Landscape and Ecology

Lecture 1

Landscape

We will start with the term landscape. When we hear the term landscape we tend to imagine natural composition of land forms, vegetation and water. But landscape can be defined in many ways. Let's look at some of the definition of landscape

Landscape: it is a piece of land which we perceive comprehensively around us, without looking closely at single components, and which looks familiar to us. Another simpler definition of landscape is the total character of a region. From ecological perspective it can be defined as a mosaic of interacting ecosystems.

So landscape can be defined in many ways in different ecological and cultural perspectives. But it can also be considered as – a point in time expression of ecological, technological, and cultural influences. Now we will move to the next term ecology. Ecology is derived from the Greek termsoaks and logos. Oikos means the house or place to live and logos means the study of. So ecology is the study of relationships between living organisms and their physical environment. Now you might be wondering I am an architect why do I need to learn the relationship between organisms and environment. How will this knowledge help me? Well ecology focusses on the vital connections between plants, animals and humans. It helps us to better understand the world around us with this understanding we can design the built environment in ways that are compatible to the natural world. This knowledge will also be helpful in managing the natural resources and improving the environment. Nowwe will look at the subject matter of ecology. All matter in nature can be organized into many levels. Starting from atoms and molecules to the galaxies and universe. Ecology focusses on 5 of these levels starting from organism to biosphere. We will look at each level now. An organism is an individual living being. Population is a group of individual of same species living in a particular place. A community is population of different species living in a particular place and potentially interacting with each other. Ecosystems are community of different species interacting with one another and with their nonliving environment. And all these together make up the biosphere. As a broad biological science, ecology can be divided into many sub disciplines some of them are population ecology, community ecology, ecosystem ecology, landscape ecology and human ecology. But in this lecture we will be focusing on ecosystems and biospheres. Let's look at the components and processes of ecosystems. What is an ecosystem? Ecosystem is a collection of all the organisms that live in a particular area along with their nonliving, physical environment. Ecosystems are found both in land and in water. Ecosystem that are found in land are called as terrestrial ecosystem,whereas that are found in water is called as aquatic systems. Example for terrestrial ecosystems are forest and grasslands. Example for aquatic ecosystems are ponds, lakes and rivers. Ecosystems are both manmade and natural. Some of the examples of manmade ecosystems are agricultural fields and reservoirs. Though we talk about terrestrial and aquatic ecosystems there are no clear boundary between different ecosystems. They merge into one another.

For example in this case between a land ecosystem and aquatic ecosystem, a Marshall land is formed this transitional zone is called acetone. These Eco tones are ecologically very important. Because they contain organisms that are found in land ecosystem and aquatic ecosystem. At the same time they serve unique habitats or certain unique species. Ecosystems have two important components. They are biotic and abiotic.Biotic components are living organisms and abiotic components are nonliving things. This figure shows the key living and nonliving components in an ecosystem. Plants animals and microorganisms are example for biotic components whereas water, and energy are examples for abiotic components. Now we will learn about biotic and abiotic components a little in detail. You would have these basic things in environmental science courses. So I am going to just touch upon little important factors. Living organisms in ecosystem are classified as producers and consumers based on how get their food. Producers sometimes called as autotrophs make their own food from components obtained from the environment. Green plants and Algae are example for producers. Andall the other organisms are known as consumers. They depend on producers directly or indirectly for their food and these consumers can be further classified into primary consumers secondary consumers and tertiary consumers depending on their source of food. Primary consumers are animals that mostly eat plants where as secondary consumers feed on primary consumers and tertiary consumers feed on secondary consumers. Decomposers recycle the organic matter in ecosystem. They break down the dead organic materials to get nutrients and release the inorganic compound to the soil and producers make use of them. Ecology is assigned every type of organism in the ecosystem to different feeding levels as shown in this energy pyramid. Next we will move on to abiotic components. Physical and chemical factors that influence the living organism are known as a biotic components. This figure shows important abiotic components in Terrestrial ecosystem and aquatic ecosystems. Example of abiotic components in terrestrial ecosystems are sunlight, temperature, precipitation, wind, fire and soil. In aquatic life ecosystem light, water, dissolved nutrient concentrations, suspended solids and salinity are abiotic components.

Different species drive under different physical conditions. Some need bright sunlight and others thrive under better sunshade. For population of a particular species to stay elite grow and function normally a range of biotic conditions must be maintained. This is known as the range of tolerance of a population. But too much or too little component of biotic factor can limit or prevent the growth of a population. This is known as the limiting tractor. For example in Terrestrial ecosystem precipitation is often a limiting factor. Too little water limit the plant growth whereas too much of water can kill the plant. So limiting factor or factor is any condition that limits population growth. Limiting factor prevents the population from getting too large. Flow of matter and energy are important for sustenance of an ecosystem. There are two such floors one is one way energy flow from the sun and the nutrient cycling of key material. Solar energy warms the earth and supports photosynthesis process and the nutrients that are essential for the growth and survival of the organisms are cycled continuously through living organisms and then back to the nonliving environment. And this nutrient cycle is known as biogeochemical cycle. Carbon cycle Phosphorus cycle, nitrogen cycle, water cycle and oxygen cycles example for biogeochemical cycles. Now we will select one biogeochemical cycle that is water cycle and discuss how water is cycled to the environment. Now we will discuss about 1 important biogeochemical cycle that is water cycle.

Biogeochemical cycle that collects purified and distributes the earth's fixed supply of water from the environment to living organisms and then back to the environment is known as hydrologic or water cycle. As shown in this picture water moves downwards through precipitation and then again downwards through the infiltration process and then reaches the underground occupiers. Then it moves laterally on the surface runoff water bodies such as lakes, rivers and oceans. Then it most vertically through evapotranspiration from water bodies or plants and soils. Air masses and wind move the water vapor from one place to all the other parts of the world and then again true condensation it comes down to the earth downwards. This is the hydrological cycle but not only hydrological but all the other biogeochemical cycles are continuously disturbed by human impacts. We will discuss this human impacts on biogeochemical process later in this lecture. I will go back to the concept of limiting factor. Any factor or condition that limits the population growth is known as limiting factor. And related concept is carrying capacity. Carrying capacity is the maximum population of a given species that a given Habitat can support over a given period. As shown in this graph this graph shows a carrying capacity. If the number of population or organism is much below the carrying capacity then it continuous to increase. When it exceeds the carrying capacity then the population cannot be supported by the resources available in the ecosystem so it tends to decline. This increase of number of organisms over a carrying capacity is known as overshoot. The carrying capacity is again not fixed. It can decrease due to degradation of ecosystem or exhaustion of resources or the carrying capacity can be increased by exploitation of new resources. This graph again shows the carrying capacity here. In this case the organisms here exponentially grows and reaches the carrying capacity. As it nears the carrying capacity its growth rate tends to decrease and whenever there is an overshoot occurs the number of organisms again declines. So in general the number of organisms tend to fluctuate around the carrying capacity of an ecosystem. This graph shows the growth of world population from 1050 to 2050, 2000 years. For many centuries the growth rate was very slow but in the last 100 years it has increased tremendously. Just in the last 100 years the population has ground from 1.5 million to 6.5 Million. This has been made possible by changes in the agricultural technology and increasing the carrying capacity in the earth. But continuing to increase the carrying capacity how many people can the earth support indefinitely. This is a question that something we all need to think about.

Concepts in Ecosystem

Now we will move to the other concepts in the ecosystem such as ecological succession, biodiversity and Ecosystem stability. Ecosystems are constantly changing. The change in response to the changing environmental conditions. Environmental conditions change due to a number of reasons. For example in a Terrestrial ecosystem such as forest the environmental conditions change due to fire or clearing of forest by human beings. In response to such changes the structure and species composition of ecosystem is changed this process is known as succession. Many of you would have observed vacant lands near your house. If a land is cleared and then left alone, slowly plants start growing in that area. Initially a layer of grass appears then

small shrubs grow and then after sometime large shrubs are seen.Such gradual changes in species composition in a given area is called succession. It is defined as a process through which the structure and species composition of communities and ecosystems change in response to changing environmental conditions. Ecology is classified to 2 different types of succession. One is primary ecological succession and other one is secondary ecological succession. This classification is based on the conditions that are present in the beginning of the process. We will look at the primary and logical succession now.Primary ecological succession is the establishment and development of an ecosystem on a barren lifeless area.Such conditions may be created due to natural process or manmade processes. For example a volcanic activity main result in Lava flow. The Lava may cool and create a lifeless Baran area. In such a surface after few years' lichens and other forms of small organisms start growing and then you can see the growth of small plants and grasses. All these are known as Pioneer species. They die and decay to the organic material of the soil and they create favorable conditions for other kinds of plants. So after many years you can see other kinds of plants such as larger shrubs and then this process continues and then eventually there will be trees and forests. So this process is known as primary succession. And then these are again classified into different stages. For example the first stage is early succession stage and then you have the intermediate stage and then you have the final stage. The second type of succession is the secondary succession. In this case the initial condition is different. Secondary succession is the Re-establishment of an ecosystem where there remnants of a previous biological community. Such conditions may be created for example a forest fire. Forest fire may destroy all the plants but may just leave certain some soil or certain sediments. So this creates, this favors the growth of plants such as annual plants and grasses. And then the rest of the process is similar to primary succession. So here again you have the Pioneer species that creates favorable growing conditions for other intermediate and climax community plants. As a natural process ecological succession enhances the energy flow and nutrient cycling. It increases the complexity of food webs. It increases the biodiversity that is species richness and interactions among species. It enhances the sustainability of the system. Next we will look at the biodiversity that is biological diversity.

Biodiversity is the variety of life on earth and the natural patterns it forms. Generally when we talk about the biodiversity we tend to think about the species diversity that is the different species that exist in an ecosystem. They are important but there are other components to biological diversity. Another important component of biodiversity is Genetic diversity. This is genetic variation of species. These are very important for adaptation in harsh environments. Ecological diversity is another component. This includes both species diversity and Genetic diversity. These are the variety of ecosystems found on the earth. Another important component of the biodiversity is functional diversity. This is the diversity of biological and chemical processes found in ecosystems. Biodiversity is important because it helps to sustain life on earth. We use biodiversity to provide us food, fibers and energy. It enhances the stability and sustainability of an ecosystem. That takes us to the next concept stability of an ecosystem.

The ability of an ecosystem to maintain its structure and function over long periods of time despite disturbances is known as the ecosystem stability.

There are two components to ecosystem stability they are resistance and resilience. An ecosystem displays resilience if following a disturbance it eventually regains its normal structure and function.

An ecosystem displays resistance if it keeps its structure and continuous normal function even when environmental conditions change. Ecosystem which show a high degree of stability may have different combinations of resistance and resilience. Species diversity is the key to both system resistance and resilience. An ecosystem rich in biodiversity will likely to be more stable. Ecological balance is a term describing how- ecosystems are organized in a state of stability where species coexist with other species and with their environment. But balance in stability in this contexts are different from static conditions in which there is no change. The nature is continuously changing. Natural system typically correct those self when small changes occur. For instance if a particular species become too plentiful then the number of Predator species may also increase temporarily to bring total number of species back into balance. So ecosystem stability is not a static property but a dynamic balance as exhibited here. Human effects ecosystem stability in many ways. Interfering normal chemical cycling and energy flow in the ecosystem is one important effect. Ecosystems are frequently destroyed for agricultural activity and Urban Development. According to the 2005 Millennium ecosystem assessment about 60% of the world's major terrestrial ecosystems are being degraded or used unsustainably. We will discuss human effects on ecosystem now. We will see some images that shows how human activities affect the ecosystem. Natural systems are replaced by man-made systems and human conceived patterns are superimposed on landscapes. Landscapes are stripped off its natural resources and human waste are dumped in ecosystem and resources are extracted continuously and monotonous landscape is a result. We discussed about the natural water cycle or hydrologic cycle. Now we will discuss about how the human activities have affected the hydrologic cycle. Some of the activities that affect the hydrological cycle are removal of vegetation. Mostly vegetation is removed and it is replaced by agricultural land use or urban Development. So the surface which vegetation istransformed into the surface of concrete and Asphalt. This results in excess run off. As a result flooding occurs. It also reduces the infiltration into the groundwater aquifers. Water bodies are polluted and all these affects the natural hydrological water cycle. And all human impact on the ecosystem have multiple effects. For example if vegetation is removed from forest then it increases the erosion. As a result nutrient loss occurs. This again leads to more vegetation death. As a result vegetation decreases further and this process goes on. This is known as feedback loop. Here we are going to see some more images of landscape changes. This is an aerial view. Can you even guess what this is now? This is world's biggest Tire Graveyard in Sulabiya, Kuwait. Such man-made landscapes are created throughout throughout the world and this looks like a river in the Urban Development but actually this is a river of trash. When a landfill was closed in Lebanon people started dumping wastes along the roads. So this created a river of trash.

Human Impacts on Ecosystem

So we will summarize the human impacts on ecosystem.

Human effects ecosystem by fragmenting and degrading habitat. Simplifying natural ecosystem. Introducing new or nonnative species. Eliminating some species. Interfering with normal chemical cycling and energy flow in ecosystem.
Over harvesting renewable resources. To survive and support the growing number of people we are exploiting and modifying parts of nature. We may do so. We need to understand that, intrusion into nature has multiple effects, most of them are unpredictable.
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