Biodiversity and its Conservation and Role of Biosystems Engineerung

Biodiversity

Biodiversity is the variety and differences among living organisms from all sources ,including terrestrial, marine, and other aquatic ecosystem s and the ecological complexes of which they are a part.

- It Is virtually synonymous with "Life on earth".
- Biologists most often define "biological diversity" or "biodiversity" as the "totality of genes, species, and ecosystems of a region".
- The biodiversity found on Earth today consists of many millions of distinct biological species, which is the product of nearly 3.5 billion years of evolution.

Levels or Types of Biodiversity

☐ **Community and Ecosystem diversity**

(different habitats, niches, species interactions)- Interactomics and bioengineering at populations levels etc.

☐ **Species diversity**

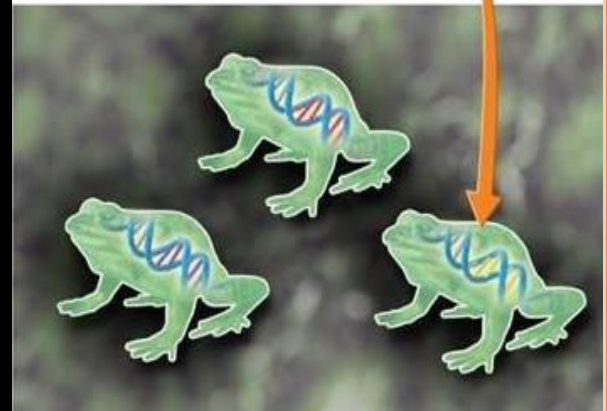(different kinds of organisms, relationships among species)

Genetic diversity

☐ (different genes & combinations of genes within populations), Genetic Engineering, Proteomics, Metabolic engineering, Systems Biology etc.


Ecosystem diversity

Species diversity

Genetic diversity

Community and Ecosystem diversity:

- **Ecosystem diversity refers to the diversity of a place at the level of ecosystems. This has 3 perspectives:**

- **Alpha Diversity: Within community diversity. Alpha diversity refers to the diversity of organisms sharing the same Community / Habitat.**

- **Beta Diversity: Between community diversity. It refers to the diversity of organisms sharing two habitat.**

- **Gamma Diversity: Diversity of the habitat over the total landscape or geographical area is called gamma diversity**
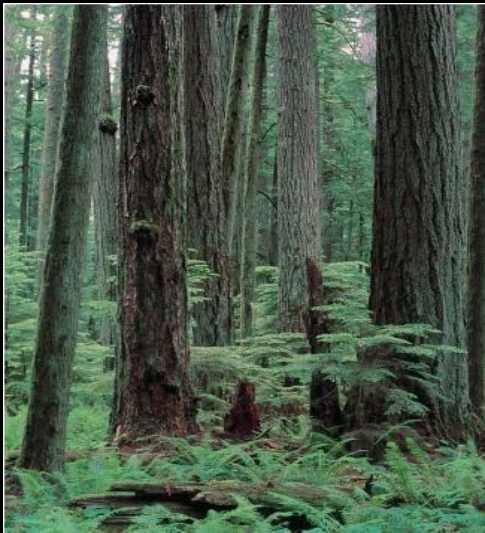
Temperate Rain forest

Tropical rain forest

Species diversity:

- It refers to the variety of species with in a region.

- Species diversity is an index that incorporates the number of species in an area and also their relative abundance (Simpson Index).

- It is generally a much more useful value than species richness (Shennon Wiener Index).

Video
Video

https://www.youtube.com/watch?v=1drkFgHbcWY

Lectures from Experts at the University of Califormia, Berkeley
and
Stanford University.

Genetic Diversity:

- It is a level of biodiversity that refers to the **total number of genetic** characteristics in the genetic make up of a speciesi.e., variation within species- different breeds of dogs, rose flower etc.

Values of Biodivesity

Food:

☐ **About 80,000 edible plants and about 90% of present day food crops have been domesticated from wild.**

Drugs & Medicines:

☐ **About 75% of world's population depend on plants and plants extracts**

Fuel:

☐ **Forests have been used since ages for fuel wood. Fossil fuels are also products of Biodiversity.**

Social Value:

☐ **Many of the plants like Tulsi, Lotus, Peepal etc are considered holy and sacred.**

☐ **About 2.1 million species have been identified till date, while many more species are believed to exist.**

☐ **India's position is 10th intheworld&4thinAsiaintermsof Plant diversity.**

Hot-spots of Biodiversity

- A biodiversity hotspot is a biogeography region with a significant reservoir of biodiversity that is threatened with destruction.

- An area is designated as a hotspot when it contains atleast 0.5% of plant species as endemic.

- There are 25 such hotspots of biodiversity on a global level, out of which two are present in India.

- These are: Indo-Burma (earlier The Eastern Himalayas) and The western Ghats & SriLanka..

- These hotspots covering less than 2% of the world's land area are found to have about 50% of the terrestrial biodiversity

What is biosystem engineering?
How can this protect biodiversity?

Biosystems engineering is an integrated science that combines engineering design and analysis with biological sciences to address the agricultural, environmental, food safety and other ecological concerns across the production-processing system from farm and production to consumers.
Bioengineering and Biosystem engineering can be employed to protect and sustain biodiversity in the world.

Engineering can have more positive and rather very less negative effects on biodiversity. In some cases, engineering interventions such as eco-engineering and nature-based solutions can enhance biodiversity by providing habitat heterogeneity and supporting unique species . Engineers and developers will be required to 'design in' ways to protect, conserve, improve or extend biodiversity.

Collect, analyze and manage environmental data gathered in the field. Perform risk and quality control assessments to determine environmental impact levels. Identify areas of negative human impact on the environment and negative environmental impacts on communities and society and devise solutions-NABET, QCI,

Criteria for determining hot-spots:

- No. of Endemic Species i.e. the species which are found no where else. Degree of threat, which is measured in terms of Habitat loss.

- **Indo-Burma   (Eastern Himalayas) Hotspot:**

- **The hotspot includes all of Cambodia, Vietnam & Laos, and nearly the entire areas of Thailand, Myanmar & Bhutan as well as part of Nepal, far eastern India and extreme southern China**

- **In addition, it covers several off shore Island including Main   Islands in the south China Sea and And adoman & Nicobar Islands in Indian Ocean.**

- **Indo Burma is one of the most threatened biodiversity hotspots, due to the rate of resource exploitation and habitat loss.**

- **Western Ghats and Sri Lanka:**

- **Western Ghats and SriLanka, also known as the "Sahyadri Hills" encompasses the montane forests in the south western parts of India and on the neighboring Islands of SriLanka.**

- **The entire extent of hotspot was originally about 1,82,500 square kms, but due to tremendous population pressure, now only 12,445 square Km or 6.8% is in pristine condition.**

- **The important populations include Asian elephant, Indian tigers and the endangered lion tailed macaque.**

Threats to Biodiversity

Extinction is a natural event and, from a geological perspective, routine.

- In last century, human impact has been so severe that thousands of species and varieties are becoming extinct annually.

- Some of the main causes are: Population Growth, Global Warming, Industrial Pollution, Change of lifestyles, Hunting etc. The following causes are :

Habitat loss, degradation, fragmentation:

- Habitat loss & degradation are major causes of species extinction, affecting 89% of all threatened birds, 83% of mammals & 91% of all threatened plants assessed globally(IUCN,2000)

- The main causes of habitat losses are agriculture activities, Mining, development of human settlement, industry etc.

Poaching of Wildlife:

- Poaching is another threat that has emerged in recent decades as one of the primary reason for decline in number of species.

- Wildlife is sold and traded in many countries for live specimens, folk medicines, furs, Skin, and other products such as Ivory, horns etc amounting to millions of dollars.

Man –wildlife conflicts:

- The conflict between man and wildlife started with the evolution of man, but intensity increased due to the activities of modern man

- Due to the lack of stable food and disruption of movement, wild animals came out of forest area and attack the agricultural field and humans and in turn got killed by the humans.
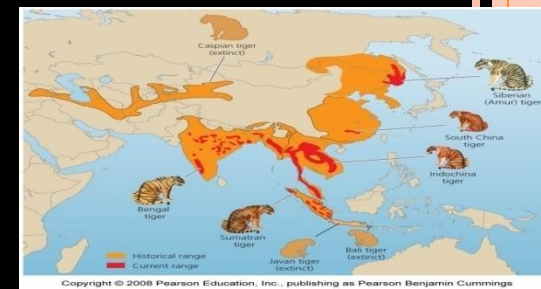
: (1) Threatened species (2) Extinct species (3) Endemic species (4) Endangered species

(1) Threatened species: Threatened Species are any species, which includes animals, plants, fungi, etc., which are vulnerable to endangerment shortly. Eg, Bengal tigers.
(2) Extinct species: These are species that are not found after searches of known or likely areas where they may occur. A species may generally be extinct from a local area, region, country, continent, or the entire earth. E.g. Quagga, Dodo, etc.
(3) Endemic species: These are species that are found only in some particular areas, usually isolated by natural or even geographical barriers. E.g. Asiatic lion
(4) Endangered species: These are species that are in danger of extinction. The survival of this species is difficult if negative factors which have led to a decline in

Endangered Species:

- According to The International Union of Conservation of Nature and Natural Resources (IUCN), the species that considered in imminent danger of extinction and whose survival is unlikely, if factors causing their decline continue to operate.
  Out of about 47,000 species of plants in our country, 7000 are endemic

- India contains 172 species of animals considered globally threatened by IUCN, or 2.9% of the world's total number of threatened species.

- These include 53 species of mammals, 69 birds, 23 reptiles and 3 amphibians

- As many as 3,000-4,000 higher plants may be under high degree of threat in India

- Thus Indian subcontinent has about 62% endemic flora, restricted mainly to Himalayas, khasi Hills & Western Ghats.

- A large number out of a total of 81,000 species of animals in our country is endemic. About 62% amphibians and 50% lizards are endemic to western Ghats.

- Golden monkey, Niligiri Langur, Indian Wolf, Red Fox, Himalayan Brown Bear, Great Indian One Horned Rhinoceros, White Winged Wood Duck, Black Necked Crane, Indian Pea Fowl, Gharial, Indian egg eating Snake, Indian Salamander etc. are some examples of endemic animal species of India.

Can we live without mosquitoes?

They are a source of food for many species of birds, fish, and other animals. Mosquitoes also play a role in pollinating certain plants. While it is true that humans could technically survive without mosquitoes, their presence is important for maintaining the balance of nature.

Nuisance :

chikungunya.
dengue fever.
Eastern and Western equine encephalitis.
Japanese encephalitis.
La Crosse encephalitis.
Malaria.
St. Louis encephalitis.
VERY DANGEROUS FOR HUMANS.

Advantages of flies

Flies act as scavengers consuming rotting organic matter so we don't have to deal with it which is a very important role in the environment. If it wasn't for flies, there would be rubbish and dead animal carcasses everywhere. A lovely thought to mull over while you're grilling. However, House flies are strongly suspected of transmitting at least 65 diseases to humans, including typhoid fever, dysentery, cholera, poliomyelitis, yaws, anthrax, tularemia, leprosy, and tuberculosis. Flies regurgitate and excrete wherever they come to rest and thereby mechanically transmit disease organisms - Very dangerous for humans

Conservation of Biodiversity and Biodiversity Management – An Engineering Approach :

- The Convention on Biological Diversity held in Rio De Janeiro in June, 1992 stressed the need of the conservation of Biodiversity for sustainable development and perpetuation of human beings on earth.

- Conservation is defined as " the management of human use of the biosphere so that it may yield the greatest sustainable benefit to the present generation while maintaining its potential to meet the needs and aspirations of the future generations".

- The two basic approaches to wildlife conservation in protected habitats are:

1) **In-situ conservation and**
2) **Ex-situ conservation.**

In-situ conservation Engineering :

- It simply means conservation of species in its natural ecosystem or even in manmade ecosystems.

- This strategy emphasizes protection of total ecosystem through a network of "protected area".

- Protected Areas: an area of land and / or sea specially dedicated to the protection and maintenance of biological diversity and managed through legal effective means.

- There are different categories of protected areas which are managed with different objectives. These include; Biosphere reserves ,National parks, Wild Life Sanctuaries etc.

- At present we have 11 major biosphere reserves, 80 National parks, 420 wildlife sanctuaries in our country covering 4% of the geographic area.

- The JIM CORBETT National Park was 1st national park established in India.

- What is Difference among Biosphere reserves, National parks, Wild Life Sanctuaries ?

Examples of Biosphere reserves of India

- 1.Nilgiri-5,520 sq.km2.Nanda Devi-5,860.69 sq. km3.Manas–2837 sq. km4.Gulf of Mannar–10,500 sq. km5.Great Nicobar –885 sq. km6.Panchmarhi–4,926.28 Sq Km

- Examples of some National park in India1.Kaziranga-Assam, GirNational Park- Gujarat, Periyar–Kerala, Sariska–Rajasthan

- Examples of some Wild Life Sanctuaries of India:1.Ghana Bird sanctuaries2.Hazaribaghsanctuaries3.Aboharwild life sanctuaries4.Jaldaparawild life sanctuaries5.Mudamalai wild life sanctuaries

Ex-situ conservation - Biochemical Engineering Approaches :

- It is defined as "the conservation of component of biological diversity (Sample of genetic diversity, particularly of endangered species) outside their natural habitats".

- It involves maintenance and breeding of endangered plant and animal species under partially or wholly controlled conditions. E.g. Zoos, Botanical Gardens, Aquaria, Nurseries, DNA bank (Genetic Engineering) , Seed bank, Gene bank etc.

- There are more than 1500 Botanical gardens in the world containing more than 80,000 species.

- There are more than 800 zoos around the world with about 3,000 species of mammals, birds, reptiles and amphibians.

- In India, we have many gene banks. The important ones are:

- National Bureau of Plant genetic Resources (NBPGR),

- New Delhi:

- Agricultural and horticultural crops and their wild varieties are preserved by cryo-preservation of seeds (at -196º C in Liquid Nitrogen), pollen etc. National Facility for Plant Tissue Culture Repository

- (NFPTCR) at NBPGR Campus New Delhi:

- It has been set up for the development of a facility of conservation of varieties of crop plants/ trees by tissue culture.

What is the Goal of Conservation?

• Conservation efforts focus on protecting entire ecosystems as well as single species.

• Protecting an ecosystem will ensure that the natural habitats and the interactions of many different species are preserved at the same time.

Conservation Challenges

• Protecting resources for the future can require people to change the way they earn their living today.

• Conservation regulations must be informed by solid research and must try to maximize benefits while minimizing economic costs.
• Awareness through teaching courses at all levels from school to colleges to research levels and executive levels in Goi and other organizations.

Values of Biodiversity

There are direct and indirect economic, aesthetic, and scientific reasons for preserving biodiversity.

Direct Economic value:

- Humans depend on plants and animals to provide food, clothing, energy, medicine, and shelter.

- Genetic diversity in species that might be needed in the future is important because

  - Most of the world's food crops come from just a few species.

  - Wild species serve as reservoirs of desirable genetic traits that might be needed to improve domestic crop species (disease- and insect-resistance).

  - Many of the medicines that are used today are derived from plants or other organisms.

  - Scientists continue to find new extracts from plants and other organisms that help in the treatment of human diseases.

  - However, many species of organisms are yet to be identified, especially in remote regions of Earth, so their usefulness in providing extracts or useful genes is unknown.

Why should we protect biodiversity?

Reasons to protect Biodiversity

1. Medicinal
2. Agricultural
3. Commercial
4. Ecological
5. Ethical/Aesthetic

Medicines and Biodiversity: Natural sources of pharmaceuticals		
Plant	Drug	Medical application
Pineapple (Ananas comosus)	Bromelain	Controls tissue inflammation
Autumn crocus (Colchicum autumnale)	Colchicine	Anticancer agent
Yellow cinchona (Cinchona ledgeriana)	Quinine	Antimalarial
Common thyme (Thymus vulgaris)	Thymol	Cures fungal infection
Pacific yew (Taxus brevifolia)	Taxol	Anticancer (especially ovarian cancer)
Velvet bean (Mucuna deeringiana)	L-Dopa	Parkinson's disease suppressant
Common foxglove (Digitalis purpurea)	Digitoxin	Cardiac stimulant

Medicinal: 40% of modern medicines come from plants/animals/fungi, 95% of known plant species have never been tested for medicinal value

Drugs from snake venom toxins

Captopril. The antihypertensive drug captopril was the first drug based on a bioactive component from snake venom that was approved in the US by the FDA in 1981 and in European countries from 1984 onwards. ...
Tirofiban. ...
Eptifibatide. ...
Batroxobin. ...
Haemocoagulase. ...
α-Cobrotoxin. ...
Anfibatide. ...
Crotamine.
Misuse ?

What medicines came from nature?

Aspirin, morphine and chemotherapy: the essential medicines powered by plants
Aloe vera has been used for thousands of years to soothe burns and irritated skin. Genetics is used now a days.Flavonoids as Antioxidants,Hydnocarpin?,Antimicrobial, Antiviral, Anticancerous etc.
Willlow bark has been used for centuries to treat aches and pains, relieve menstrual cramps and bring down a fever.
Turmeric- Curcumin, Triterpenes/Alkaloids – etc.- Computation Biology , Flavonoids, Coumatns,Terpenoids, Alkaloids etc.
Neem(Azadirachta)   and other Natural Products

Agricultural:

Of 80,000 known edible plants on the planet, we depend on 20 species to provide 90% of global food supply. Corn, rice and wheat are 50% alone! India- UP

Loss of Biodivesity in   agricultural

- Apples – 14,000 apple cultivars in N. America have been reduced to 11 which supply 90% of our supply

- Coffee – 28% decline in Latin American production as climate change has brought new rainfall and pest patterns.

Fruits on the Brink of Extinction: Climate Change Threatens Bananas, Oranges, Avocados.

3. Commercial

4. Ecological

5. Ethical/Aesthetic

Why Biodiversity is Important?

The natural environment is the source of all our resources for life.

Environmental processes provide a wealth of services to the living world — providing us with air to breathe, water to drink and food to eat, as well as materials to use in our daily lives and natural beauty to enjoy.

Complex ecosystems with a wide variety of plants and animals tend to be more stable. A highly diverse ecosystem is a sign of a healthy system. Since all the living world relies on the natural environment, especially us, it is in our best interests and the interests of future generations to conserve biodiversity and our resources. The benefits and services provided by ecosystems include:

- Generation of soils Maintenance of
- soil quality Maintenance of air
- quality Maintenance of water
- quality Pest control
- Detoxification and decomposition of wastes
- Pollination
- Crop production
- Climate stabilization
- Prevention and mitigation of natural disasters Provision
- of food security
- Provision of health care – medicines
- Income generation Spiritual and
- cultural value

Video

VIDEOThe Insect Effect: Insect Decline and the Future of Our Planet :

https://www.floridamuseum.ufl.edu/earth-systems/the-insect-effect/

in Biodiversity

Role of Engineeris in fighting loss of Biodiversity

Biodiversity crisis is serious to have, far reaching impacts on many aspects of our lives. Despite this grave situation, the consultation process was extremely positive with a strong focus on the opportunities that exist to tackle the biodiversity crisis.

The 'Engineering 2020' report, published by Engineers Ireland, found that engineers and the public overwhelmingly agree that engineers have an. ethical responsibility to tackle biodiversity loss

Ensuring
that we are following through on this ethical
responsibility will require significant adjustments
to engineering practice. This represents a huge
opportunity but conversely there is huge
reputational risk for the sector if it does not adapt
as needed.
Engineering education should also train and
educate the engineers to understand the
importance of controllling the biodiversity loss,
Sab ka sath sab ka vikas sab ka vishwas sab ka
survival and sab ke future ka vikas etc.
सर्वेषां सहकार्यम्
sarvesham sahakaryam
Cooperation of All. Environment Clearance from
MOEFCC, GOI, Accreditation of Environmental

Companies, Coordinators by NABET, QCI

To date, the emphasis has been on value for money and project delivery. However, more and more our environment is being eroded and a balance needs to be struck between commercial value and biodiversity in terms of the final outcome of all engineering projects. It is our responsibility as engineers to ensure that our actions are sensitive to our environment and that our work does not result in biodiversity loss and environmental damage. Engineers Ireland has already begun planning for

new CPD (Continuing Professional Development) events focused on biodiversity and will be working on other actions related to biodiversity over the coming months. Engineers play an important role in shaping the world around us and it is critical that environmental considerations and achieving the best for society are always at the centre of our profession and the work

of engineers. As a professional body with 25,000 members, Engineers Ireland declared a climate and

biodiversity emergency in March 2020 and committed to act as a leading voice for sustainability. The Engineers Ireland Code of Ethics includes environmental and social obligations for members to promote
and practice sustainable development considering the needs of present and future generations, to promote the importance of social and environmental factors to professional colleagues, employers, and clients, and to foster environmental awareness within the engineering profession and among the public.
Green engineering of USEPA is the design, commercialization, and use of processes and products that minimize pollution, promote sustainability, and protect human health.

Ecosystem engineers directly influence ecosystems by modifying environments, creating habitats, altering cycles, increasing biodiversity, and modulating ecological processes, thus playing a crucial role in maintaining biodiversity and ecosystem functioning.

Why is it important to study the biodiversity?
Biodiversity is essential for the processes that support all life on Earth, including humans. Without a wide range of animals, plants and microorganisms, we cannot have the healthy ecosystems that we rely on to provide us with the air we breathe and the food we eat.

Sab ka Sath Sab ka Vikas Sab ka vishwas- Wellbeing of Universe.

The environment provides essentials such as clean air and safe drinking water. Therefore, environmental engineering has a significant impact on people's daily lives. It aids in the provision of safe drinking water, the reduction of water pollution, and the facilitation of proper waste disposal. Environmental engineers design systems for managing and cleaning municipal water supplies. Environmental engineers use engineering disciplines in developing solutions to problems of planetary health. Their work may involve concerns such as waste treatment, site remediation, and pollution control technology.

Survival of humanity and the continuation of clean and easily livable earth for posterity is our joint responsibility as human being and as Engineers.
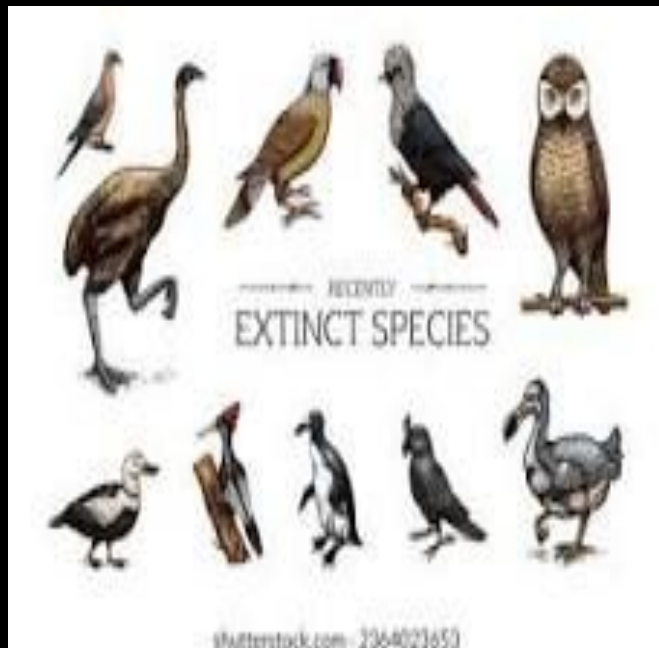
Assignment _ Not to be submitted :
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Extinction Prevention via Engineering :
Referencec :

https://www.teachengineering.org/lessons/view/cub_lifescience_lesson02.

Extinct Virds and Animals :

Thank you…!