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Plant Ecology, Conservation and Phytogeography

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UNIT – I

Factors of Environment

Interpretation of Effects of Climate, Edaphic,Topographic and Biotic factors on vegetation

The integrated **effects** of the individual processes, are observed at the level of populations, communities, or ecosystems.

Climatic factor

The main natural elements that define the climate, are solar radiation, wind, and humidity, in the form of vapour and precipitation act directly on the growth, survival, reproduction, and movement of individuals

Edaphic factors

These factors affect the ability of soil to sustain biological production and diversity, regulate and partition water, filter and buffer contaminants, store and cycle nutrients, and provide plant support. The role of the edaphic factor in generating habitats within which plants and their associated organisms live, interact, reproduce, and diverge over time. Plants generally obtain nutrient elements and water from soil. Thus, soil features that affect the availability and uptake of nutrients and water are of great importance to plants. Texture is important for plant growth because it influences water availability and soil fertility, that is, the ability of a soil to supply nutrients to plant roots. Open spaces among soil particles represent the pore space of a soil. This pore space may be filled by water, air, or plant roots. Thus, the amount of pore space greatly influences the amount of water that a soil can contain. Soil depth can greatly influence the types of plants that can grow in them. Deeper soils generally can provide more water and nutrients to plants than more shallow soils. Organic matter in soils ranges from recognizable plant parts (roots, leaves, stems) to humus, which is partly decomposed plant material that is amorphous and spongy in nature. Organic matter contributes to a soil's ability to retain nutrients and water. Soil pH is an extremely important ecological parameter. Its most important effect on plant growth is its influence on ion availability in the soil solution.

Topographic factor

Both environmental factors and soil properties can affect topographic variation in soil respiration. Generally, soil moisture declines as elevation along a slope increases. Moreover,due to soil classifications, soil type is often different from each other between low and high parts in a slope. Thus, slope scale should focus on the various topological scales to estimate topological effect on soil respiration.

Biotic factor

Nearly all species are influenced by biotic factors in one way or another. If the number of predators was to increase, the entire food chain would be affected as any prey falling below that specified predator in the food chain will become prey. If the prey is not given enough time by the predator to repopulate, this could not only cause endangerment and extinction in the prey, but the predator as well. Contradicting a decrease in population size, if a particular species reproduces too rapidly, this will cause an increase in population size, thus affecting the environment around them.

Pathogens and Disease Outbreaks -When disease outbreaks occur, it can be detrimental to an ecosystem. When a disease hits, it will usually affect more than one species, thus causing a serious outbreak. This has the potential to set off a chain reaction thus, causing endangerment to a variety of species within that ecosystem.

Human Contact-Humans make the most sudden and long-term changes in an environment (e.g. pollution and waste). These changes can either drive species out of their territory or force them to adapt to their new surroundings. These changes have the largest impact on an ecosystem's population size, typically causing a serious decrease.

Principle of Limiting factor

In biology, the term *limiting factor* is defined as an environmental factor or variable that has the capacity to restrict growth, abundance, or distribution of a population in an ecosystem. These factors are present in limited supply. Different limiting factors affect the ecosystem. They are (1) keystone species, (2) predators, (3) energy, (4) available space, and (5) food supply.

Principles and laws

The principle of limiting factors is defined as the principle whereby a factor that is in shortest supply will limit the growth and development of an organism or a community. Liebig's *law of the minimum*, Blackman's *law of limiting factor*, and Shelford's *law of tolerance* are the laws that explain the principles of limiting factors.

Liebig's *law of the minimum*

Law of the minimum was originally developed by Carl Sprengel and then later popularized by Justus von Liebig. This law states that the growth is regulated by a limiting factor, i.e. the scarcest resource, rather than by the total resources available.

Blackman's law of limiting factor

The law of limiting factor was proposed in 1905 by the British plant physiologist, Frederick Frost Blackman. According to this law, a process that depends on multiple factors will have a rate limited by the pace of the slowest factor. Photosynthesis, for example, is a biological process that depends on multiple factors. The general chemical reaction of photosynthesis is $6CO_2+12H_2O+energy=C_6H_{12}O_6+6O_2+6H_2O$. Based on this equation, CO_2, H_2O, and light energy (sunlight) are the limiting factors of this reaction. If any of them become accessible at a pace slower or lower than the usual, the rate of photosynthesis is expected to become slow based on the pace of the slowest factor. For example, if CO_2 concentration becomes scarce (e.g. due to closure of stomatal openings in response to elevated temperatures in the environment), the rate of photosynthesis becomes slow even if H_2O and light energy levels are amply available. The same result will occur if light energy becomes less available or less intense, the rate of photosynthesis will be slower despite the abundance of CO_2 and H_2O. Light becomes a limiting factor in photosynthesis when the plant is unable to collect light, for instance, due to shade resulting from the dense population of plants.

Shelford's law of tolerance

The *law of tolerance* was developed in 1913 by American zoologist Victor Ernest Shelford. It states that the success of an organism depends on a complex set of environmental conditions (environmental factors). And that organism would have definite *minimum*, *maximum,* and *optimum* environmental factors that determine success. These signify the limit of tolerance of that organism. However, the tolerance ranges may vary within the same organism, for example depending on the life stage (larval vs. adult).

Types of limiting factors

Density-dependent limiting factor definition

Density-dependent limiting factor refers to the factor restricting the size of a population based on density. A large, dense population are more strongly affected than a small or less dense population. For example, a dense population would have higher demands for food and water compared to a small population. In this case, food and water supply is the limiting factor and it depends on density. Disease as a factor is also density-dependent. It spreads faster in dense population than small ones.

Density-independent limiting factor definition

Density-independent limiting factor refers to the limiting factor that is not dependent on density. The limiting factor can restrict population size independent of how dense the population is. For example, a catastrophic event, such as an earthquake or a volcanic eruption, could cause a population decline regardless of population density.

Single-limiting and co-limiting

A *single-limiting factor* is when there is one factor that limits the system. A *co-limiting factor* is when a factor affects the population of organisms in an ecosystem indirectly but increases the limitation of the factor directly affecting the population.

Limiting factors examples

The common limiting factors in an ecosystem are food, water, habitat, and mate. The availability of these factors will affect the carrying capacity of an environment. As population increases, food demand increases as well. Since food is a limited resource, organisms will begin competing for it. The same thing goes for space, nutrients. Since these resources are available for a limited amount over a given period of time, inhabitants of a particular ecosystem will compete, possibly against the same species (intraspecific competition) or against other group of species (interspecific competition). In the wild, another predominant symbiosis is the predator-and-prey relationship. The deer populations, for instance, could decline if predation is high. If the number of wolves is relatively greater than the number of deer as their prey, the number of deer could drop. However, with the dwindling number of deer, the number of wolves could also eventually decline. This predator-prey factor is an example of a biotic factor in an ecosystem.

Physical and Biological Limiting Factors

Physical factors or *abiotic factors* include temperature, water availability, oxygen, salinity, light, food and nutrients; These physic - chemical factors include sunlight, humidity, temperature, atmosphere, soil, geology of the land, and water resources. Temperature, for instance, is a major limiting factor primarily due to the fact it affects the effectiveness of enzymes and catalysts, which are essential in an efficient system, both biological and chemical.

Resources

Resources such as food, water, light, space, shelter and access to mates are all limiting factors. If an organism, group or population does not have enough resources to sustain it, individuals will die through starvation, desiccation and stress, or they will fail to produce offspring. In the case of photosynthesizing organisms such as plants, light is a vitally important limiting factor, essential for their growth. This is most prominent in understory plants of a forest, where photon energy from light is made less available, as it is unable to penetrate through higher canopy levels. However, many different plants are adapted to withstand different levels of light, allowing them to survive with less light energy input.

As well as light, growth of plants is limited by the availability of the nutrients nitrogen (N), phosphorus (P), potassium (K) and sulfur (S). Each plant needs a specifically balanced ratio of these nutrients in order to survive. If one of the nutrients is not present in sufficient amounts, this is considered the limiting factor to growth.

Environmental Conditions

Limiting factors are also present as environmental conditions. Two of the most prominent examples are temperature and precipitation; these are widely affected by the climate, and seasonal changes within the climate. Although sunlight tends to be a factor which controls the temperature of a habitat, and thus affects photosynthesis in terms of photon energy, correct temperature is also important for *catalyzing enzymes* in photosynthetic reactions. Above the optimum temperature, enzymes are catalyzed at an increased rate, which can lead to *denaturing* of the enzymes. This is called a *light independent reaction*. Increased temperature also leads to desiccation of leaves, as it causes increased *evapotranspiration* and removes too much water from the plant. Conversely, if temperatures fall too low, frost may form on leaves, which damages the cell walls and cell contents.

The amount of precipitation in an environment is also important for plants. The absorption of water as a resource is vital for plant growth and other functions, so lack of rainfall can lead to wilting, scorching and damaged cells. Precipitation is also important because many plants are evolved to withstand different amounts of atmospheric humidity. As the thin, tough leaves of cacti make them specifically adapted to surviving in hot and arid conditions, too much rainfall can affect their ability to reproduce, which in turn restricts the population growth. Too much rainfall may also flood the soil, reducing the amount of oxygen available to the roots, causing root loss or leaving the plants susceptible to fungal damage.

Biotic factors

Limiting factors can also be categorise as biological factors or *biotic factors.* As well as resource and climatic factors affecting population growth, biotic factors such as *predation*, *herbivory*, *parasitism*, and interspecific and intraspecific competition, are also limiting factors; these tend to be density dependent factors.

Parasitism, like disease, is generally more destructive to large, dense populations because the parasite is able to effectively parasitize more individuals if they are in close contact. Within tropical ecosystems, the *Cordyceps* fungus is a prominent parasite, and has many strains specialized on different species. Because it is such a successful parasite, it keeps many populations down, working as a limiting factor, and it is thought to be one of the main reasons that most species in tropical rainforests are *rare*. The availability of host species, which the *Cordyceps* fungus can parasitize, is a limiting factor for the fungus.

Human Limiting Factors

The increase in human population is responsible for placing many limiting factors on species that did not historically exist. Density dependent limiting factors such as decreased availability of space due to deforestation is a global issue, causing decline and extinctions in many populations. Resources are also increasingly scarce due to hunting and leaching of nutrients from soil, which causes intraspecific and interspecific competition within and between populations. Removal of predators has also disturbed the balance of natural biotic, cycle of predators and prey; in some cases, prey animals have been able to thrive in the absence of predators, exceeding the carrying capacity of ecosystems and causing environmental damage. Predators have also been introduced as *invasive species* into ecosystems, putting pressure on prey populations and thus on the prey’s natural predators.

There are also many density independent factors that have been caused by humans. Leaking pollutants and other habitat destruction has destroyed entire ecosystems. The onset of *climate change* as a result of burning *fossil fuels*, is rapidly increasing global temperatures, as well as changing weather patterns and increasing the rate of natural disaster events, such as hurricanes, floods, fires and more.

Trigger factors

1) High quantity of Exhaust gases: The biggest reason by far for all kinds of environmental damage is the exorbitant amount of gases, harmful to the environment, which is released by the various industries. Prime amongst these gases are C02, S02 and NH3. Of course there are many more, and these are the main culprits for ozone holes and global warming.

2) Deforestation: Close second comes the deforestation all over the world, to harness forest resources, to clear land, for wood and for various other reasons. Deforestation causes major problems for one simple reason; it decreases the number of trees, which clean the environment, provide oxygen and also affect rain patterns.

3) High number of industries such as mining: Mining creates a lot of pollution, mainly because it releases particulate matter, which qualifies as Respirable Particulate Matter (RPM); the particulate matter which can enter our lungs and can harm the entire respiratory system.

4) Chemical effluents: Effluents are another by-product of industries which poses threat to the environment, leather and tanning industries, petroleum industries and chemical manufacturing industries create major waste products which are released directly into nearby streams without treatment, creating river pollution and causing harm to aquatic life.

5) Transport: As the spending power of the population increases and as cars become available more, the number of vehicles on the road increases. Smog is a nuisance that is created because of vehicular pollution, and Hydro-Carbons released from engines are the cause of creation of lower level ozone that is harmful to humans.

6) Unprecedented Construction: Construction causes removal of vegetative cover which usually allows for better exchange of heat. This effect causes constricted circulation of air, which traps pollutants released in urban areas and does not allow for mixing of the air, thus decreasing the air quality.

7) Secondary Pollutants: Secondary pollutants are ones that are not directly emitted; however they get created when primary pollutants react amongst themselves. Major amongst them is the creation of ozone from reaction between non-burnt Hydrocarbons and Nitrous Oxides.

8) Ruinous agricultural policies: Overloading the land with fertilizers, overgrazing and shifting agriculture are ruinous agricultural policies that degrade land, creating soil erosion that leads to silting in major rivers and reservoirs. Soil degradation is a continuous cycle and it ultimately leads to desertification and degradation of land quality by allowing the direct action of eroding agents on cultivable land.

9) The Population Explosion: The increasing population creates a load that the entire environment has to support, not only in terms of food and lodging, but also in terms of the amount of waste that it generates and the ability of the environment to sustain this growth.

10) Unplanned Land-use policies: Land models are available these days which help in proper planning and use of land resources. However, failure to use these models and land management policies can lead to land pollution and degradation of the worst kind. Extraction from mines renders them unusable for habitation and if rehabilitation work is not carried out, the piece of land is sure to lose all its value and become unusable. Land classification is one of the major activities that help in proper land use, and it should be followed with utmost care.

Holistic environment

The holistic approach in **ecology** and **environmental science** derives from the idea proposed by Harrison Brown that "a precondition for solving [complex] problems is a realization that all of them are interlocked, with the result that they cannot be solved piecemeal The holistic approach has been successfully applied to environmental management. The United States **Forest Service** , for example, has implemented a multi-level approach to management that takes into account the complexity of forest ecosystems, rather than the traditional focus on isolated incidents or problems.

Population Ecology

In **population biology**, the term *population* refers to a group of members of a species living in the same area.Population is a set of individuals of a particular species, which are found in a particular geographical area. The population that occupies a very small area, is smaller in size, such a population is called local population. A group of such a closely related local population is called meta-population.

The definition of *population ecology* is the study of how various factors affect population growth, rates of survival and reproduction, and risk of extinction. Population ecology is an important area of ecology because it links ecology to the population genetics and evolution. Natural selection operates at a levels of population.

Population Growth:

The size of a population for any species is not a static parameter, it keeps changing with time.
It depends on the following factors:
(i) Food availability (ii) Predation pressure (iii) Weather

Population Growth curve

The growth is one of the dynamic features of species population. Population size increases in a characteristic way. When the number of individuals of population is plotted on the y-axis and the times on the x-axis, a curve is obtained that indicates the trend in the growth of population size in a given time. This curve is called population growth curve.

There are following two models of population growth:

Exponential Growth:

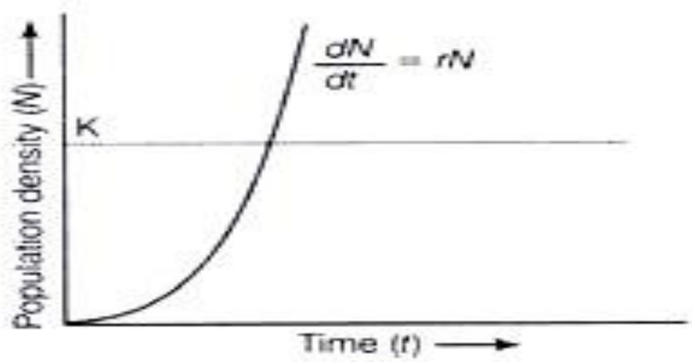

Fig. 13.5 Population growth curve showing exponential growth

Availability of resources (food and space) is essential for the growth of population. The unlimited availability results in population exponential. The increase or decrease in population density (N) at a unit time period (t) is calculated as (dN/dt)

Let dN/dt = (b – d) XN

Let (b-d) = r, then, dN/dt = rN

Where, N is population size, b is birth per capita

d is death per capita, t is time period

and r is intrinsic rate of natural increase.

r, is an important parameter that assess the effects of biotic and abiotic factors on population growth. It is different for different organisms.

Integral form of exponential growth is Nt = N0ert

Where,

Nt = Population density after time t,

N0 = Population density at time zero (beginning),

r = Intrinsic rate of natural increase,

e = Base of natural logarithms (2.71828).

Any species growing exponentially under unlimited resource conditions, without any checks can reach enormous population densities in a short time.

Logistic Growth:

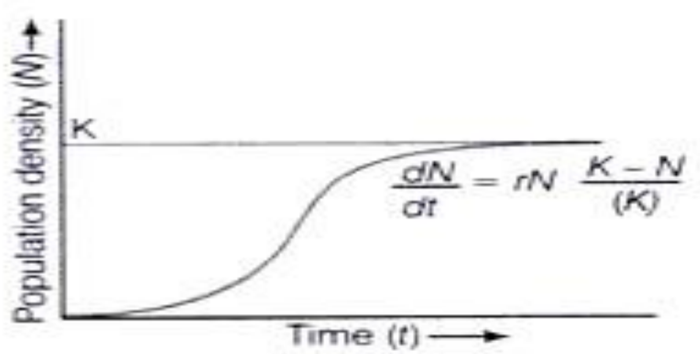

Fig. 13.6 Population growth curve showing logistic growth

Practically, no population of any species in nature has unlimited resources at its disposal. This leads to competition among the individuals and the survival of the fittest. Therefore, a given habitat has enough resources to support a maximum possible number, beyond which no further growth is possible.

This is called the carrying capacity (K) for that species in that habitat. When N is plotted in relation to time t, the logistic growth show sigmoid curve and is also called Verhulst-Pearl Logistic Growth and is calculated as

$dN/dt = rN (K – N/K)$

Where, N is population density at time t K is carrying capacity and r is intrinsic rate of natural increase. This model is more realistic in nature because no population growth can sustain exponential growth indefinitely as there will be completion for the basic needs.

Characteristics of Population Ecology

A population is all of one kind of species residing in a particular location. *Population size* represents the total number of individuals in a habitat. *Population density* refers to how many individuals reside in a particular area.

Population Size is represented by the letter N, and it equals the total number of individuals in a population. The larger a population is, the greater its generic variation and therefore its potential for long-term survival. Increased population size can, however, lead to other issues, such as overuse of resources leading to a population crash.

Population Density refers to the number of individuals in a particular area. A low-density area would have more organisms spread out. High-density areas would have more individuals living closer together, leading to greater resource competition.

Population Dispersion: Yields helpful information about how species interact with each other. Researchers can learn more about populations by studying they way they are distributed or dispersed.

Population distribution describes how individuals of a species are spread out, whether they live in close proximity to each other or far apart, or clustered into groups.

- *Uniform dispersion* refers to organisms that live in a specific territory. One example would be penguins. Penguins live in territories, and within those territories the birds space themselves out relatively uniformly.
- *Random dispersion* refers to the spread of individuals such as wind-dispersed seeds, which fall randomly after traveling.

- *Clustered or clumped dispersion* refers to a straight drop of seeds to the ground, rather than being carried, or to groups of animals living together, such as herds or schools. Schools of fish exhibit this manner of dispersion.

Biotic potential

Biotic potential is described by the unrestricted growth of populations resulting in the maximum growth of that population.

Quantitative Expression

The biotic potential is the quantitative expression of the ability of a species to face selection in any environment. The main equilibrium of a particular population is described by the equation:

Number of Individuals = Biotic Potential/Resistance of the Environment (Biotic and Abiotic)

Age Structure

Another characteristic of populations that ecologists measure is **population age structure**. This characteristic is as simple as it sounds: it's a summary of the number of individuals of each age in the population. Age structure is useful in understanding and predicting **population growth**.

For instance, if you know the age of first reproduction and reproductive strategy of a population, from the **life history** we mentioned earlier, then you can predict future population growth patterns based on **age structure data**.

If most of the individuals in the population are below the age of first reproduction, then you can predict that in the near future, the population is likely to grow. However, if most of the individuals are beyond reproductive age, then you can expect the population to shrink. An understanding of population age structure is critically important to industries that harvest living organisms.

Ecologists use nifty graphs called **age pyramids** to depict the age structure of populations. Age pyramids show age groups like 0–4, 5–9, or 10–14, along the vertical axis (*y*-axis) and population size along the horizontal axis (*x*-axis). Each age group is broken into males and females, with a bar graph for each running horizontally to the left and to the right. Human age pyramids from different countries are especially interesting to examine. In industrialized countries, the age pyramids are often not pyramid-like at all, with the largest numbers of people near the middle or top of the graph. In developing countries, however, the vast majority of people are in the youngest age categories, with few surviving to older ages.

Community Ecology

A group of organisms constitute population. Each population has characteristics like natality, mortality, age structure, growth dynamics and so on. But when several populations share a common habitat and its resources, they interact among themselves and develop into a biotic community or simply, a community. Community represents the population of all species living and interacting in an area at a particular time.

Microorganisms, plants and animals populations sharing a common habitat and interacting among themselves develop into biotic communities. Thus the climate and other abiotic as well as biotic conditions of a habitat determine the type of community which survives and develops. Each biotic community exhibits a number of characteristics, such as diversity, density, dominance, composition and stratification. The transitional zone or junction between two or more diverse communities is called "eco-tone".

Structure of Community:

Communities may be small, consisting of few species populations in a small space, or large, comprising several species populations in a large area. The community structures, composition and other characteristics can be readily described by visual observation without actual measurement.

This is a qualitative approach which is easier than the quantitative population analysis where measurements are actually made. For instance, depending on the amount of water availability, plant communities may be hydrophytic (aquatic habitats), mesophytic (moderately moist soil habitat) and xerophytic (dry or arid habitat).

Similarly communities growing on conditions of abundant light are called heliophytic and those growing in shade sciophytic. Identically communities growing on various habitats designated as desert communities, mountain communities and estuarine communities and so on.

A stable and mature community is called a climax community, while communities of successional stages are called seral communities.

Community Dynamics:

Communities are dynamic systems constantly interacting with another system, the environment, which is equally dynamic. Seasonal changes in plant communities always occur at every place, particularly in areas where temperature variation is significant. However, in course of very long period of time at many places the communities have reached a peak stage and attained a dynamic balance with the environmental changes. The process of change in communities and their environment at one place in the course of time is called “ecological succession

There are two types of communities. These are major and minor community:

(a) Major Community: It is a large community which is self-regulating, self-sustaining and independent unit comprising of a number of minor communities in it. Examples of major communities are: a pond, a lake, a forest, a desert, a meadow and grassland. Each of these major communities includes several minor communities.

(b) Minor Community: It is a smaller community which is not a self-sustaining unit. It is dependent on other communities for its existence. The major community exemplified by a forest has many minor communities namely the plant community (the plant population of the forest), the animal community (the animal population of the forest) and the microbial community (bacteria and fungi population).

Characteristics of a Community:

(a) Structure: Structure of a community can be studied by determining the density, frequency and abundance of species.

(b) Dominance: Usually a community has one or more species which occur in large number. Such species are called dominants and the community is often named after them.

(c) Diversity: The community consists of different groups of plants and animals of different species, may be large and small, may belong to one life form or another but are essentially growing in a uniform environment.

(d) Periodicity: This includes study of various life processes (respiration, growth, reproduction etc.) in the various seasons of the year in the dominant species of a community. The recurrence of these important life processes at regular intervals in a year and their manifestation in nature is termed periodicity.

(e) Stratification: Natural forest communities possess a number of layers or stores or strata related to the height of plants, for example, tall trees, smaller trees, shrubs and herbaceous layers form the different strata. This phenomenon in a plant community is called stratification.

(f) Eco-tone and Edge-effect: A zone of vegetation spreading or separating two different types of communities is called eco-tone. These are marginal zones and are easily recognizable.

(g) Ecological Niche: Different species of animals and plants fulfill different functions in the ecological complex. The role of each is spoken of as its ecological niche i.e. the role that specie plays in its ecosystem: what it eats, who eats it, its range of movement etc., in other words, the total range of its interaction with other species of its environment.

(h) Interspecific Association: This is the study of two or more species growing together in close association in regular occurrence.

(i) Community Productivity: The study of production of biomass (organic matter) is known as production ecology. The net production of biomass and storage of energy by a community per unit time and area is called community productivity.

(j) Biotic Stability: A biotic community has the ability to quickly regain equilibrium after a disturbance in population fluctuation. This is called biotic stability and is directly proportional to the number of interacting species it contains i.e. the diversity in the community.

Climate Change

The Earth absorbs sunlight, then radiates it as heat. Some of this infrared radiation is absorbed by greenhouse gases in the atmosphere, and is trapped on Earth instead of escaping into space. Concentrations of gases such as CO_2 (~20%), ozone and nitrous oxide are not temperature-dependent, and are hence considered external forcing. Ozone acts as a greenhouse gas in the lowest layer of the atmosphere, the troposphere (as opposed to the stratospheric ozone layer).

Human activity since the Industrial Revolution, mainly extracting and burning fossil fuels (coal, oil, and natural gas), has increased the amount of greenhouse gases in the atmosphere. These elevated levels of gases such as CO_2, methane, tropospheric ozone, CFCs, and nitrous oxide drive up temperatures via radiative forcing. CO_2 emissions primarily come from burning fossil fuels to provide energy for transport, manufacturing, heating, and electricity. Additional CO_2 emissions come from deforestation and industrial processes, which include the CO_2 released by the chemical reactions for making cement, steel, aluminum, and fertilizer. Methane emissions come from livestock, manure, rice cultivation, landfills, wastewater, coal mining, as well as oil and gas extraction. Nitrous oxide emissions largely come from the microbial decomposition of inorganic and organic fertilizer.

Climate change, on the other hand, is a **long-term change in the Earth's weather patterns**brought on by those same greenhouse gas emissions. While climate changeincludes rising global temperatures, it also comprises of many other impacts those greenhouse gases are having on the planet, which even includes some regions getting colder!

Just as fluctuations in Earth's temperature is natural, a changing climate is a natural aspect of life on Earth. However, the term climate change refers to unexpected, abnormal, and longerterm changes brought on by human activity.

The effects of climate change include a broad range of changes, which, over the last century, have become undeniable. There have been more droughts, floods, and heat waves, sea levels have risen, biodiversity has been lost, and wildfires and hurricanes have become more intense than ever before. All of which point to a dramatically and rapidly changing climate.

Where global warming refers to one process (rising global temperatures due to increased greenhouse gas production), climate change encapsulates all the symptoms experienced as a result of pollution and greenhouse gas production damaging and altering our environment.

Global Warming

Where global warming refers to one process (rising global temperatures due to increased greenhouse gas production), climate change encapsulates all the symptoms experienced as a result of pollution and greenhouse gas production damaging and altering our environment.

Global warming refers to a steady and consistent rise in global temperatures and is therefore only one aspect of the broader phenomenon of climate change. Though the Earth's temperature fluctuates over long periods of time (hundreds to thousands of years), the term **global warming most commonly refers to the rising temperatures brought on by human activities** over the last 100 to 150 years.

This increase is caused by an excess of greenhouse gas emissions (carbon dioxide, nitrous oxide, methane, ozone, and water vapor) in the Earth's atmosphere - mainly due to the burning of fossil fuels since the industrial revolution. As the level of emissions trapped in the Earth's atmosphere continues to rise, so to do global temperatures.

Every year over the past decade, CO_2 concentrations (the most common greenhouse gas) have been steeply rising and are now at their highest levels in more than 60 years of observation.

Each year, scientists learn more about the consequences of global warming, and many agree that environmental, economic, and health consequences are likely to occur if current trends continue. Melting glaciers, early snowmelt, and severe droughts will cause more dramatic water shortages and increase the risk of wildfires in the American West.

Rising sea levels will lead to coastal flooding on the Eastern Seaboard, especially in Florida, and in other areas such as the Gulf of Mexico. Global warming means that Antarctica and Greenland ice sheets are melting and the oceans are expanding. Recent climate change would still cause a 6 meters (20 ft) sea-level rise even if greenhouse gas emissions were reduced in 2015 per a scientific paper in *Science*.

Low-lying areas such as Bangladesh, Florida, the Netherlands and other areas face massive flooding.

- Forests, farms, and cities will face troublesome new pests, heat waves, heavy downpours, and increased flooding. All those factors will damage or destroy agriculture and fisheries.
- Disruption of habitats such as coral reefs and Alpine meadows could drive many plant and animal species to extinction.
- Allergies, asthma, and infectious disease outbreaks will become more common due to increased growth of pollen-producing ragweed, higher levels of air pollution, and the spread of conditions favorable to pathogens and mosquitoes.