around the world. Mangrove ecosystems demonstrate close links between vegetation assemblages and geo-morphologically defined habitats. Mangroves are a diverse group of salt-tolerant trees that grow along warm, calm marine coasts around the world. Growing in shallow, tidal mudflats, mangroves help stabilize shorelines, blunt the force of storms, and build land by trapping sediment and organic material. Detritus, including fallen leaves, collects below mangroves and provides nutrients for a diverse community of animals and plants. Both marine species (such as crabs and fish) and terrestrial species (such as birds and bats) rely on mangroves for shelter and food. Mangroves are found in south Florida, the Caribbean, Southeast Asia, Africa, and other parts of the world where tropical mudflats occur.

II. Benthic Marine Ecosystems

Benthic organisms (those living on the floor of the deep ocean) vary with depth and substrate. They are strictly heterotrophic and depend on organic matter that drifts to the bottom. They include filter feeders, collectors, deposit feeders, and predators. The sea bottom and the seashore together make up

the Benthic Division which comprises three major zones, the Littoral, the Sublittoral and the Deep Sea Zones. The Littoral Zone includes the greater part of the seashore together with the wave-splashed region above high tide level. The Sublittoral Zone is the shallow sea bottom extending from the lower part of the shore to the continental edge. The Deep Sea Zone lies below the continental shelf, and can be subdivided into Bathybenthic and Abyssobenthic Zones. The Bathybenthic zone lies between the continental edge and a depth of about 4000 m, comprising mainly the continental slope. The Abyssobenthic Zone is the bottom below 4000 m, including the continental rise, abyssal plain and deeper parts of the sea floor.

- **Estuaries**

Rivers eventually reach the sea. The place where the one-way flow of freshwater meets the incoming and outgoing tidal water is an estuary. Estuary is defined as a semi-enclosed coastal body of water that extends to the effective limit of tidal influence, within which seawater entering from one or more free connections with the open sea or any other saline coastal bodies of water is significantly diluted with freshwater derived from land drainage and can sustain euryhaline biological species, either a part or whole of their life cycle (Perillo, 1995). The intermingling of freshwater and tides creates a nutrient trap exploited by estuarine life. Estuaries are especially important as nursery sites for fish and crustaceans such as flounder and shrimp. The adults enter these productive, sheltered areas to reproduce and then return to the ocean.

DO YOU KNOW!

About half of the global primary production takes place in marine systems. Most of the primary production in the world's ocean is due to microscopic phytoplankton, since micro algae are restricted to a rather to a narrow band of coastlines.

24.3.2 Freshwater Ecosystems

Freshwater ecosystems, the study of which is known as **limnology**, are conveniently divided into two groups: lentic or standing water habitats, and lotic or running water habitats.

I. Lentic

The term **lentic** refers to standing bodies of water such as lakes, reservoirs, and ponds. Lakes and ponds can be divided into both horizontal and vertical zones based upon light penetration, temperature, and chemical characteristics. Associated with them are a variety of biological communities. On the basis of Light Penetration the lake can be classified into two zones i.e. littoral zone and limnetic zone. The littoral zone is the region near the shore where sufficient light reaches the bottom to support rooted plants. Littoral zone which can further be categorised into (a) zone of emergent vegetation, (b)zone of floating vegetation and (c) zone of submerged vegetation. The limnetic zone is the area of open water bounded by the littoral region.Lakes and larger ponds experience seasonal shifts in temperature. The heating and cooling of surface waters changes temperatures throughout the basin. In late spring and early summer increased solar radiation and warmer air temperatures heat surface waters faster than deep water. The surface water becomes lighter as its temperature rises. Inevitably a layer of lighter, warm water forms on top of a denser cooler layer. When this happens the lake has stratified. On the basis of Temperature Stratification lentic ecosystems stratified into epilimnion, metalimnion and hypolimnion. One system for classifying bodies of water is based on their productivity or trophic status on the basis of which a lake can be classified into oligotrophic and eutrophic lakes.

- **Wetlands**

Wetland ecosystems are estimated to cover more than 1,280 million hectares globally. Wetlands are area of marsh, fen, peatland or water, whether natural or artificial, permanent or temporary, with water that is static or flowing, fresh, brackish or salt, including areas of marine water, the depth of which at low tide does not exceed six metres. They are areas of land where water covers the soil – permanently or just at certain times and include: rivers, swamps, marshes, billabongs, lakes, lagoons, oases, salt marshes, mudflats, mangroves, coral reefs, bogs, fens, and peatlands. There are even underground wetlands. There are a range of wetland classifications used for different purposes, based on hydro-geomorphology and/or vegetation characteristics, such as:

- Marine (coastal wetlands, including coastal lagoons, rocky shores and coral reefs)

- Estuarine (including deltas, tidal marshes, and mangrove swamps);
- Lacustrine (wetlands associated with lakes);
- Riverine (rivers and wetlands along rivers and streams); and
- Palustrine (marshes, swamps and bogs).

Threats to wetland ecosystems comprise the increasing biotic and abiotic pressures and perils.

II. Lotic

The term 'Lotic' referes to the running water ecosystems such as streams and rivers. Apart from being a crucial ecosystem linking the land and ocean systems, rivers serve as a prominent geological agent in tropical and subtropical regions. River ecology deals mainly with the energy transformation, nutrient turnover, and storage and processing of organic matter. Rivers are basically heterotrophic as a substantial proportion of the biotic energy that drives stream communities is organic matter derived from allochthonous sources. Many aquatic plants, invertebrates, and fishes have adapted to fill a specific niche. Within most rivers, the pattern of flow variation, and its ramifications in terms of substrate stability and water quality, is the dominant factor controlling species distributions. Lotic ecosystems are longitudinally interdependent and that energy processing depends on the retention and cycling of nutrients by biological communities in upstream areas. Biological community of a river ecosystem includes a variety of plants and animals. Producers in aquatic systems include diatoms, blue green algae, and water moss. Nymphs of dragon flies, may flies and stone flies, beetles, snails, fishes, etc. are the common consumers in river ecosystems. Riparian and in stream vegetations are the integral components of the river ecosystems. The riparian vegetation plays an important role in sustaining the vitality of rivers. It is a source of organic matter, which forms an important source of energy in most of the river ecosystems.

Summary

i. Complex interactions of many macro and microscopic species of plants and animals, together with the rich arrays of symbiotic fungi and lichens, are the base of every ecosystem, from forests to coral reefs and freshwater to soils. All ecosystems are not only sources of rich biodiversity, but also extremely productive areas, offering a lot of benefits to mankind.

ii. All types of ecosystems fall into one of two categories: terrestrial or aquatic. Terrestrial ecosystems are land based, while aquatic are water based.

iii. The distribution of terrestrial ecosystems is primarily related to precipitation and temperature.

iv. Terrestrial ecosystems can be classified into three types i.e. forest ecosystem, grassland ecosystem and desert ecosystem.

v. Global aquatic ecosystems fall into two broad categories defined by salinity – fresh water ecosystems and salt water ecosystems.

vi. Aquatic ecosystems that have little dissolved salt are called freshwater ecosystems, and those that have a high salt content are called marine ecosystems.

vii. The two major divisions of the Marine ecosystem are the *Pelagic* and the *Benthic*, the Pelagic Division comprising the whole body of water forming the seas and oceans, and the Benthic Division the entire sea bottom.

viii. Fresh water ecosystems can be divided into two groups: lentic or standing water habitats, and lotic or running water habitats.

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