



Unit 2

Factors of Locality I - Atmosphere and Climate

Learning Objectives

After completing this unit you shall be able to:

- ▶ **Define factors of locality**
- ▶ **Explain the types of factors of locality**
- ▶ **Explain atmosphere and climate as a factor of locality**
- ▶ **Describe the importance and role of various climatic factors**
- ▶ **Explain bio-climate and microclimate**

Factors of Locality

Definition

Factors of locality may be defined as “**Effective climatic, topographic, edaphic and biotic conditions operating in an area or site, which have influences on the biotic components of the area**”. These are also referred to as ‘**site factors or habitat factors**’

Types of locality factors

- ▶ **Climatic factors** (Atmosphere and Climate): It includes Solar radiations (Light, Heat and temperature), Moisture, Wind, Pressure,
- ▶ **Topographic factors:** It includes Configuration of land surface, altitude, latitude, slope, aspect and exposure
- ▶ **Edaphic factors:** It includes physical properties of soil, chemical properties of soil.
- ▶ **Biotic factors:** It includes plants, wild animals, insects-pests, man and his domesticated animals.

Climatic factors (Atmosphere and Climate)

- ▶ Atmospheric gases
- ▶ Light or Solar radiations
- ▶ Heat and Temperature
- ▶ Moisture
- ▶ Air currents or wind

Atmospheric gases

► Oxygen

1. Earth's atmosphere contains 21 per cent of oxygen
2. Oxygen is needed for energy generation in almost all the living organisms except chemosynthetic bacteria
3. Anything that impairs with photosynthesis will have impacts of oxygen and thereby affect the life processes.
4. Burning takes place in the presence of Oxygen only

► Nitrogen

1. About 79 % of nitrogen is present in the atmosphere
2. It is also an essential element which is needed in amino acids, nucleic acids and various other enzymes.
3. Nitrogen is absorbed by plants from the soil as nitrates and then nitrogen compounds are transferred from plants to other organisms through food chain. Nitrogen is released back to atmosphere as a result of death and decay of organisms.
4. Availability of nitrogen in the soil effects growth and development processes.

► Carbon dioxide

1. About 0.04 % of the volume of the atmosphere consist of carbon dioxide
2. Source of CO₂ in the atmosphere combustion or decomposition of plants, the breathing of animals, volcanoes, combustion of coal and lignite, from various minerals as for instance calcium carbonate.
3. Plants, except certain parasites and saprophytes, take up carbon dioxide for photosynthesis
4. After death and decay of organisms, carbon is converted back into carbon dioxide, and returned to the atmosphere; hence, plants form an important link in the movement of carbon dioxide.
5. Being a greenhouse gas, CO₂ has impacts on global as well as local climates and weather changes.

Atmospheric gases

► Solid bodies

1. solid bodies remain in suspension due to their light weights and minute size
2. These bodies are carried about by air currents and may be deposited in certain localities.
3. Further, certain quantity of these solid bodies are also distributed along with rain, snow, or hail.
4. Amongst the substances which are brought to the ground in this way, are calcium carbonate, magnesium carbonate, sodium chloride, calcium sulphate, ferric oxide, alumina, silica, organic nitrogenous matter, etc.
5. Solid particles in the atmosphere act as condensation nuclei and help in the condensation process and also enriches the soil, where they get deposited.

► Ammonia and Nitric Acid

1. Ammonia and nitric acids are in limited quantities and they supply nitrogen to forest plants in adequate quantities sufficient for the formation of seeds.
2. A certain quantity of ammonia and nitric acid is brought into the soil by the annual rainfall and helps in meeting the requirements of forest for its growth and development.
3. Species belonging to Leguminosae family are capable of absorbing nitrogen directly from atmosphere and assimilating them into amino acids.

Light or Solar radiations

Solar radiations are important for:

- ▶ Sunlight is needed for the formation of chlorophyll in green plants. The amount of chlorophyll in turn affects the quality and quantity of photosynthesis by leaf tissues.
- ▶ Sunlight influences daily opening and closing of stomata which in turn influences the vital processes such as transpiration, absorption and release of CO_2 and O_2 , thereby, controls rate of respiration and photosynthesis
- ▶ Sunlight is required in the process of photosynthesis by green plants which in turn influences growth and development of whole plant.
- ▶ The position of leave in many plants changes during the day in order to affect the angle of incoming light.
- ▶ Leaves are the plant part which is most susceptible and undergo the greatest change in response to light. The continuous exposure of leaves to sunlight results in the formation of palisade cells which are placed at right angles to the leaf surface. The amount of palisade tissue developed in the leaves of the same plant may vary from one position to another position.
- ▶ The Form and structure of plants is affected by Light and also influences certain physiological functions considerably. The elongation of stem and branches is a response to light in forest. Lack of light is the main stressor for vegetation on the forest floor.
- ▶ Light intensity and light quality has a relation with phototropic effects
- ▶ Intensity of light determines the growth of trees by affecting rate of photosynthesis.
- ▶ Good light conditions have a positive role in improvement of resistance to cold and drought as well as to disease, insect attack, and other unfavorable influences.
- ▶ have a tendency to bend towards the light. The amount of light is greatly influenced by latitude, altitude and season which in turn affect many processes directly which require light such as flowering, fruiting, and dormancy.

Photoperiodism and its importance

- ▶ Photoperiodism is the phenomenon of physiological changes that occur in plants in response to relative length of day (i.e. photoperiod).
- ▶ The photoperiodism was first discovered by Garner and Allard (1920).
- ▶ Thus, the length of the growing season influences the degree to which a tree will stand shade. Thus, the kind of species or plants in a locality greatly depends upon length of photoperiod. Based on this, the plants are classified into three main categories:
 1. **Short day plants (SDP) or long-night plants**
 2. **Long day plants**
 3. **Day neutral plants (DNP):**

Short day plant	Long day plant
Plants flower when photoperiod is less than the critical day length	Plants flower when photoperiod is more than the critical day length
Interruption during light period with darkness does not inhibit flowering	Interruption during light period with darkness inhibit flowering
Flowering is inhibited if the long dark period is interrupted by a flash of light	Flowering occurs if the long dark period is interrupted by a flash of light
Long continuous and uninterrupted dark period is critical for flowering	Dark period is not critical for flowering
Flowering does not occur under alternating cycles of short day and short light period.	Flowering occurs under alternating cycles of short day followed by still shorter dark periods Phytochrome

Light and shade in relation to tree growth are of the greatest importance in practical silviculture, especially in the regeneration, tending of woods, the composition of mixed woods, etc. The most important period in this respect is early youth, because at that time several species require some shelter, either against heat or frost. If that shelter, on the other hand, is excessive the young trees may be permanently injured, or even die. Some species, which are shade bearing, require a certain amount of shelter, or protection, during early youth, therefore, are called “**shade demanding**”.

Heat and Temperature

Temperature has a diversity of effects on vegetation and other living beings. The effects may be summarized in the following point:

- ▶ It affects the organisms through its effect on various metabolic processes.
- ▶ It increases rate of transpiration, respiration and photosynthesis which in turn results in growth and development of species or organisms.
- ▶ It enhances microbial activities in the soil which results in faster recycling of organic wastes and releases nutrients into soil which are subsequently taken up by plants for their growth and development. Thus, temperature results into diversity of species in an area. The more the temperature the more diversity of species will be there. For example, tropical region have very high species diversity in comparison to the colder temperate or alpine regions of the world.

Effects of very high temperature on plants

- i) The solar radiation directly as well as through its influence on air temperature provides heat to the plant body and helps in satisfactory initiation and continuation of various physiological activities, e.g., transpiration, photosynthesis and respiration.
- ii) High temperature increases transpiration while low temperature decreases it.
- iii) Increase of temperature upto 25° C increases photosynthesis, after that it decreases sharply
- iv) the rate of respiration increases as temperature rises from 0°C to 40°C but it decreases when temperature is below 0°C or higher than 40°C.
- v) Seed germination is highly dependent on temperature. Soil temperature is one of the major environmental factors that influence not only the proportion of germinated seeds, but also the rate of emergence and the subsequent establishment, even under optimum soil and irrigation conditions.
- vi) most of the enzymes are active within the range of 30–45°C, beyond 45°C they get denatured and deactivated
- vii) Very high temperature results into loss of humidity and thus, adversely affects the plants.
- viii) Seedlings are highly sensitive and affected due to wilting. Severe wilting results into seedling mortality.
- ix) Excessively high temperature results into cracking of stems particularly those having thin bark.

Effects of very low temperature on plants

Excessively low temperature below 5°C results into **frost and snowfall**. Both of these phenomenon are harmful for plants.

A) Harmful effects of frost

1. During frost nights, the water below the soil freezes. In the morning when sun rises, the solar radiations causes leaf surfaces to heat up and accelerate the rate of transpiration. Whereas the water below the soil is still frozen resulting into partial or permanent death of plants.
2. Frost lifting is a phenomenon which results into uprooting of young seedlings as a consequence of volume increment inside the earth due to freezing of water. This causes unearthing of soil.
3. Frost also causes damage to cells due to freezing of water which in turn results into damage to protoplasm and cell wall.
4. Frost causes damage to the wood due to freezing of water and increase in volume, thus resulting into cracking of wood tissues known as **frost crack**. IN the course of time a callus is formed by plants to cure the damaged portion, however, continued damage to this site by frost results into failure of the function of callus and develops a site which is easily affected by fungi. This is called **frost canker**.

B) Beneficial effects of Snow

1. Heavy winter snowfall and thus, low temperature is essential for the germination of temperate species such as deodar
2. Snow recharges streams and reservoirs
3. Snow acts as blanket and prevents further drop in temperature and thereby safeguards seedlings and vegetation from the damaging effect of excessive cold and frost.

C) Injurious effects of snow

1. It causes mechanical bending of tree bole and branches
2. Breaking of tree crown and branches results from heavy accumulation of snow
3. Soil erosion and uprooting of trees results from sliding snow

Effect of air temperature

1. The air temperature provides heat to the plant bodies and helps in completion of various physiological activities such as respiration, photosynthesis and transpiration. High temperature enhances transpiration whereas low temperature reduces it. Rate of photosynthesis is increased by temperature upto 25°C and decreases after that. Similarly respiration rate is increased as temperature increases from 0°C to 40°C however the same is decreased below 0°C and above 40°C.
2. Air temperature increases microbial activities and thereby enhances decomposition or degradation processes in the ecosystem. It also helps in release of nutrients in the soil and thus makes them available to plants for absorption.
3. Enzyme activities are influenced by air temperature. Very high temperature (above 50°C) and very low temperature (below 0°C) causes ceasing of enzyme activities.
4. Air temperature enhances metabolic and divisional activities in cambium cells in shoot.
5. As air temperature affects various physiological activities through its effect on enzymes and other activities, thus, it affects growth and development of plants.
6. Temperature is essential for seed germination.

Effect of soil temperature

1. Soil temperature affects absorption of moisture and nutrients. However, temperature rise above 35°C causes adverse action on absorption as at this rise in temperature affects the permeability of plasma membrane.
2. Soil temperature affects cambial activities particularly in temperate climate. The activity gets increased during warmer soils whereas decreased in colder soils.

Importance of water

Water is fundamental to the vital processes of plants, animals and other organisms. The significance of water to organisms can be understood by the following facts:

- ▶ It supplies the soil with water, where it is taken up by the roots of the trees.
- ▶ It governs the degree of transpiration from the leaves of the trees.
- ▶ Water is present in all protoplasm, all cell walls and vacuoles. The water in vacuoles causes turgidity and growth of cells and thus, of organisms.
- ▶ Water is an important constituent of carbon / food assimilation process during photosynthesis and is, thus, directly assimilated. Carbon assimilation gets retarded in non-turgid plants and ceases in wilted plants.
- ▶ Ascent of sap in stems results in absorption of nutrients and its transfer to various organs.
- ▶ Respiration also requires water and the process is ceased when the water content drops below a certain minimum.
- ▶ Water causes cooling of plant and animal body through sweating in animals and transpiration in plants.
- ▶ Water is necessary for all movements due to swelling and irritability.
- ▶ Structure of plants is influenced to a great extent by the water in the atmosphere and soil. Water is available for the trees through air or through soil. Water is mainly absorbed from soil by the roots of the plants.

Air currents or wind

Air currents or winds may affect the forest trees the following ways:

- ▶ By unfavourably modifying the temperature and moisture of a locality
- ▶ By injuring, breaking, bending, or overturning them
- ▶ Dry winds frequently reduce the moisture of a locality to a dangerous degree; moist and cold winds may reduce the temperature, and thus, interfere with the healthy growth of the trees.
- ▶ Strong winds may break the leading shoots or side branches, cause trees to assume a curved shape, or even throw single trees and whole woods to the ground.

Suggested readings

1. **Earnst, D.S., Beck, E., Klaus, M.H.** *Plant Ecology*. NewYork : Springer, 2002.
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3. **Toumey, J. W. and Korstain, C.F.** *Foundations of Silviculture: Upon an Ecological Basis*. Second Edition, Revised. NewYork, London : John Wiley & Sons, Inc. Chapman & Hall. Ltd, 1947.
4. **Khanna, L S.** *Principles and Practice of Silviculture*. Dehra Dun : Milton Book Company, 1999.
5. **John, E.W., Clements, F.E.** *Plant Ecology*. NewYork : McGraw-Hill Book Co.,, 1929.