

Chapter 26

SOME MAJOR ECOSYSTEMS

WEATHER AND CLIMATE:

Definition:

Weather refers to short-term fluctuations in temperature, humidity, cloud cover, wind and precipitation (rain or snow) etc, over period of hours or days.

Definition:

Climate in contrast refers to overall patterns of weather that prevail from year to year even century-to-century in a particular region.

AQUATIC OR HYDROSPHERIC ECOSYSTEM:

Definition:

Hydrospheric ecosystem is a “system in water where living and non-living components exchange material and transfer of energy also take place within water”. Characteristics of aquatic ecosystem.

Abundance:

Salt-water ocean sand seas are the largest ecosystem on the earth and cover less than 1%.

1. Temperature:

Water has high specific heat and changes its temperature slower than air, so temperature in aquatic ecosystem is more moderate and relatively stable.

2. Absorption of Energy:

Although water may appear quite transparent, it absorbs a considerable amount of the light energy that sustains life. Even in clearest water the intensity of light decreases rapidly with depth, so at the depth of 600 feet or more, a little light to support photosynthesis.

3. Nutrients:

The organic and inorganic nutrients in aquatic ecosystem tend to be concentrated near the bottom sediments supporting life where light level often cannot support photosynthesis.

4. Abundant water with appropriate:**Temperature:**

- Water is an essential requirement for life. It is available abundantly in aquatic ecosystem to support life.
- The major factors that determine the quantity and type of life in aquatic ecosystems are energy and nutrients.
- Appropriate temperature is present in aquatic ecosystems to carry out metabolic processes.

PRODUCTIVITY OF AQUATIC ECOSYSTEM

Definition:

The productivity can be measured by the rate of consumption of CO₂ or the release of oxygen in the process of photosynthesis.

Change in Productivity:

The productivity of aquatic ecosystem is basically determined by the light and nutrient.

- Light intensity and quality varies with the water depth. So the primary productivity also varies with light. It is maximum close to surface.
- The amount and types of nutrient forms also change with season.
- Productivity also varies from zone to zone. It is maximum in tropical regions as compared to temperate ant arctic regions.

CLASSIFICATION OF AQUATIC ECOSYSTEMS

Aquatic environment can easily be classified into two types

- (a) Fresh water
- (b) Marine (salty) water.

Fresh Water Ecosystem:

Fresh water covers less than 1% of the surface of earth.

Fresh Water Lakes:

Lakes vary tremendously in size, depth and nutrient contents.

They process distinct life zones (with specific types of living organisms) and temperature stratification (with different temperature in different parts of the lake).

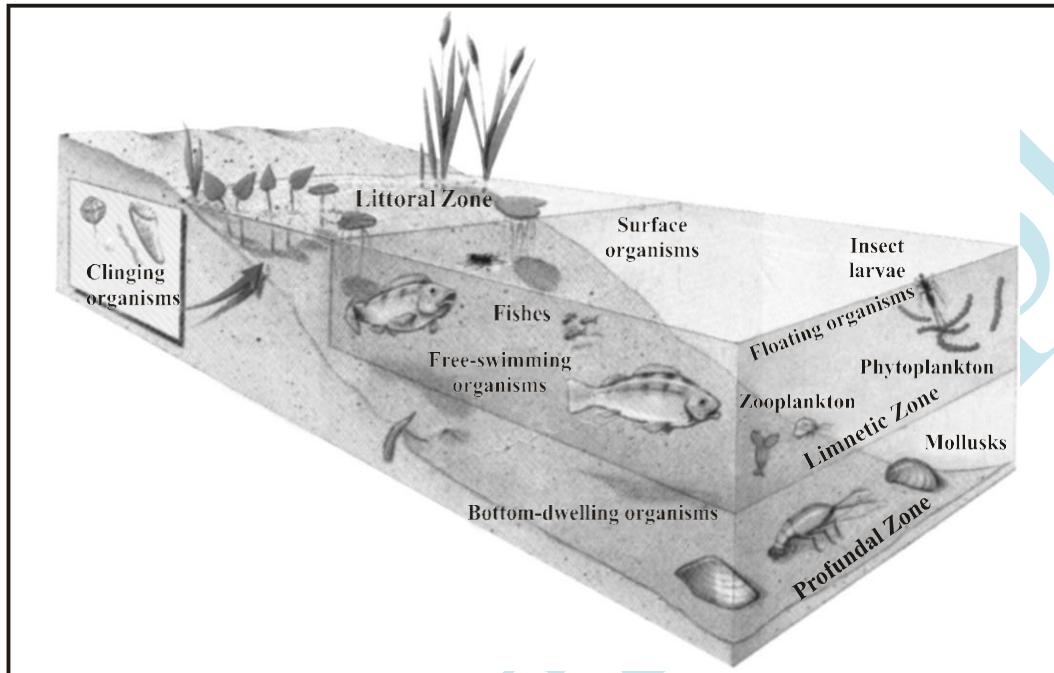
Life Zones:

The distribution of life in lakes depends on access to:

- (i) Light
- (ii) Nutrients
- (iii) Place for attachment

Due to the variations in above mentioned parameters, lake ecosystem can be divided into three main zones.

1. Littoral zone
2. Limnetic zone
3. Profundal zone



ZONE IN A LAKE

1. **Littoral Zone:**

It is shallow water area along the shore, where light penetrates up to the bottom.

Features of Littoral Zone:

In this zone

- Water is shallow (less deep).
- Plants find abundant light.
- Vast anchorage place for plants and some animals.
- There are adequate nutrients from the bottom sediments. This is the richest zone because nutrients from soil continuously enter into this region with rain water.

Plants:

Plants of littoral zone communities are the most diverse and are hydrophyte.

Phytoplankton:

These are the microscopic plants, which remain suspended in water. They move with the water current (Greek “drifting plants:). Most of the **algae** belong to this category. Other members include **photosynthetic protista and bacteria etc.**

Animals:

The greatest diversity of animals in the lake is found in this zone. The include...

(i) Zooplankton:

These are small animals which move with the water current (Greek “drifting animals”), Such as protozoa, and tiny crustaceans.

(ii) Invertebrates:

Littoral invertebrate animals include small crustaceans, insect larvae, snails flatworms, Hydra, annelid worms etc.

(iii) Vertebrates:

Vertebrates include fishes, frogs, aquatic snakes, turtles and other etc.

2. Limnetic Zone:

This is the open water area up to the effective light penetration.

Features of Limnetic Zone:

- As the water increases in depth farther from the shore, rooted plants are unable to anchor to the bottom.
- Enough light penetrates to support photosynthesis in this zone.

Plants:

No rooted plants are found. Main producers are phytoplankton, which includes Algae and Cyanobacteria (Blue green alga).

Animals:

This area is inhabited by

- Zooplankton, which include protozoa and small crustaceans.
- Many free living invertebrates and small and large fish types.

3. Profundal Zone:**Features of Profundal Zone:**

This is the deep-water region where light is absent or is insufficient to support photosynthesis. This area is mainly nourished by detritus that falls from the littoral and limnetic zone and by incoming sediments.

Life Forms:

Producers are absent in this region. Decomposers and detritus feeders such as snails, worms certain insect larvae, bacteria, fungi and fishes, inhabit it.

INTERVENTION OF MAN IN AQUATIC – ECOSYSTEM

Human activities are continuously spoiling the quality and life forms of aquatic ecosystems. Two main human impacts are mentioned here.

1. Eutrophication:

This is the natural process of excessive enrichment of water with nutrients. Large quantities of organic nutrients develop in water.

Addition of Excessive Nutrients:

Humans greatly accelerate the process of eutrophication (enrichment of nutrients), by contributing the huge quantities of nutrients in the water bodies.

- Nutrients are carried into lakes from farm feedlots and sewage.
- Even if soiled waste are removed, water discharged from sewage treatment plant is often rich in phosphates and nitrates dissolved from wastes and detergents.
- Gases soluble at low temperature like cold water.
- Excessively enriched water also washes off excretory products from fields where the manure of thousands of cattle is accumulated.
- Phosphates and nitrates are carried to the water bodies from fertilizers, which are added in fields.

Algal Blooms and their Effects:

Excessive growth of organisms especially algae and/or cyanobacteria due to the excessive nutrients in water is known as bloom.

- The dead plant bodies are decomposed by bacteria, utilizing the oxygen present in the water.
- Deprived of oxygen, fish, snails and insect larvae die, and their decaying bodies provide more food for bacterial growth, further depleting oxygen.
- Even without oxygen, certain anaerobic bacteria grow in number and produce foul smelling gases and unpleasant colours.
- Although it is full of life and nutrients, polluted lake gives bad smell.
- Most of the trophic levels including the fish eliminate and the bacteria and blue green algae dominate the community.

TERRESTRIAL OR LITHOSPHERIC ECOSYSTEM

The ecosystem present on land or soil is called terrestrial or lithospheric ecosystem.

Characteristics of Terrestrial Ecosystem:

Various environment components, like light, nutrients, water and temperature etc. influence the life on land.

(i) Light and Nutrients:

Terrestrial ecosystem receives plenty of light, and the soil provides abundant nutrients. Both these components vary in different regions.

(ii) Water:

Availability of water is limited and depends upon precipitation (rain fall and snow), which is very unevenly distributed both in place and in time.

(iii) Temperature:

Favourable temperatures are also very unevenly distributed on land in place and time. For example:

On poles the average temperature is below freezing, while in **temperate zones** only during certain seasons of the year it is quite favourable, but in **tropic zones** uniformly, warm, moist climate is present.

(iv) Air:

In terrestrial ecosystem air is in constant motion so its composition is more uniform. The amount of O₂ and CO₂ in air is much constant and most beneficial for terrestrial ecosystem.

ADAPTATIONS FOR TERRESTRIAL ECOSYSTEM

Plants and animals shifting from water to land developed various types of adaptations for land habitat e.g.

(i) Supporting Tissues:

- Plants have evolved supporting tissues like vascular bundles (xylem-phloem) for support and conduction against the pull of gravity.
- Roots are evolve in plants for anchoring and absorption of water and nutrients from soil.
- Skeleton (bones & cartilage) in animals is evolved to support them on land.

(ii) Conservation of Water:

Plants and animals evolved various methods to conserve water in their body e.g.

- Plants posses bark, thick and waxy cuticle, reduced number of stomata and ability to store water in stem or leaves.
- Animals have skin especially in reptiles, birds and mammals for protection against water loss and physical injuries, in addition to many physiological and behavioural modifications (more details on page).

(iii) Homeostasis:

The mechanism for regulation of temperature, minerals, water and many substances was developed by land plants and animals, with the help of many structures like **bark** and **skin** etc.

DIVISIONS OF TERRESTRIAL ECOSYSTEM

Terrestrial ecosystem can be divided into following main types such as:

1. Forest ecosystem:

Where dominant species are trees. It is further sub-divided into

- (a) **Tropical Rain Forests** found in warm and moist conditions of tropical regions.
- (b) **Temperate Deciduous Forests** found in moderate conditions of temperate regions.
- (c) **Coniferous Alpine and Boreal Forests** cone producing trees in cool but moist places at **higher altitudes** and **higher latitudes**.

2. Grass Land Ecosystem:

When dominant species are grasses, having a few or no trees. Tropical grasslands are known as savannas.

3. Desert Ecosystem:

Regions of scarcity of water characterized by very low rainfall.

4. Tundra Ecosystem:

Found in artic circle, with very low temperature short growing season.

SOME MAJOR ECOSYSTEMS IN PAKISTAN

Pakistan has of seasons and climate ranging from hot dry in plains to cold snowy on mountains with high monsoon rains.

S.No	MAJOR TERRESTRIAL ECOSYSTEM	LOCATION IN PAKISTAN
1.	Temperate Deciduous forests.	Shogran and Neelam valley (Muzaffarabad).
2.	Coniferous Alpine Forests.	Northern mountains of Kaghan, Kalam, Malam Jaba (swat) Dir, Chilas, higher altitudes of Murree and adjoining areas.
3.	Grassland ecosystem	Gilit and Kashmir, Waziristan, Lower chitral and North Kallat.
4.	Desert ecosystem	Thall in Western Punjab (Mianwali, Bakkhar, Tonsa), Cholistan in Southern Punjab (Fort Abbas, Bahawal Nagar, Yazman, Bhawal Pur, Khan Pur and R Yar-khan Thar in Sind

5.

Tundra ecosystem (alpine tundra)

Mountains of Kara-Koram
and Hindukush.

TEMPERATE DECIDUOUS FORESTS

Location in Pakistan & World:

In Pakistan temperate moist conditions are present in Neelam Valley and Shogran. These forest originally covered India, Southeast Asia, Eastern North America, Europe, China, Australia, Japan, North and South America

Climate Condition:

- Temperate regions are those where there are two distinct seasons summer with intense heat and winter with chilling temperatures.
- The rainfall is not very constant, and there are pronounced wet and dry seasons as there are distinct summer and winter seasons.
- During dry season, the trees cannot get enough water from the soil to compensate for evaporation from their leaves.
- As a result, the plants have adapted to the dry season by shedding their leaves until the drought passes.

Rainfall:

The average annual rainfall is between 750 – 1500 mm.

Temperature:

Moderate temperature ranges from 4°C to 30°C.

Plants:

Plants in these forests are arranged in layers.

1. **Tree layer** formed by some dominant trees such as *Taxus baccata*, *pinus wallichiana*, *Berberis lyceum* usually with height 8 to 30 meters.
2. **Shrub layer** formed by many herbs and shrubs having height of 5m.
3. **Field layer** is formed by some grasses, ferns and other herbaceous plants.
4. **Forest floor** formed by many mosses, liverworts and lichens covered with leaf litter (a layer formed by fallen leaves).

Animal Life:

Great diversity of animals is found here. Some very common animals are *Macaca mulatt* (Rhesus monkey), *Solenorotos tibitanus* (black bear), *Felis bengalensis* (leopard cat), deer, wolves with a variety of pheasants.

Decomposers:

Various types of micro organisms such as bacteria and fungi convert the litter into the simple organic matter.

Soil Conditions:

The soil of temperate deciduous forests is grayish brown in colour, very fertile and rich in organic matter, with maximum water holding capacity.

HUMAN IMPACT

- In temperate deciduous forests, large mammals such as black bear, deer, wolves, bobcats and mountain lions were formerly abundant, but these predators have been largely wiped out by humans.
- Many game birds and animals are mercilessly killed for fun, food or commercial purposes.
- Many trees are cut to fulfill the need of wood for fuel and construction.
- Another reason of deforestation is the use of land for agricultural purpose. Due to these and many other reasons, deciduous forests of the world have been reduced to a great extent. They must be protected for future generations.

CONIFEROUS FORESTS**Location:**

- In Pakistan these forests are found in Upper Kaghan, Dir, Chilas, Malam Jaba in Swat valley and at higher altitudes of Murree, Nathia Gali and adjoining areas.
- In the world they are found across Eurasia (Europe + Asia), Northern parts of America and Canada just south of the tundra.
- Coniferous forests at higher altitudes are known as alpine forests.
- Northern coniferous forests (at higher latitudes in Siberia etc.) are also called boreal forests or Taiga.

Climatic Conditions:

- Conditions in taiga are harsher than those in the temperate deciduous forests.
- The winters are longer and colder, and the growing season is shorter.
- The few months of warm weather are too short to allow trees the luxury of re-growing.
- As a result, evergreen coniferous trees populate these types of forests almost entirely with small waxy needles.
- The waxy coating and small surface area of the needles reduce water loss by evaporation during cold months, and leaves remain on the trees year around.

Alpine:

Coniferous Forest located at high altitude are called Alpine.

Boreal:

Coniferous forests located at high latitude and called Boreals.

Snow Cover:

There is a constant cover of snow characterized by long severe winter.

Temperature:

Temperatures may be below freezing point, up to 10°C.

ANIMAL LIFE

Because of its harsh climate, the diversity of life is much low

Large mammals, bison, wolf black bear, deer, Marco polo sheep and smaller animals such as small Kashmir flying squirrel, snowshoe hare, wolverine and crossbills are present.

Many animals pass the winter in burrows, while some other migrate to moderate places.

PLANT LIFE

Tall trees, like *Pinus wallichiana*, *Pinus roxburgii*, *Abies pindrow*, *picea smithiana* and *cederous deodara* are commonly present along with many herbaceous and shrubby plants.

HUMAN IMPACT

Due to severity of climate and remoteness, many of the coniferous forests remain undisturbed, but these forests are major source lumber (wood) for construction (for example pines and Deodar), so much of the forests have been cleared in the world.

GRASS LAND ECOSYSTEM

Location:

Grassland ecosystem in Pakistan are found in Gilgit, Kashmir, Waziristan, Lower Chitral.

World over they are found in the interior of all continents, such as prairies of North America, pampas of Argentina, Steppes of Russia and Velds of Africa.

Prairies: A grass land in temperate climate & do not have woody trees.

Savanna:

The grasslands in tropic climates have clumps of woody trees, especially in low areas and closer to water bodies. These are called Savanna.

Rain Fall:

- Average annual rainfall is about 250 to 750 mm (10 – 30 inches).
- The grasslands usually face severe droughts.
- These grasslands occur in regions where mean annual rainfall is midway between forest and a desert.

Soil Conditions:

- The soil moisture is limited due to low precipitation and high evaporation.
- Upper soil layer in which grasses are rooted is normally moist but deeper layers are constantly dry.

The soil of grassland is basically impermeable with excessive salinity.

PLANT LIFE

- The dominant species are graminoids i.e. grasses, and grass like plants.
- Certain forbs (any broad-leaved herbaceous plant) such as composites (family of sunflower), legumes and many other herbaceous plant species are also associated with grasses.
- Tolerance against water and fire gives the grasses an edge in the competition with trees because grasses are more tolerant than trees.
- In general, these ecosystem have a continuous cover of grass and virtually no trees at all except along the rivers.

Layering:

Grasses of different sizes arrange themselves in layers. Most commonly three layers are recognized in these grasslands, which are the following.

- **First layer** is formed by the tall grasses such as *Andropogon* and *Panicum*.
- **Second layer** is formed by the mid high grasses such as *stipa*, *sporobolus* and *Oryzopsis* etc.
- Third layer is formed by short grasses and forbs and warfare species such as (**poa** and **Bromus**) with mosses and lichens.

ANIMAL LIFE

As there are limited places of shelter from intense sunlight and predators, so most of the animals are burrowing or fast runners.

Herbivores:

- Dominant species are herbivores.
- Invertebrates become so numerous that they can compete with other herbivores for plant foliage.
- Large animals like zebras, wild horses and bison are important.

Predators:

The predators are reptiles, amphibians and mammals, such as Lizards, toads and turtles, which prey on insects and other small animals. Foxes and wolves among mammals are very common.

DECOMPOSERS

Among decomposers many bacteria, actinomycetes and fungi like molds, Yeasts, mushrooms, and bracket fungi are most common.

PRODUCTIVITY

- Productivity can be defined as the rate of production of new biomass per unit time per unit area.
- In temperate grasslands, the rate of primary production is about 700 – 1500 g/m² annually.
- In sub humid tropical grasslands it is more than 4 kg.
- In annual grasslands, large grazing animals consume relatively small amount of (5-10%) of the total plant matter produced.
- Invertebrates, rodents (rats porcupine etc) and birds may consume equal amount or a little more.

HUMAN IMPACT

Only a few grasslands have been protected, while most of the other have been excessively exploited by man.

Crop Production:

- The natural grasslands in world are used for crop production and live stock management.
- Only a small fraction of world's grassland is still under cultivation due to arid (dry) climatic conditions, with soil erosion (removal of surface layers of soil) and salinity.
- Deficiency of water, in many countries like Pakistan is overcome by the canals or tube wells. This system has its own problems of water logging and salinity.

GRAZING:

- Grazing has prominent effects on grassland.
- Over-grazing causes reduction in herbage cover and result is soil erosion.
- Many lands are converted into desert by over grazing, a process called desertification.

DESERT ECOSYSTEM

Location:

- (a) **In Pakistan** the desert ecosystems are found in different parts.
- **Thal** is found in western Punjab (Mianwalli, Bukhar).
 - **Cholistan** in southern Punjab, areas like Fort Abaas, Bahawal nagar, Yazman Bahawal Pur (Cholistan), Khan pur and Rahim yar khan.
 - **Thar** is the desert ecosystem in Sindh is called Thar.

(b) **World over**, these biomes are found in every continent often around 20 to 30 north and south latitude and also in the rain shadows of major mountain ranges.

Sahara of Africa is the largest in the world.

Rain Fall:

Annual rain fall is less than 25 to 50 cm (10 – 20 inches) or not at all as in Sahara or Chile.

PLANT LIFE

The plants are often spaced evenly as if planted by hand.

The perennial plants are bushes or cacti with large shallow root systems.

Adaptations in Plants:

1. Plants are covered with the thick waterproof waxy cuticle to prevent evaporation of precious water.\
2. Number of stomata is reduced in desert plants to minimize water loss.
3. Succulents have the ability to store water for use during the period of drought. Water is stored in thick stem or leaves of cacti and other succulents.
4. Leaves of many plants are reduced or absent.
5. Certain shrubby plants can survive long periods of drought in dormant condition.
6. Certain plants have short life cycle. Their seeds germinate and rapidly complete their life cycle whenever little water is present.

ANIMAL LIFE

Desert animals are also specially adapted to survive on little water. A few adaptations in desert animals in response to the scarcity of water are the following

1. Most of the smaller animals survive without ever drinking at all getting all the water they need from their food and water produced during cellular respiration in their tissues.
2. Large animals such as desert big horn sheep and camel are dependent.
3. Many desert animals are nocturnal. Most deserts appear to be almost completely devoid of animal life during day, because the animals seek relief from the sun and heat in cool under ground burrows and come out in the cool night such as horned lizards, snakes and other reptiles emerge to feed, as do mammals such as kangaroo, rat and birds such as burrowing owl.
4. Most of the animals excrete crystals of uric acid as nitrogenous waste because it needs little water for removal.
5. Number of sweat glands is reduced.

HUMAN IMPACT

While human activities are reducing the extent of many biomes, they are causing the spread of deserts, a process called desertification. A dramatic example is occurring in the Sahel, which borders the southern edge of the Sahara desert in Africa. Twenty-five years of below average rainfall, coupled with rapid growth of the human population have caused a steady southward spread of deserts.

The Sahel is an example of human population's exceeding the carrying capacity of the land. The loss of the productivity of the ecosystem is nearly irreversible and massive famines, such as occurred in Ethiopia in the mid 1980s are a tragic result.

TUNDRA ECOSYSTEM

This ecosystem is characterized by intense cold with very short growing season. It is of two types

- (a) Arctic tundra
- (b) Alpine tundra

(a) Arctic tundra:

The arctic tundra is a vast treeless region bordering the Arctic Ocean. It is used to describe types of vegetation in treeless high latitudes between taiga and polar ice caps. Arctic tundra stretches across northern North America, Northern Europe and Siberia.

(b) Alpine tundra:

It is found at high altitude across the mountains, above timberline such as mountains of Karakoram and Hindu Kush in Pakistan.

PLANT LIFE

- Plants grow only during short summer. Trees are totally absent.
- In summer, the ground is carpeted with small perennial flowers and dwarf willows no more than few centimeters tall. A willow 10 centimeters (4 inches) high may have a trunk 7 centimeters (3 inches) in diameter and be 50 years old.
- Large lichen called reindeer moss is frequently found on the surfaces of other plants.

ANIMAL LIFE

- Tundra is almost lifeless in winter. A few animals are found in long, severe winter.
- When in brief summer, ice melts, small pools are formed. These standing pools provide superb mosquito habitat. The mosquitoes and other insects provide food for numerous birds (ducks and geese).

- Most of birds (ducks and gees etc) and mammals (caribou, reindeer etc) are migratory, which move to moderate areas. Most of these birds migrate to a long distance to nest and raise their young's during the brief summer season.
- The tundra vegetation supports lemmings, which are eaten by wolves, snowy owls arctic foxes and even grizzly bears.

HUMAN IMPACT

Most Fragile:

The tundra is perhaps the most fragile (delicate) of all the biomes because of its short growing season.

Scars are Left:

Human activities in the tundra leave scars that persist for centuries.

Localized Effect:

Fortunately for the tundra inhabitants, the impact civilization is localized around oil drilling sites, pipelines, mines and military bases.

HUMANS AND ECOSYSTEMS

The expanding human population has left relatively few ecosystems undisturbed. Our impacts on natural ecosystem are very diverse and wide ranging. For example

- Grasslands have been converted to agricultural land.
- Weeds are eliminated from the crops.
- Forests are cut for wood, which is used as fuel or construction.
- Desertification is facilitated by excessive tilling etc.
- Predatory animals are killed to protect domestic animals.
- Game animals are killed for precious skins or tusks etc.

Ecosystems dominated by people tend to be simple that is, have fewer species (crops, vegetables, useful animals etc) and fewer community interactions than undisturbed ecosystem.

**Q.1 Fill in the blanks.**

- (i) Water is slower to heat than _____.
- (ii) The distribution of life in lakes depends on to _____ and to place for attachment.
- (iii) Ecosystem on land is also called as _____ ecosystem.
- (iv) Ecosystem on land is also known as _____ ecosystem.

ANSWERS

(i) Air	(ii) Nutrients
(iii) Terrestrial or lithospheric	(iv) Aquatic or hydrospheric

Q.2 Encircle the correct answer from the multiple choices.

- (i) The soil or terrestrial ecosystems have some adaptations for animals and plants:
 - (a) Supporting tissues
 - (b) Retention of food
 - (c) Temperature
 - (d) Nutrients
- (ii) Most plants fit only into a few ecosystems which type of plants seem in ecosystem of grass land:
 - (a) Trees
 - (b) Shrubs
 - (c) Perennial herbs
 - (d) Annual weeds
- (iii) In which type of ecosystem the smallest fraction of nutrients is present in soil:
 - (a) Savanna
 - (b) Tundra
 - (c) Grassland
 - (d) Desert

ANSWERS

(i) (a) (ii) (c) (iii) (d) (iv) (a)
(v) (c)

Q.3 Short Question:

- (i) Define Productivity of an ecosystem.**

Ans: See text.

- (ii) List four adaptations in plants and animals for terrestrial ecosystem.

Ans: See text.

- (iii) Name three zones in lake ecosystem.

Ans: See text.

- (iv) How many biomes are present in the world, name only five of them.

Ans: See text.

- (v) Give the names of some major ecosystem on land in Pakistan.

Ans: See text.

Q.4 Extensive Questions:

- (i) What are the four major requirements for life? Which two are limiting in terrestrial ecosystem?

Ans: See text.

- (ii) List some adaptations of desert plants and desert animals to heat and drought.

Ans: See text.

- (iii) Where is life in oceans (Hydrospheric ecosystem) most abundant and why?

Ans: See text.

- (iv) Distinguish between three different zones in lake – ecosystem.

Ans: See text.