SATHYABAMA
INSTITUTE OF SCIENCE AND TECHNOLOGY
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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – I – INTRODUCTION TO ECOLOGY – SAR1614

I. ECOLOGY

INTRODUCTION

Ecology is defined as the study of inter relationship and interaction of different organisms with each other and with their environment. It is concerned with the general principles that apply to both animals and plants. The meaning of the word ecology was given by German Biologist Ernst Haeckel in 1869. The word ecology is derived from Greek words 'Oikos' meaning house, habitat or place of living and 'Logos' meaning to study.

OBJECTIVES OF ECOLOGICAL STUDIES

It is important for humanity to understand its environment because we have the ability to modify the environment through the use of technology. Therefore, ecology is more than just the understanding of the interrelationships between organisms and their environment; it also has social, political, economic and technological dimensions. It also is a study of evolutionary development of organisms, the biological productivity and energy flow in the natural system. To develop mathematical models to relate interaction of parameters and to predict the effects.

CLASSIFICATION OF ECOLOGY

Based on study area :

Autecology : It deals with the study of an individual species of organisms and it's population. The ecologists study the behaviour and adaptations of particular species to the environmental condition at every stage of that individual's life cycle. It is also called the Species ecology.

Synecology : It deals with the study of communities, their composition, their behaviour and relation with the environment. It is also called as Ecology of communities.

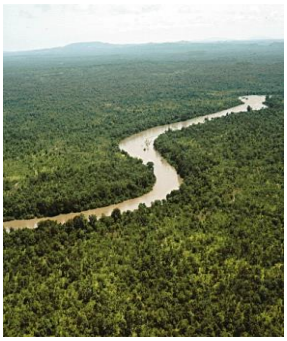
Based on Environment or habitat :

Aquatic ecology : The study of interaction of organisms in the water

Marine water ecology - Ocean, Deep Sea, Estuary

Freshwater Ecology - Letic (Running water) – River, Stream, Spring

Lentic (Standing Water) –Pond, Lake.



Terrestrial Ecology : The study of interaction of organisms on land surfaces divided as grassland ecology, forest ecology & desert ecology.

Based on Advancement in the field of ecology

a. Productive ecology
b. Population ecology
c. Community ecology
d. Ecosystem ecology
e. Microbial ecology
f. Radiation ecology
g. Pollution ecology
h. Space ecology

TYPES OF ECOLOGY LEVELS

Organism Ecology:
Organismal ecology is the study of an individual organism's behaviour, morphology, physiology, etc. in response to environmental challenges. Ecologists research how organisms are adapted to these non-living and living components of their surroundings. Individual species are related to various adaptations like physiological adaptation, morphological adaptation, and behavioural adaptation.

Population Ecology:
It deals with factors that alter and impact the genetic composition and the size of the population of same species. Population ecology examines the population distribution and density. Population density is the number of individuals in a given volume or area. This helps in determining whether a particular species is in endanger or its number is to be controlled and resources to be replenished.

Community Ecology :
It deals with how community structure is modified by interactions among living organisms. Ecology community is made up of two or more populations of different species living in a particular geographic area.

Ecosystem Ecology
It deals with the entire ecosystem, including the study of living and non-living components and their relationship with the environment. This science researches how ecosystems work, their interactions, etc.

Landscape Ecology
It deals with the exchange of energy, materials, organisms and other products of ecosystems. Landscape Ecology study the habitat fragmentation (such as deforestation) or the migration of organisms between ecosystems, etc.

Biosphere

It deals with interactions among earth's ecosystems, land, atmosphere and oceans. It helps to understand the large-scale interactions and their influence on the planet, the role of greenhouse gases, the effects of climate change on ecosystems and organisms, etc.

ECOSYSTEM

INTRODUCTION

Ecosystem is a biological community where the living and non-living components interact with each other as their physical environment. It is the functional unit of nature and varies greatly in size.

Types of Ecosystem

1. **Natural ecosystem**

a) Aquatic Ecosystem. Eg- Running water, standing water, Marine ecosystem

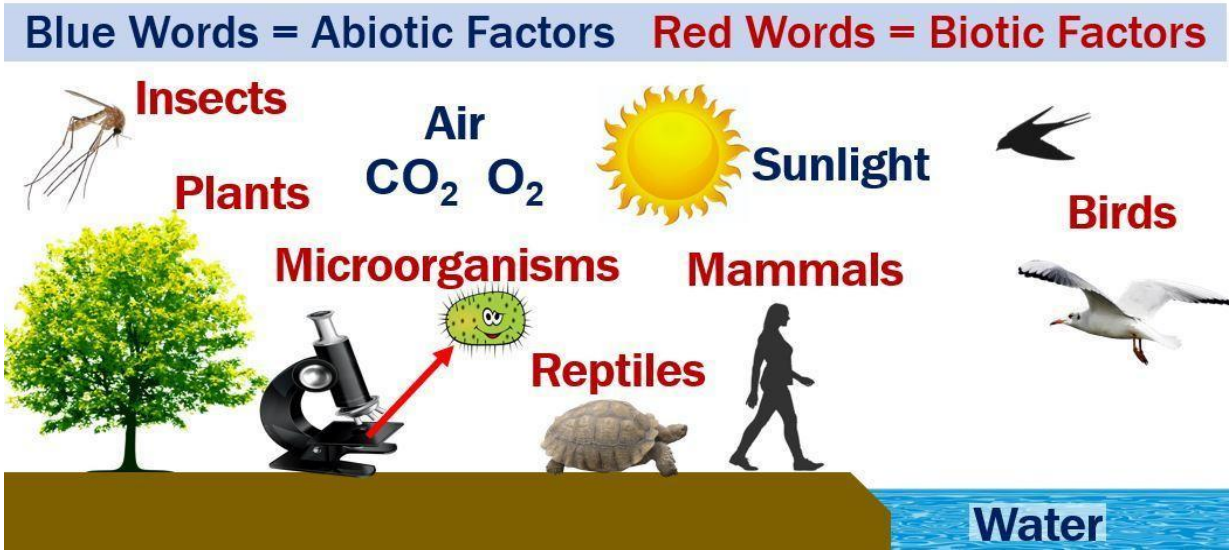
b) Terrestrial Ecosystem. Eg- Grassland, forest, desert ecosystem.

2. **Artificial ecosystem** - Man made ecosystem – operated and maintained by man himself Eg : Cropland, Gardens.

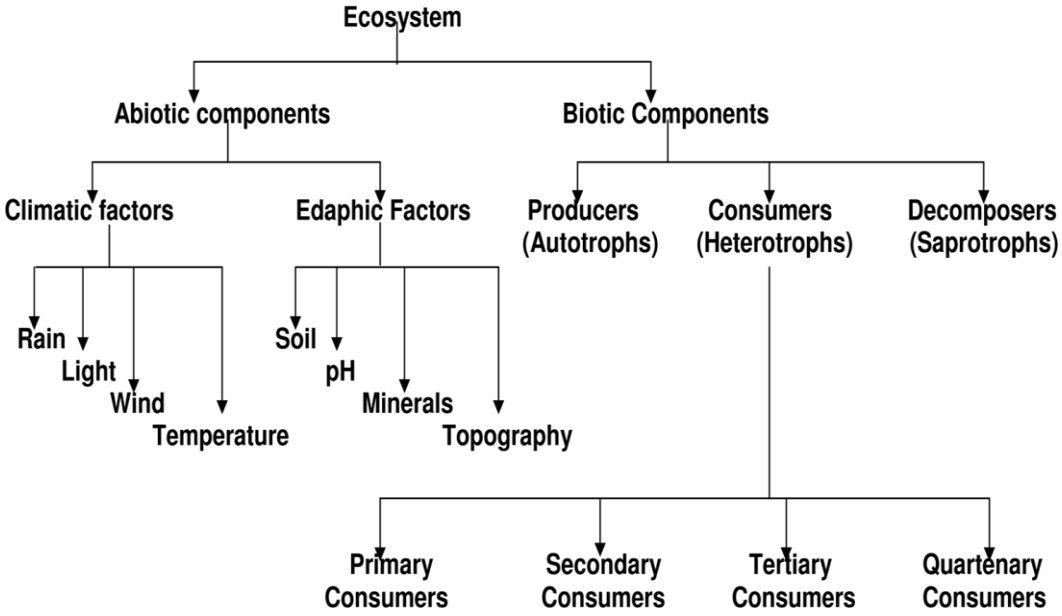
STRUCTURE (or) COMPONENTS OF AN ECOSYSTEM

The structure of an ecosystem explains the relationship between the abiotic (non –living) and the biotic (living) components. An ecosystem has two major components.

- Biotic (living) components.
- Abiotic (non living) components.



COMPONENTS OF ECOSYSTEM



Biotic components

The living organisms (or) living members in an ecosystem collectively form its community called biotic components (or) biotic community. Examples:-Plants (producers),animals (consumers) and micro-organisms (decomposers). The members of biotic components of an ecosystem are grouped in to three, based on how they get food.

- Producer (plants)
- Consumer (Animals)
- Decomposers (Micro-organisms)

Producers (Autotrophs)(self-feeders)

Make their own food from compounds that are obtained from their environment. They are the source of all food in an ecosystem. On land, most producers are green plants. In freshwater and marine ecosystems, algae and plants are the major producers near shorelines. In open water, the dominant producers are phytoplankton (most of them microscopic) that float or drift in the water.

Most producers capture sunlight to make carbohydrates (such as glucose) by photosynthesis. Eg-Photosynthesis The green pigments called chlorophyll, present in the leaves of plants, converts CO_2 and H_2O in the presence of sunlight into carbohydrates.

$6CO_2 + 12H_2O \text{ ----> } C_6H_{12}O_6 + 6O_2 + 6H_2O$.

Consumers (Heterotrophs) ("other feeders")

Get their energy and nutrients by feeding on other organisms or their remains.

Primary consumers : Are those that eat producers (plants) as a source of food. They are also known as herbivores.

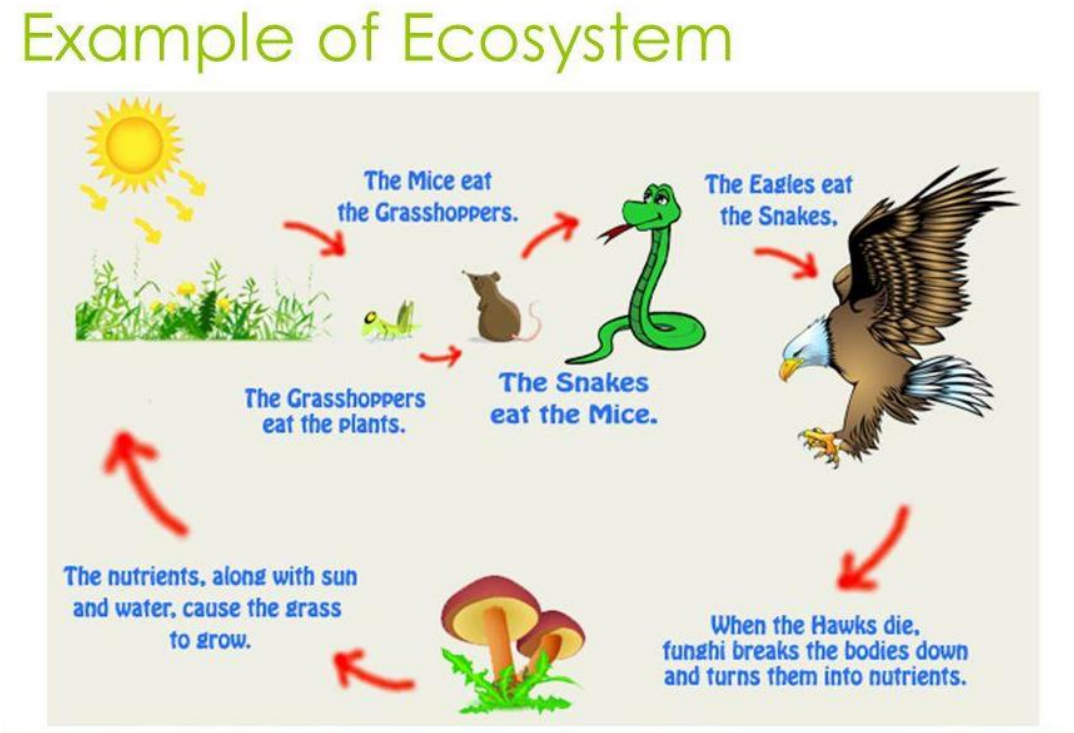
Secondary consumers or carnivores : Eat other animals.

Tertiary Consumers : Large Carnivores which feed on secondary consumers.

Quaternary Consumers : Largest Carnivores that feed on tertiary consumers. They are not eaten by any animals.

Omnivores : Have mixed diet that include both plants and animals.

Decomposer :
Mostly certain types of bacteria and fungi are specialized consumers that recycle organic matter in ecosystems. They do this by breaking down (biodegrading) dead organic material to get nutrients and releasing the resulting simpler inorganic compounds into the soil and water, where they can be taken up as nutrients by producers.



Abiotic components
Consists of Non-living chemical & physical components such as water, air, nutrients in the soil or water & Solar Energy. Physical & chemical factors that influence living organisms in land (terrestrial) ecosystem & aquatic life zones. Abiotic factors can act as limiting factors that keep a population at a certain level.
Abiotic Components are mainly of two types they are Climatic factors and Edaphic factors
Climatic Factors: which include rain, temperature, light, wind, etc.
Edaphic Factors: which include soil, pH, Topography, Minerals, etc.

ECOLOGICAL BALANCE

Introduction
Ecological balance is a term used to describe the equilibrium between living organisms such as human being, plants, and animals as well as their environment. Human being plays a key role to

maintain ecological balance because they have the highest thinking capacity as compared to other living organisms. Sufficient food availability to all living organisms and their stability reflect the existence of ecological balance. Therefore, this balance is very important because it ensures survival, existence and stability of the environment. For example, human activities such as farming and resources exploitation are checked to prevent excessive destruction of the forests. Deforestation leads to drought. Drought reduces food production resulting to insufficient food. Insufficient food leads to starvation and later death occurs, hence reducing the existence of some species.

ECOLOGICAL IMBALANCE

Ecological imbalance is when a natural or human-caused disturbance disrupts the natural balance of an ecosystem. A disturbance is any change that causes a disruption in the balance of an ecosystem.
Examples of natural disturbances are volcanic eruptions, floods and natural fires.
Examples of human-caused disturbances are the introduction of a new species against nature logging a forest, pollution and overhunting of a species.

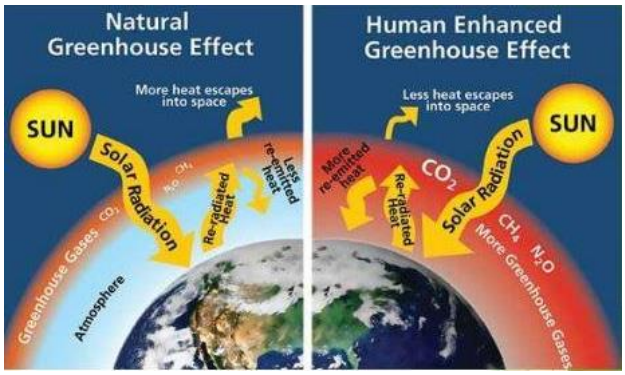
Environmental Issues Related to Ecological Imbalance

Global problems:- These are problems that affect different nations and can only be resolve through solidarity of affected nation. Some global problems are global warming or greenhouse effect, acid rain, pollution (Air and Marine Pollution), depletion of ozone layer in the atmosphere and radioactive fallout because of nuclear war.

National problem:- These are problems that affect a country and can only be resolved within the country. These national environmental issues are pollution (air, water and soil), degradation of natural resources such as soil erosion, deforestation, depletion of wildlife, shortage of energy, degradation of marine ecosystems and depletion of mineral resources and alteration and inconsistent land use like the conversion of agricultural land into industrial estates, conversion of mangrove swamps into fishponds and salt beds.

Greenhouse effect:

When the Sun's energy reaches the Earth's atmosphere, some of it is reflected back to space and the rest is absorbed and re-radiated by greenhouse gases. Greenhouse gases include water vapour, carbon dioxide, methane, nitrous oxide, ozone and some artificial chemicals such as chlorofluorocarbons (CFCs). The problem we now face is that human activities – particularly burning fossil fuels (coal, oil and natural gas), agriculture and land clearing – are increasing the concentrations of greenhouse gases. This is the enhanced greenhouse effect, which is contributing to warming of the Earth.



Acid Rain:

Acid rain refers to rain which is acidic in nature. It is generally complex mixture of $H2S04$ along with $H2SO3$ and $HNO3$ along with $HNO2$ .The SO2 and NOX react with water, oxygen and other chemicals to form sulfuric and nitric acids. These then mix with water and other materials before

falling to the ground. The major sources of SO2 and NOX in the atmosphere are burning of fossil fuels to generate electricity -Two thirds of SO2 and one fourth of NOX in the atmosphere come from electric power generators, vehicles and heavy equipment, manufacturing, oil refineries and other industries.

Theories of balance

Gaia hypothesis

The entire range of living matter on Earth from whales to viruses and from oaks to algae could be regarded as constituting a single living entity capable of maintaining Earth's atmosphere to suit its overall needs and endowed with faculties and powers far beyond those of its constitute parts" . Two ways Gaia accomplishes this include:

1. Allowing evolution so species may meet new environmental changes
2. Ensuring a great diversity of life.

Chaos Hypothesis:

Chaos theory, in mechanics and mathematics, the study of apparently random or unpredictable behavior in systems governed by deterministic laws. Chaotic behavior exists in many natural systems, such as weather and climate. It also occurs spontaneously in some systems with artificial components, such as road traffic.

Maintaining The Ecological Balance

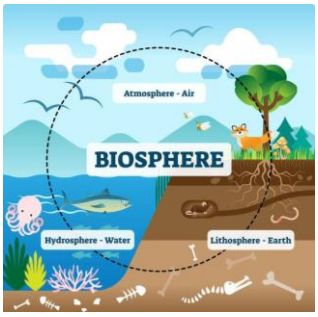
Manage Natural Resources Carefully, Control the Population, Protect the Water, Reduce Logging, Reduce chlorofluorocarbon, Stop open burning.

BIOSPHERE

The biosphere is made up of the parts of Earth where life exists. The biosphere extends from the deepest root systems of trees, to the dark environment of ocean trenches, to lush rain forests and high mountain tops.

The biosphere is made of three parts, called

- Lithosphere - Earth
- Atmosphere - Air
- Hydrosphere - Water



LITHOSPHERE

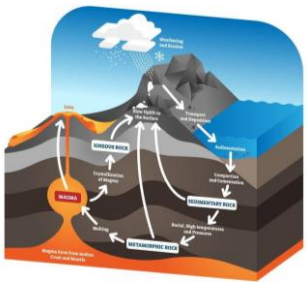
The lithosphere is the terrestrial part of the biosphere. The deeper parts of the lithosphere, known as the lower mantle and the core, do not support life, other parts of lithosphere supports a variety of life from bacteria to large mammals and trees. The weathering of the lithosphere crust forms soil, which provides minerals and organic waste to support life. This solid, rocky crust is composed of a number of different rocks that have been grouped into three categories are metamorphic rocks, igneous rocks and sedimentary rocks.

Metamorphic rocks – Metamorphic rocks are formed by heat and pressure from pre-existing rocks.

Igneous rocks – igneous rocks are formed by the cooling of hot molten rock also known as magma. When the hot magma cools it begins to harden meaning once it had fully cooled it create what is known to be an igneous rock

Sedimentary rocks – sedimentary rocks are formed from pre-existing rocks. When rocks erode and mix with other dirt, clay and particles then settle together the mix together to form a sedimentary rock

CYCLE OF ROCK FORMATION

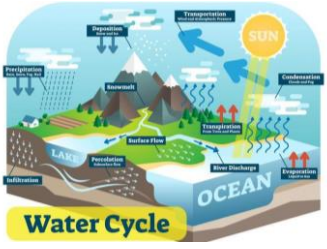


ATMOSPHERE

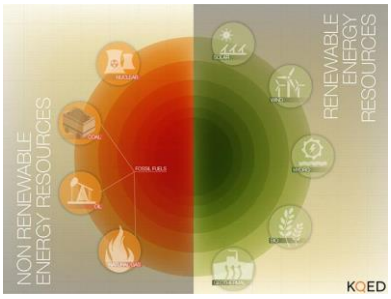
The atmosphere is the gaseous envelope surrounding a planet. On Earth, it is also called air. The lower regions of the atmosphere contain gases such as oxygen and carbon dioxide that are essential for plant and animal respiration. Birds, insects and other life can be found up to approximately 2,000 meters above the earth's surface. The atmosphere also plays critical roles in shaping the biosphere by deflecting harmful radiation from the sun and determining weather patterns.

HYDROSPHERE

The hydrosphere is the aquatic part of the biosphere. This includes oceans, rivers, lakes and other bodies of water. The hydrosphere is always in motion as seen through the movement and flow of water in rivers, streams and the ocean. Plant and animal organisms rely on the hydrosphere for their survival as water is essential. The hydrosphere is also home to many plants and animals and it believed that the hydrosphere covers approximately 71% of the earth's surface. The hydrosphere also plays an important part in atmosphere formation. The frozen part of Earth's hydrosphere is made of ice: glaciers, ice caps and icebergs. The frozen part of the hydrosphere has its own name, the cryosphere.



RENEWABLE ENERGY NON RENEWABLE ENERGY

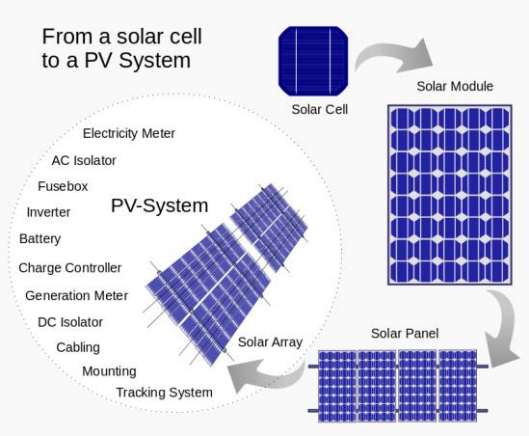


RENEWABLE ENERGY

Renewable energy, often referred to as clean energy, comes from natural sources or processes that are constantly replenished. The five major renewable energy resources are solar, wind ,water, also called hydro, biomass, or organic material from plants and animals geothermal, which is naturally occurring heat from the earth.

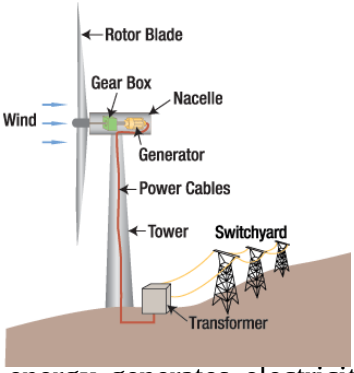
SOLAR ENERGY

Sunlight is one of our planet's most abundant and freely available energy resources. The amount of solar energy that reaches the earth's surface in one hour is more than the planet's total energy requirements for a whole year**.**



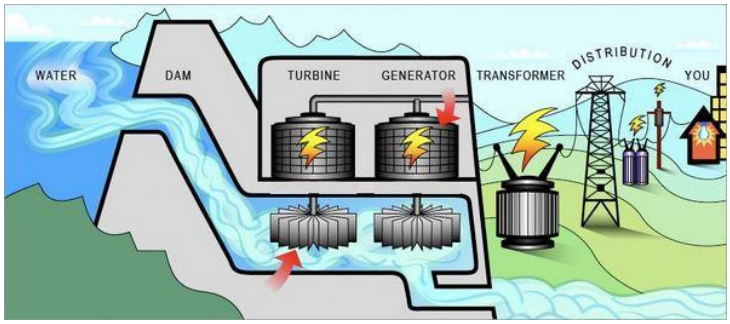
The term solar panel is used for a photo-voltaic (PV) module. A PV module is an assembly of photo-voltaic cells mounted in a framework for installation. Photo-voltaic cells use sunlight as a source of energy and generate direct current electricity. A collection of PV modules is called a PV Panel, and a system of Panels is an Array. Arrays of a photovoltaic system supply solar electricity .

WIND ENERGY



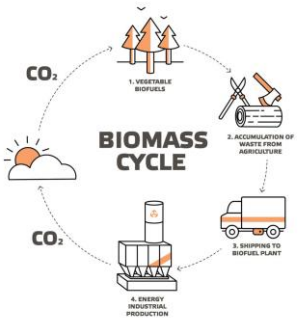
Wind is a plentiful source of clean energy. Wind energy generates electricity by turning wind turbines. The wind pushes the turbine's blades, and a generator converts this mechanical energy into electricity. This electricity can supply power to homes and other buildings, and it can even be stored in the power grid.

HYDRO ENERGY



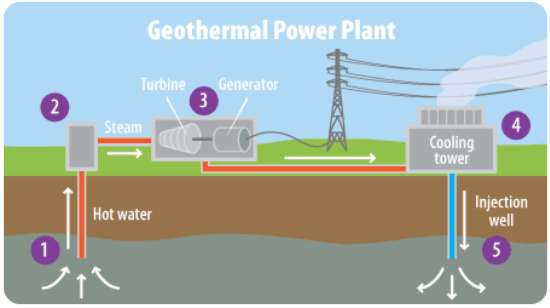
As a renewable energy resource, hydro power is one of the most commercially developed. By building a dam or barrier, a large reservoir can be used to create a controlled flow of water that will drive a turbine, generating electricity. This energy source can often be more reliable than solar or wind power and also allows electricity to be stored for use when demand reaches a peak.

BIOMASS ENERGY



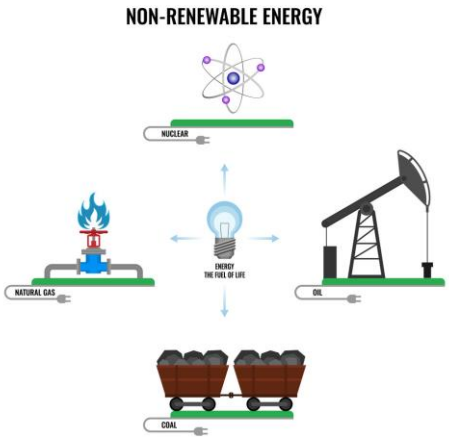
Biomass energy is the conversion of solid fuel made from plant materials into electricity. Although fundamentally, biomass involves burning organic materials to produce electricity, and nowadays this is a much cleaner, more energy-efficient process. By converting agricultural, industrial and domestic waste into solid, liquid and gas fuel, biomass generates power at a much lower economic and environmental cost.

GEOTHERMAL ENERGY



Geothermal energy comes from the heat generated deep within the Earth's core. Geothermal reservoirs can be found at tectonic plate boundaries near volcanic activity or deep underground. Geothermal energy can be harnessed by drilling wells to pump hot water or steam to a power plant. This energy is then used for heating and electricity.

NON RENEWABLE ENERGY



Non-renewable energy resources are available in limited supplies, usually because they take a long time to replenish. The advantage of these non-renewable resources is that power plants that use them are able to produce more power on demand. The non-renewable energy resources are coal , nuclear , oil and natural gas. Fossil fuels were formed within the Earth from dead plants and animals over millions of years. They are found in underground layers of rock and sediment. Pressure and heat worked together to transform the plant and animal remains into crude oil, coal, and natural gas. The energy in the plant and animal remains originally came from the sun; through the process of photosynthesis, solar energy is stored in plant tissues, which animals then consume, adding the energy to their own bodies. When fossil fuels are burned, this trapped energy is released. Crude oil is a liquid fuel fossil fuel that is used mostly to produce gasoline and diesel fuel for vehicles, and for the manufacturing of plastics. It is found in rocks below Earth's surface and is pumped out through wells.

Natural gas is widely used for cooking and for heating homes. It consists mostly of methane and is found near oil deposits below Earth's surface. Natural gas can be pumped out through the same wells used for extracting crude oil. Coal is a solid fossil fuel that is used for heating homes and generating power plants. It is found in fossilized swamps that have been buried beneath layers of sediment. Since coal is solid, it cannot be extracted in the same manner as crude oil or natural gas; it must be dug up from the ground. Nuclear energy comes from radioactive elements, mainly uranium, which is extracted from mined ore and then refined into fuel. Unfortunately, human society is for the time being dependent on non-renewable resources as primary source of energy. Approximately 80 percent of the total amount of energy used globally each year comes from fossil fuels.

ELEMENTS OF ENVIROMENTAL PLANNING

Environmental planning concerns itself with the decision making process where they are required for managing relationships that exist within and between natural systems and human systems. Environmental planning endeavours to manage these processes in an effective, orderly, transparent and equitable manner for the benefit of all constituents within such systems for the present and for the future. Some of the main elements of present day environmental planning are socio-economic development, urban development, regional development, natural resources management and governance frameworks.

Socio-economic development is the process of social and economic development in a society. Socio-economic development is measured with indicators, such as GDP, life expectancy, literacy and levels of employment. Changes in less-tangible factors are also considered, such as personal dignity, freedom of association, personal safety and freedom from fear of physical harm, and the extent of participation in civil society.

Urban planning is a technical and political process concerned with the use of land and design of the urban environment, including air, water, and the infrastructure passing into and out of urban areas such as transportation and distribution networks.

Urban Planning is also referred to as urban, regional, town, city, rural planning. Urban planning guides and ensures the orderly development of settlements and satellite communities which commute into and out of urban areas or share resources with it. It concerns itself with research and analysis, strategic thinking, architecture, urban design, public consultation, policy recommendations, implementation and management. Urban Planners work with the cognate fields of Architecture, Landscape Architecture, Civil Engineering, and City Administration to achieve strategic, policy and sustainability goals.

Regional development is the provision of aid and other assistance to regions which are less economically developed. Regional development may be domestic or international in nature. The implications and scope of regional development may therefore vary in accordance with the definition of a region, and how the region and its boundaries are perceived internally and externally.

Natural resource management refers to the management of natural resources such as land, water, soil, plants and animals, with a particular focus on how management affects the quality of life for both present and future generations. Natural resource management deals with managing the way in which people and natural landscapes interact. It brings together land use planning, water management, biodiversity conservation, and the future sustainability of industries like agriculture, mining, tourism, fisheries and forestry. Natural resource management specifically focuses on a scientific and technical understanding of resources and ecology and the life-supporting capacity of those resources.

Governance frameworks - Environmental governance refers to the processes of decision-making involved in the control and management of the environment and natural resources. International Union for Conservation of Nature (IUCN), define environmental governance as the 'multi-level interactions i.e., local, national, international/global. Interest in environmental governance has led to research at all scales from the local to the global and focused on issues such as resource scarcity and conflicts, allocation and access, and biodiversity conservation in forest, agricultural, freshwater, marine, and even atmospheric systems.

AREAS OF ENVIROMENTAL PLANNING ASSESSMENT

The environmental planning assessments encompass areas such as

- Land use,
- transportation,
- economic and housing characteristics,
- air pollution,
- noise pollution,

- the wetlands,
- habitat of the endangered species,
- flood zones susceptibility,
- coastal zones erosion,
- visual studies among others,

and is referred to as an Integrated environmental planning assessment. It is the ability to analyze environmental issues that will facilitate critical decision making.

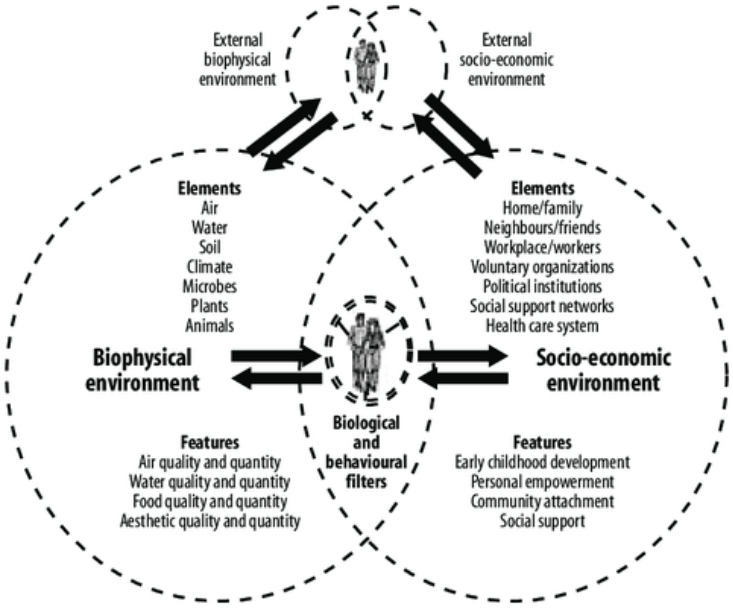
MAIN SPHERS OF ENVIROMENTAL PLANNING

The primary concern of environmental planning is expressed in the assessment of three spheres of environmental impact by human economic activity and technological output.

1. Bio-physical environement.
2. Socio-economic environment.
3. Built environment.

Bio-physical environement.
Biophysical environment comprising the earth life support system – air minerals , soil and water- and the biodiversity which these sustain. The biophysical environment is the biotic and abiotic surrounding of an organism or population, and consequently includes the factors that have an influence in their survival, development and evolution. The biophysical environment can vary in scale from microscopic to global in extent. It can also be subdivided according to its attributes.

Socio-economic environment.
Socio-economic environment composed of human social groupings, their cultural activities and the economic process of which they are interrelated.



Built environment- The term built environment, refers to the human-made environment that provides the setting for human activity, ranging in scale from buildings and parks or green space to neighbourhoods and cities that can often include their supporting infrastructure, such as water supply, or energy networks. The built environment is a material, spatial and cultural product of human labor that combines physical elements and energy in forms for living, working and playing. It has been defined as "the human-made space in which people live, work, and recreate on a day-to-day basis". The "built environment encompasses places and spaces created or modified by people including buildings, parks, and transportation systems".

NATURAL RESOURCES

Natural resources are resources that exist without any actions of humankind. This includes all valued characteristics such as commercial and industrial use, aesthetic value, scientific interest and cultural value. Major Natural Resources are

- Land
- Soil
- Water
- Natural Vegetation

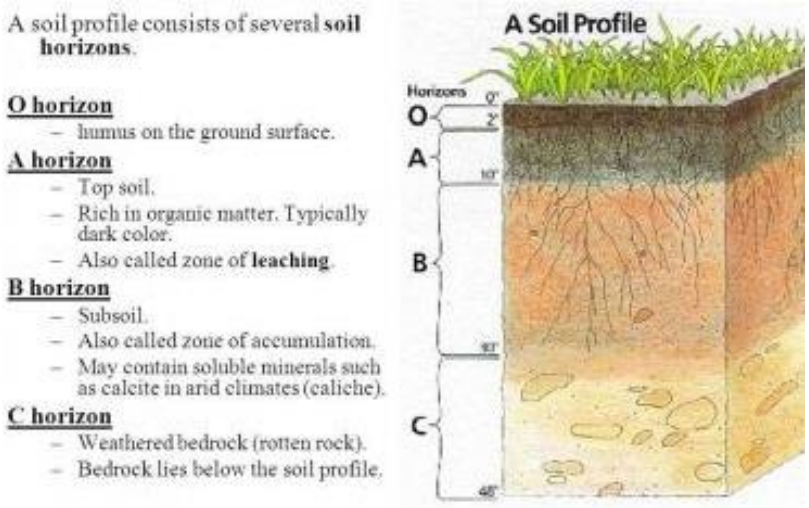
Land

Land is the most important natural resources. It covers only about thirty per cent of the total area of the earth's surface. The supporter of natural vegetation, wildlife, human life, economic activities, transport and communication systems. Land is used for different purposes such as agriculture, forestry, mining, building houses, roads and setting up of industries.

The use of land is determined by physical factors such as topography, soil, climate, minerals and availability of water. Human factors such as population and technology are also important determinants of land use pattern.

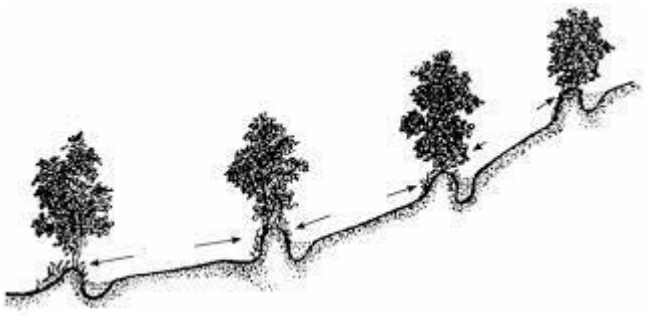
Soil

Soil The thin layer of grainy substance covering the surface of the earth is called soil. It is closely linked to land. Landforms determine the type of soil. Soil is made up of organic matter, minerals and weathered rocks found on the earth. This happens through the process of weathering. The right mix of minerals and organic matter make the soil fertile.



Factors which lead to soil degradation are deforestation, overgrazing, overuse of chemical fertilisers or pesticides, rain wash, landslides and floods.

Some methods of soil conservation are listed below are



Mulching: The bare ground between plants is covered with a layer of organic matter like straw. It helps to retain soil moisture.

Contour barriers: Stones, grass, soil are used to build barriers along contours. Trenches are made in front of the barriers to collect water.

Rock dam: Rocks are piled up to slow down the flow of water. This prevents gullies and further soil loss.

Terrace farming: Broad flat steps or terraces are made on the steep slopes so that flat surfaces are available to grow crops. They reduce surface runoff and soil erosion .

Intercropping: Different crops are grown in alternate rows and are sown at different times to protect the soil from rain wash.

Contour ploughing: Ploughing parallel to the contours of a hill slope to form a natural barrier for water to flow down the slope.

Shelter belts: In the coastal and dry regions, rows of trees are planted to check the wind movement to protect soil cover.

Water

Water About 97% of the earth's water supply is in the ocean. Due to high salt content, it is unfit for human consumption as well as other activities. Out of the remaining 3 percent, 2.3 percent is locked in polar ice caps. Subsequently, balance 0.7 percent is available as freshwater of which 0.66 percent is groundwater. Thus leaving a mere 0.03 percent available to us as freshwater in rivers, lakes, and streams. Therefore despite the earth's surface being covered with water, a very small percentage is usable. Thus there is a need for conservation of water.

Forest and other vegetation cover slow the surface runoff and replenish underground water.

Water harvesting is another method to save surface runoff. The canals used for irrigating field should be properly lined to minimise losses by water seepage. Sprinklers effectively irrigate the area by checking water losses through seepage and evaporation. In dry regions with high rates of evaporation, drip or trickle irrigation is very useful. The valuable water resource can therefore be conserved by adopting these means of irrigation.

Natural vegetation

Natural vegetation refers to a plant community which has grown naturally without human aid as well as has been left undisturbed by humans for a long time. The following major categories of forests.

Tropical Evergreen Rain Forests - precipitation is more than 200 cm, Arunachal Pradesh, Meghalaya, Assam, Nagaland, the Western Ghats

Deciduous or Monsoon Type of Forests - The precipitation in this area is between 100 cm and 200 cm, lower slope of the Himalayas, West Bengal, Chhattisgarh, Bihar, Orissa, Karnataka, Maharashtra Jharkhand

Dry Deciduous Forests - precipitation is between 50 cm and 100 cm, Central Deccan plateau, Punjab, Haryana, parts of Uttar Pradesh, Madhya Pradesh, and South-east of Rajasthan

Mountain Forests - slopes of the mountain

Tidal or Mangrove Forests - Forests grow by the side of the coast and on the edges of the deltas

Semi-Desert and Desert Vegetation's - receives rainfall of less than 50 cm, Gujarat's, Punjab, and Rajasthan.

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – II – ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATION – SAR1614

II. ENVIRONMENTAL IMPACT ASSESSMENT AND LEGISLATION

INTRODUCTION

Environmental Impact Assessment (EIA) is a process of evaluating the likely environmental impacts of a proposed project or development, taking into account inter-related socio-economic, cultural and human-health impacts, both beneficial and adverse. Environment Impact Assessment in India is statutorily backed by the Environment Protection Act, 1986 which contains various provisions on EIA methodology and process.

History of EIA in India

The Indian experience with Environmental Impact Assessment began over 20 years back. It started in 1976-77 when the Planning Commission asked the Department of Science and Technology to examine the river-valley projects from an environmental angle.

Till 1994, environmental clearance from the Central Government was an administrative decision and lacked legislative support. On 27 January 1994, the then Union Ministry of Environment and Forests, under the Environmental (Protection) Act 1986, promulgated an EIA notification making Environmental Clearance (EC) mandatory for expansion or modernisation of any activity or for setting up new projects listed in Schedule 1 of the notification. The Ministry of Environment, Forests and Climate Change (MoEFCC) notified new EIA legislation in September 2006. The notification makes it mandatory for various projects such as mining, thermal power plants, river valley, infrastructure (road, highway, ports, harbours and airports) and industries including very small electroplating or foundry units to get environment clearance.

TECHNIQUES AND PROCESS

EIA involves the steps mentioned below. However, the EIA process is cyclical with interaction between the various steps.

Screening: First stage of EIA, which determines whether the proposed project requires an EIA and if it requires, then the level of assessment required.

Screening criteria are based upon:

- Scales of investment
- Type of development
- Location of development

Project Category ‘A’ : Projects in this category typically require an EIA. The project type, scale and location determine this designation. The potentially significant environmental issues for these projects may lead to changes in land- use, as well as changes to social, physical, and biological environment.

Project Category ‘B’ : Only difference between projects in this category and those in Category ‘A’ is the scale. Larger Power plants fall under category ‘A’, Medium Sized Power Plants projects are in category ‘B’. These projects are not located in environmentally sensitive area. Mitigation measures for these projects are more easily prescribed.

Project Category ‘C’: This category is for projects that typically do not require an environmental assessment. These projects are unlikely to have adverse environmental impacts.

Scoping: This stage identifies key issues and impact that should be further investigated. This stage also defines the boundary and the time limit of the study. It is done by consultant in consultation with the project proponent and guidance by the agency.

Quantifiable impacts are to be assessed on the basis of magnitude, prevalence, frequency and duration.

Baseline Data: Impact prediction is a way of 'mapping' the environmental consequences of the significant aspects of the projects and its alternatives. Environmental impact can never be predicted with absolute certainty, and this is all the more reason to consider all possible factors and take all possible precautions for reducing the degree of uncertainty. The following impacts of the projects should be assessed.

AIR:

• Changes in the ambient level and the ground level concentrations due to emissions from point, line and area source.

• Effects on soils, materials, vegetation's and human health.

NOISE:

•Changes in the ambient level due to noise generated from equipment and movement of vehicles.

• Effects on fauna and human health.

WATER:

• Availability to competing users

• Changes in the quality

• Sediment transport

• Ingress of saline water.

LAND

• Changes in the land-use and drainage pattern

• Changes in land quality including effects of waste disposal

• Changes in shoreline/riverbank and their stability.

BIOLOGICAL

• Deforestation and shrinkage of animal habitat

• Impact on flora and fauna due to contaminants/pollutants.

• Impact on rare and endangered species, endemic species and migratory path of animals including birds.

• Impact on breeding and nesting grounds

SOCIO-ECONOMIC

• Impact on the local community including demographic changes

• Impact on economic status

• Impact on human health

• Impact of increased traffic.

Impact prediction:

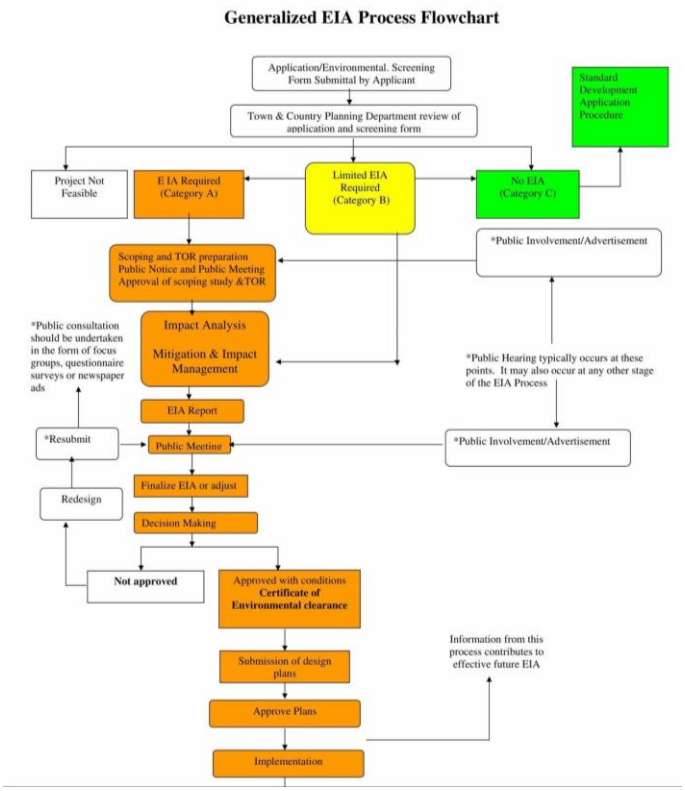
• Assessment of Alternatives,

• Delineation of Mitigation Measure and

• Environmental Impact Assessment Report.

For every project possible alternative should be identified and environmental attributes compared. Alternatives for project location & process technologies Alternative of 'no project' should also be considered. Based on the best environmental option for optimum economic benefits to the community at large, alternatives should be ranked. Mitigation plan for the selected option have to be drawn, and is supplemented with the Environmental Management Plan (EMP) to guide towards, Environmental Improvement.

Mitigation measures and EIA report: Mitigation plan for the selected option have to be drawn, and is supplemented with the Environmental Management Plan (EMP) to guide towards, Environmental Improvement. The EIA report should include the actions and steps for preventing, minimizing or by passing the impacts or else the level of compensation for probable environmental damage or loss.
Public hearing: On completion of the EIA report, public and environmental groups living close to project site may be informed and consulted.
Decision making: Impact Assessment Authority along with the experts consult the project-in-charge along with consultant to take the final decision, keeping in mind EIA and EMP (Environment Management Plan).
Monitoring and implementation of environmental management plan: The various phases of implementation of the project are monitored. Assessment of Alternatives, Delineation of Mitigation Measures and Environmental Impact Assessment Report: For every project, possible alternatives should be identified, and environmental attributes compared. Alternatives should cover both project location and process technologies. Once alternatives have been reviewed, a mitigation plan should be drawn up for the selected option and is supplemented with an Environmental Management Plan (EMP) to guide the proponent towards environmental improvements.
Risk assessment: Inventory analysis and hazard probability and index also form part of EIA procedures.



EIA Methodologies
The EIA Practitioner faces vast varieties of raw and unorganized information that must be collected and analysed in preparation of an EIA report.
The best methods should be able to

- Organize a large mass of heterogeneous data Allow summarization of data
- Aggregate the data into smaller sets with least loss of information
- Display the raw data and the derived information in a direct and relevant fashion
- Target audience should also be considered (if not educated use color codes, size etc.).

Methodologies of EIA identifies and predicts the likely Environmental and social impact of the proposed project and evaluates the significance

- Impact Identification
- Impact Prediction
- Impact Evaluation

Impact Identification answers, “what will happen when a project enters its operational stage?”

A List of important impacts such as changes in ambient air quality, changes in water and soil qualities, noise levels, wildlife habitats, species diversity, social and cultural systems, employment levels etc may be prepared. The important sources of impact like smoke emission, consumption of water, discharge of effluents etc are identified.

The methodologies can be broadly divided into five types on the basis of impact identification strength.

- Ad hoc method
- Checklist method
- Matrix method
- Network method
- Overlay method

EIA Methodologies - Ad hoc Method

Ad hoc methods indicate broad areas of possible impacts by listing composite environmental parameters (Ex: flora and fauna) likely to be affected by the proposed activity. These methods involve assembling a team of specialists who identify impacts in their area of expertise. Here, each parameter is considered separately and the nature of impacts (long term or short term, reversible or irreversible) are considered. In this method, the assessor relies on an intuitive approach and makes a broad-based qualitative assessment.

Types of Ad hoc method are:

- Opinion poll
- Expert opinion and
- Delphi method

ADVANTAGE

- Specialists on a particular area will provide guidance.
- This method is very simple and can be performed without any training

DISADVANTAGE

- It gives no assurance that a comprehensive set of all relevant impacts have been studied.
- Short/long term impact are merely examined on guess basis.
- Identification , prediction and interpretation of impacts are quite poor.

EIA Study on a Highway construction project

Impact Area	Positive Effect	Negative Effect	Adverse	Beneficial	Problematic	Short Term	Long Term	Reversible	Irreversible
Wildlife		*					*	*	
Endangered species		*					*	*	
Natural vegetation						*		*	
Exotic vegetation			*		*		*		*
Grazing									
Social characteristics									
Natural drainage									
Groundwater									
Noise			*		*				
Air quality		*							
Visual description and services		*				*		*	
Open space									
Recreation									
Health and safety									
Paved Surface	*								
Public facilities	*								
Public amenities	*								
Employment Opportunities	*								

EIA Methodologies – Checklist Method

In this method, environmental factors are listed in a structured format by giving importance weightings for factors and application of scaling techniques for impacts of each alternative. Checklists are strong indicators of impact identification. They effectively gather the attention and awareness of their audience.

Checklists types:

Simple Checklist - are a list of parameters without guidelines regarding either interpretation or measurement of environmental parameters.
Descriptive checklists - include list of environmental factors along with information on measurement, impact prediction and assessment.
Scaling and weighting checklists facilitate decision making. Such checklists are strong in impact identification. While including the function of impact identification, they include a certain degree of interpretation and evaluation.
Advantages

- It is simple to understand and use
- It is good for site selection and priority setting

Disadvantages

- It does not distinguish between direct and indirect impacts
- It does not link action and impact
- It is cumbersome at times

SIMPLE CHECKLIST

Items	Nature of Likely Impacts: Adverse ST	LT	R	IR	L	W	Beneficial ST	LT	SI	N
Aquatic Ecosystems		x		x	x					
Fisheries		x		x	x					
Forests		x		x	x					
Terrestrial Wildlife		x		x		x				
Rare & Endangered Species		x		x		x				
Surface Water Hydrology		x		x		x				
Surface Water Quality		x								
Groundwater	*	*	*	*	*	*	*	*	*	*
Soils										
Air Quality	x				x					
Navigation		x			x					
Land Transportation								x	x	
Agriculture							x			x
Socioeconomic								x		x
Aesthetic		x			x					

Legend x indicates potential for type of impact; R denotes Reversible; W denotes Wide; ST denotes Short Term; IR denotes Irreversible; SI denotes Significant; LT denotes Long Term; L denotes Local; N denotes Normal

SIMPLE CHECKLIST DEVELOPED FOR THE HUASAI-THALE NOI ROAD PROJECT

*SOURCE - NATIONAL ENVIRONMENT BOARAD 1980

WEIGHINNG & SCALING CHECKLIST

Two alternative examples to illustrate weighting and scaling techniques.

Factors	Weights	Alternative One			Alternative Two		
		Raw Data	Scaled	Weighted	Raw Data	Scaled	Weighted
Wildlife Habitat Preserved (ha.)		5000			10000		
Employment Increase (jobs)		5000			3000		
Wildlife Habitat Index	1		0.5			1	
Employment Increase Index	1		1			0.6	
Wildlife Habitat Weighted Index	0.2			0.1			0.2
Employment Increase Weighted Index	0.8			0.8			0.48
Grand Index		n/a	1.5	0.9	n/a	1.6	0.68

Matrix methodology provides a framework of interaction of different activities of a project with potential environmental impacts caused by them. A simple interaction matrix is formed when project actions are listed on one axis (usually vertical) and environmental impacts are listed along the other axis. This technique was pioneered by Leopold et al in 1971. It lists about 100 project actions and about 88 environmental characteristics and conditions. The entries of the cell of the matrix can be either qualitative or quantitative estimates of impact.

Environmental Components	Project Activities: Plant Construction	Farming of Kenaf	Use of Pesticide Fertilizer	Transport of Raw Materials	Water Intake	Solid Waste	Effluent Discharge	Emissions	Employ-ment
Surface Water Quality			x			x	x		x
Surface Water Hydrology					x				
Air Quality				x				x	
Fisheries			x				x		
Terrestrial Wildlife Habitat	x								
Terrestrial Wildlife	x								
Land Use Pattern		x							
Highways/Railways				x					
Water Supply			x				x		
Agriculture		x							
Housing									x
Health						x	x	x	
Socioeconomic									x

Leopold Matrices

Identify all actions that are part of the proposed project. Under the each of the proposed actions, place a slash at the inter-section with each item on the side of the matrix if an impact is possible. 10 represent the greatest magnitude of impact, 1 is the least magnitude of impact (no zeroes). Before each number place + (if the impact would be beneficial). In the lower right hand corner of the box place a number from 1 to 10 which indicates the importance of the possible impact.

Environmental impact / Elements of the environment	Regime modification	Surface transformation	Urbanization and structures on the surface	Changes in vehicle traffic	Pollutant movement	Use of chemicals	Extraordinary hazards and accidents
Soil	2		3	4	4	1	2
Water	1	1		4	3	1	2
Atmosphere	4		4	5			2
Land use	3	1				1	
Qualities of the landscape	2						
Infrastructure		1	3	2			

Advantages:

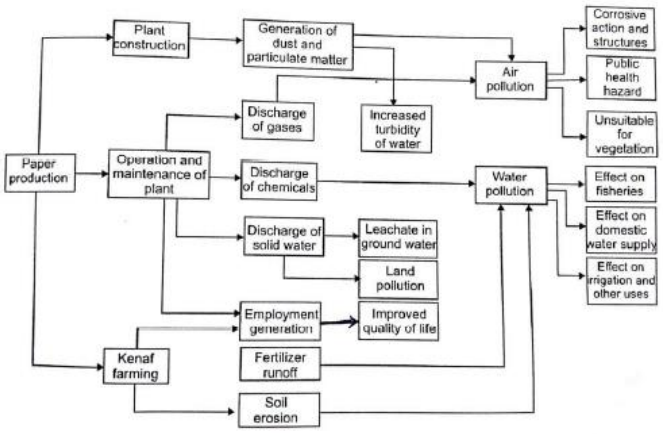
- The matrix method is that it links action to impact
- This is a very good method for displaying EIA result.

Disadvantages:

- It is difficult to distinguish between direct and indirect impacts using this method.
- There is potential for double-counting of impacts.
- It is qualitative in nature and does not refer to quantity of impact.

Network Method

Network method uses the matrix approach and extends it to include both the primary as well as the secondary impacts. It is shown in the form of a tree called impact tree. This diagram is also called as reference or sequence diagram. Identification of direct, indirect along with short, long term impact is a crucial and basic step of making an impact tree. The impact tree is used to identify cause-effect linkages. The impact tree is a visual description of linkages.



Network of pulpmill impacts.

Advantages:

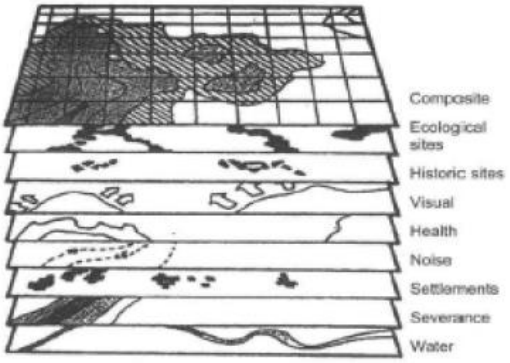
- It links action to impact.
- It is useful to check second order impacts in a simplified form.
- It handles direct and indirect impacts.

Disadvantages:

- It becomes overly complex if used beyond simplified version.
- It is completely qualitative in nature.

Overlay Method

Overlay method depends on a set of maps of a project area's environmental characteristics covering physical, social, ecological and aesthetic aspects. It enables separate mapping of critical environmental features at the same scale as project's site plan (Ex: wetlands, steep slopes, soils, floodplains, bedrock outcrops, wildlife habitats, vegetative communities, cultural resources, etc). In the old technique, environmental features were mapped on transparent plastic in different colours Modern technique of the same activity is done using computer software, hardware, data and skilled people. It is called GIS (Geographic Information Systems).



Advantages:

- It is easy to understand and use
- It has a good display
- It is good for setting site selection

Disadvantages

- The weakness of the overlay method is that it is only moderate comprehensive, because there is no mechanism that requires consideration of all potential impacts.
- There is no provision for quantification and measurement of the impacts nor is it assured that all impacts will be covered.

Issues in Environmental Impact Assessment

Difficulties in ensuring adequate and useful public involvement (or participation). Insufficient integration of EIA work at key decision points in relation to feasibility and similar studies in the project life-cycle. with some major decisions being made even before EIAs are completed. Lack of consistency in selection of developments requiring specific environmental impact assessment studies. Inadequate understanding of the relative roles of baseline description and impact prediction.

Poor integration of biophysical environmental impacts with social, economic and health effects also adds to the Problems in Environmental Impact Assessment. Production of EIA reports which are not easily understood by decision makers and the public because of their length and technical complexity.

Lack of mechanisms to ensure that EIA reports are considered in decision-making. Weak linkages between environmental impact assessment report recommendations on mitigation and monitoring and project implementation and operation.

Evolution of planning legislation

Evolutionary Process of Acts

City Improvement acts

- Bombay Improvement Act - 1898
- Mysore Improvement Act - 1903
- Calcutta improvement Act - 1911

Town Planning act

- Bombay town planning act, -1915
- Madras town planning act, -1920
- Madhya Pradesh town planning act, -1948
- Jammu and Kashmir town planning act, -1963

Town and Improvement trust acts

- Bihar town planning and Improvement trust act, -1931
- Orissa town planning and Improvement trust act, -1956

Town and country planning acts

- Assam town and country planning act, -1959
- Mysore town and country planning act, -1961
- Gujarat town and country planning act, -1964

Significance Of Law And Its Relationship To Development

Sanitary Commission 1864 An agency under the 'Sanitary Commission' charged with the responsibility of town improvements was formed in India in 1864. In the same year Sanitary commissions were set up in Bombay, Madras and Bengal at the instance of Royal Sanitary Commission, which had been appointed by Britain in 1859, to "give advice and assistance in matters relative to public health and Sanitation, to advice on the Sanitary improvement of native towns and prevention and migration of epidemic diseases". The sanitary improvement of native towns, prevention and mitigation of epidemic diseases, and generally to exercise a constant oversight on the sanitary condition of the population.

Bombay Improvement act -1898

The year 1898 made another epoch in the history of town improvement when the first improvement trust was constituted in the city of Bombay, just two years of before the outbreak of bubonic plague. It compelled the government under the improvement trust to adopt proper measures for the removal of insanitary dwellings, overcrowding and to carry out necessary sanitary improvements so as to secure better living conditions for the people. The Mysore Improvement Trust was set up in 1903 and was followed by Calcutta Improvement Trust in 1911.

Bombay town planning act - 1915

The first town planning legislation was enacted in India 1915 under the title 'Bombay Town Planning Act 1915'. It confers on the local authorities the most valuable powers, the chief of which are

To control the future growth of the town, to prevent formation of slums to provide healthy dwellings,

To take active measures to make life more comfortable for the poor and middle class people.

The Model Town and Country Planning Act 1960

The old enactments were found to be ineffective to tackle many of city problems, Hence it was felt necessary for a new comprehensive legislation, For this purpose the Institute of Town planners, which was founded in 1951 in India, drafted a Model Town Planning Act in 1957 and circulated it among all the states for implementation . The model acts deals with in regard to constitution of planning authority for large areas of urban centres of state. The act contains important provisions coming under or outside municipal limits. The objective of this act is to provide for regulation of planned growth of land use and development so as to execute the town planning scheme in the state.

The Model Town and Country Planning Act 1960

The act is necessary for the following;

To create favourable conditions for the planning and redevelopment of urban and rural areas to provide civic and social amenities .

To prevent uncontrolled development of land.

To preserve and improve the existing recreational and other facilities.

To provide facilities for the orderly growth of commerce and industry etc.

Salient features of the Model Town Planning Act 1960

The act deals with various important provisions which are as under; It provides the constitution of a state Town Planning Board to advise the State Government with regard to planning and local development and to work out a broad principle and policy for the balanced development of the state. The Government may, by notification, declare any area in the state to be local planning area for the purpose of this act and on such declaration this act shall apply to these areas, except the military cantonment area. Such notification shall also define the limit of planning area.

After consultation with the Board, the State Government may amalgamate or sub-divide the planning area and constitute a special planning authority or Town Improvement Board to function as planning authority. The planning authority constituted under the sub-section 2 shall consist of the following members, namely

- A chairman appointed by the State Government
- A town planning officer, to be the member-secretary
- Representatives of local bodies coming under the jurisdiction of their planning area and total number of such representatives shall not exceed five.

The State Government, by notification, shall specify the date with reference to which the present land use has to be determined and different dates may be fixed for different areas in the state.

Every planning authority shall prepare Master plan in two

stages A. Preparation of an outline Development Plan or an interim master plan: within a period of two years, the planning authority has to conduct the survey and prepare outline development plan and submit the same to the Government through the Director for approval.

Stage B. Preparation of Comprehensive development plan or detailed master plan.

NATIONAL ENVIRONMENTAL POLICY

The NATIONAL ENVIRONMENTAL POLICY was first formulated in 2006, by Government of India, Ministry of Environment and Forest. It was an effort towards India's commitment to clean environment and making positive contribution to international efforts. The NEP builds on the various earlier policies which had addressed the challenges of environment and need of sustainable development. The National Environment Policy seeks to extend the coverage, and fill in gaps that still exist, in light of present knowledge and accumulated experience. It does not displace, but builds on the earlier policies. The dominant theme of this policy is that while conservation of environmental

resources is necessary to secure livelihoods and well being of all the most secure basis of conservation is to ensure that people depend on particular resources to obtain better livelihoods from the fact of conservation rather than the degradation of the resources.

THE MAIN OBJECTIVES OF NEP, 2006

CONSERVATION OF CRITICAL ENVIRONMENTAL RESOURCES:

To protect and conserve critical ecological systems and resources, and invaluable natural and man-made heritage, which are essential for life support, livelihoods, economic growth, and a broad conception of human well-being.

INTRA-GENERATIONAL EQUITY: LIVELIHOOD SECURITY FOR THE POOR:

To ensure equitable access to environmental resources and quality for all sections of society, and in particular, to ensure that poor communities, which are most dependent on environmental resources for their livelihoods, are assured secure access to these resources.

INTER-GENERATIONAL EQUITY:

To ensure judicious use of environmental resources to meet the needs and aspirations of the present and future generations.

INTEGRATION OF ENVIRONMENTAL CONCERNS IN ECONOMIC AND SOCIAL DEVELOPMENT:

To integrate environmental concerns into policies, plans, programmes, and projects for economic and social development.

EFFICIENCY IN ENVIRONMENTAL RESOURCE USE:

To ensure efficient use of environmental resources in the sense of reduction in their use per unit of economic output, to minimize adverse environmental impacts.

ENVIRONMENTAL GOVERNANCE:

To apply the principles of good governance (transparency, rationality, accountability, reduction in time and costs, participation, and regulatory independence) to the management and regulation of use of environmental resources.

ENHANCEMENT OF RESOURCES FOR ENVIRONMENTAL CONSERVATION:

To ensure higher resource flows, comprising finance, technology, management skills, traditional knowledge, and social capital, for environmental conservation through mutually beneficial multi-stakeholder partnerships between local communities, public agencies, academic research community, investors, multilateral bilateral development partners.

THE WILDLIFE PROTECTION ACT

As everyone knows, wild animals collectively and the native fauna (and sometimes flora) of a region is called wildlife. Wildlife traditionally refers to non domesticated animal species, but has come to include all plants, fungi, and other organisms that grow or live wild in an area without being introduced by humans. Wildlife can be found in all ecosystems. Deserts, forests, rain forests, plains, grasslands, and other areas including the most developed urban sites, all have distinct forms of wildlife.

The Wild Life Protection Act, 1972 is an Act of the Parliament of India enacted on 9th September, 1972. It provides for protection of wild animals, birds and plants ; and for matters connected therewith or ancillary or incidental thereto. It extends to whole of India, except Jammu and Kashmir. It has six schedules which give varying degrees of protection.

Salient Features of Wildlife Protection Act

- Wild life protection Act provides for the protection of a listed species of animals, birds and plants, and also for the establishment of a network of ecologically-important protected areas in the country.
- The Act provides for the formation of wildlife advisory boards, wildlife wardens, specifies their powers and duties, etc.
- It helped India become a party to the Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES).
- The Act prohibited the hunting of endangered species.
- Scheduled animals are prohibited from being traded as per the Act's provisions.
- The Act provides for licenses for the sale, transfer and possession of some wildlife species. It provides for the establishment of wildlife sanctuaries, national parks, etc.
- Its provisions paved the way for the formation of the Central Zoo Authority. This is the central body responsible for the oversight of zoos in India. It was established in 1992.
- The Act created six schedules which gave varying degrees of protection to classes of flora and fauna. Schedule I and Schedule II (Part II) get absolute protection and offences under these schedules attract the maximum penalties. The schedules also include species which may be hunted.

Schedule I

- This Schedule covers endangered species. These species need rigorous protection and therefore, the harshest penalties for violation of the law are for species under this Schedule.
- Species under this Schedule are prohibited to be hunted throughout India, except under threat to human life. Absolute protection is accorded to species in this list.
- Trade of these animals is prohibited.
    - Examples: tiger, blackbuck, Himalayan Brown Bear, Brow-Antlered Deer, Blue whale, Common Dolphin, Cheetah, Clouded Leopard, hornbills, Indian Gazelle, etc

Schedule II

- Animals under this list are also accorded high protection. Their trade is prohibited.
- They cannot be hunted except under threat to human life.
    - Examples: Kohinoor (insect), Assamese Macaque, Bengal Hanuman langur, Large Indian Civet, Indian Fox, Larger Kashmir Flying Squirrel, Kashmir Fox, etc.

Schedule III & IV

- This list is for species that are not endangered.
- This includes protected species but the penalty for any violation is less compared to the first two schedules.
    - Examples: hyena, Himalayan rat, porcupine, flying fox, Malabar tree toad, etc.

Schedule V

- This schedule contains animals which can be hunted.
    - Examples: mice, rat, common crow, fruit bats, etc.

Schedule VI

- This list contains plants that are forbidden from cultivation.
    - Examples: pitcher plant, blue vanda, red vanda, kuth, etc.

Protected Areas under the Wildlife Protection Act

There are five types of protected areas as provided under the Act.

1. Sanctuaries: "Sanctuary is a place of refuge where injured, abandoned and abused wildlife is allowed to live in peace in their natural environment without any human intervention."
    - They are naturally-occurring areas where endangered species are protected from poaching, hunting and predation.
    - Here, animals are not bred for commercial exploitation.
    - The species are protected from any sort of disturbance.
    - Animals are not allowed to be captured or killed inside the sanctuaries.
    - A wildlife sanctuary is declared by the State government by a Notification. Boundaries can be altered by a Resolution of the State Legislature.
    - Human activities such as timber harvesting, collecting minor forest products and private ownership rights are permitted as long as they do not interfere with the animals' well-being. Limited human activity is permitted.
    - They are open to the general public. But people are not allowed unescorted.
    - Boundaries of sanctuaries are not generally fixed and defined.
    - Biologists and researchers are permitted inside so that they can study the area and its inhabitants.
    - The Chief Wildlife Warden (who is the authority to control, manage and maintain all sanctuaries) may grant permission to persons for entry or residence in the sanctuary for the study of wildlife, scientific research, photography, the transaction of any lawful business with persons residing inside, and tourism.
    - Sanctuaries can be upgraded to the status of a 'National Park'.

2. National Parks: "National Parks are the areas that are set by the government to conserve the natural environment."

    - A national park has more restrictions as compared to a wildlife sanctuary.
    - National parks can be declared by the State government by Notification. No
    - alteration of the boundaries of a national park shall be made except on a
    - resolution passed by the State Legislature.
    - The main objective of a national park is to protect the natural environment of the area and biodiversity conservation.
    - The landscape, fauna and flora are present in their natural state in national parks.
    - Their boundaries are fixed and defined.
    - Here, no human activity is allowed.
    - Grazing of livestock and private tenurial rights are not permitted here.
    - No person shall destroy, remove or exploit any wildlife from a National Park or destroy or damage the habitat of any wild animal or deprive any wild animal of its habitat within a national park.
    - They cannot be downgraded to the status of a 'sanctuary'.

3. Conservation Reserves: The State government may declare an area (particularly those adjacent to sanctuaries or parks) as conservation reserves after consulting with local communities.

4. Community Reserves: The State government may declare any private or community land as a community reserve after consultation with the local community or an individual who has volunteered to conserve the wildlife.

5. Tiger Reserves: These areas are reserved for the protection and conservation of tigers in India. They are declared on the recommendations of the National Tiger Conservation Authority.

THE AIR ACT

Air pollution refers to the release of pollutants into the air that are detrimental to human health and the planet as a whole. It is an undesirable change in the physical, chemical or biological characteristics of air. Sources of Air Pollution are Man-made & Natural.

Major Air Pollutants

- Carbon Monoxide
- Sulphur Dioxide
- Carbon Dioxide
- Chloro floro Carbon
- Nitrogen Oxide
- Ozone

- 1948 – Factories Act and Amendment in 1987 was the first to express concern for the working environment of the workers. The amendment of 1987 has sharpened its environmental focus and expanded its application to hazardous processes.
- 1981 – Air (Prevention and Control of Pollution) Act provides for the control and abatement of air pollution. It entrusts the power of enforcing this act to the Central Pollution Control Board.
- 1982 – Air (Prevention and Control of Pollution) Rules defines the procedures of the meetings of the Boards and the powers entrusted on them.
- 1982 – Atomic Energy Act deals with the radioactive waste.
- 1987 – Air (Prevention and Control of Pollution) Amendment Act empowers the central and state pollution boards to meet with grave emergencies of air pollution.
- 1988 – Motor Vehicles Act states that all hazardous waste is to be properly packaged, labeled and transported.

The Air(Prevention and Control of Pollution)Act, 1981 is a central Act of Parliament, which provides for the prevention and control of air pollution and maintaining the good quality of air. It also provided for the establishment of the Central and State Boards for the Prevention and Control of Air Pollution. It is applicable to whole of India except Jammu and Kashmir.

Objective

- To provide for the prevention, control and abatement of air pollution.
- To provide for the establishment of central and state board with a view to implement the Act.
- To confer on the boards the power to implement the provisions of the Act and assign to the boards functions relating to pollution.

Central Pollution Control Board

Central Pollution Control Board constituted under sec.3 of the Water Prevention and Control Act,1974 was authorized to exercise the powers and performs the functions for the prevention and control of air pollution. CPCB of India is a statutory organisation under the Ministry of Environment, Forest and Climate Change. It serves as a field formation and provide technical and financial services.

The functions of Central Board under the Air Act

The main functions of the Central Board, as specified in Section 16 of the Act, shall be:-

- Advise the Central Government on any matter concerning the improvement of the quality of air and the prevention, control of abatement of air pollution.

- Plan and cause to be executed a nation-wide programme for the prevention and control of air pollution.
- Coordinate the activities of the State Boards and resolve dispute among them.
- Provide technical assistance and guidance to the State Boards.
- Collect, compile and publish technical and statistical data relating to air pollution and measures devised for its effective prevention and control.

State Pollution Control Board

SPCB is constituted under section 4 of Water Prevention And Control of Pollution was also authorized to exercise the powers and performs the functions for the prevention and control of air pollution. Like CPCB it is also responsible for the implementation of legislation relating to prevention and control of environmental pollution but their powers and functions are different.

The functions of State Boards under the Air Act

- To advise the State Government on any matter concerning the prevention, control or abatement of air pollution.
- To advise the State Government with respect to the suitability of any premises or location for carrying on any industry which is likely to cause air pollution.
- To collaborate with the Central Board in organising the training of persons engaged or to be engaged in programmes relating to prevention and control of air pollution and to provide mass education programmer relating thereof.
- To provide various standards for the emissions of different industrial plants with regard to quantify and composition of emission of air pollutant into the atmosphere.

Penalties

The persons managing industry are to be penalized if they produce emissions of air pollutants in excess of the standards laid down by the State Board. Whoever is founded to be work against the clauses of the Act or any order or direction issued is punishable with Rs.10,000 in case of three months and if in case offence is continue then extra Rs.5000is charged for everyday.

THE WATER ACT

- The Water (Prevention and Control of Pollution) Act was enacted in 1974 to provide for the prevention and control of water pollution, and for the maintaining or restoring of wholesomeness of water in the country.
- The Act was amended in 1988.
- The Water (Prevention and Control of Pollution) Cess Act was enacted in 1977, to provide for the levy and collection of a cess on water consumed by persons operating and carrying on certain types of industrial activities.
- This cess is collected with a view to augment the resources of the Central Board and the State Boards for the prevention and control of water pollution constituted under the Water (Prevention and Control of Pollution) Act, 1974.
- The Act was last amended in 2003.

Water Act

It defines pollution as

- Contamination of water.
- Alteration of the physical, chemical or biological properties of water.
- Discharge of any sewage or trade effluent or any other liquid, gaseous or solid substance into water (whether directly or indirectly)

- It is likely to create a nuisance or rend such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural or other legitimate uses.
- Harmful or injurious to the life and health of animals or of aquatic organisms.
- This Act paved the way for the creation of Central Pollution Control Board (CPCB) and State Pollution Control Boards (SPCBs).
- The main function of the CPCB 'shall be to promote cleanliness of streams and wells in different areas of the States'.
- The term stream includes river, watercourse, inland water, subterranean waters, and sea or tidal waters to such extent or such point a State Government may specify in this behalf.

Functions of Central Board (sec. 16)

• The Central Board may establish or recognize a laboratory or laboratories to enable the Central Board to perform its functions under this section efficiently.

• The Central Board may-

(a) delegate any of its functions under this Act generally or specially to any of the committees appointed by it;

(b) do such other things and perform such other acts as it may think necessary for the proper discharge of its functions and generally for the purpose of carrying into effect the purposes Of this Act.

Functions of the State Board

a) Functions of a State Board has been prescribed in section 17.
b) But the state pollution board have confined themselves only to grant consents to the industries.
c) After the legislation of Environment (Protection) Act, 1986 wherein the Standards for Effluent has been prescribed in the EP Rules, the Boards merely mentioned those rules in the conditions of the consent.
d) More so Boards are issuing consent with the condition "Zero Discharge" without ensuring whether this condition could be met or complied by the Industry.

Penalties

- The penalties for non-compliance are imprisonment from 18 months to 6 years with a fine for the first contravention and additional fine upto Rs.5000 per day till the failure continues.
- This Act does not cover groundwater contamination. Municipalities which are primarily responsible for treating residential wastes remain free from direct liability.
- It allows the Government agencies too much flexibility. For example the Act States that the head of a polluting unit would not be punished 'if he proves that the offence was committed without his knowledge or that he exercised all due diligence to prevent it'.
- This Act does not give the victims the right to go to the courts to punish the erring units; charges can be brought to courts only by the Boards.

THE FOREST CONSERVATION ACT

FOREST CONSERVATION Act has been passed with a view to check deforestation which has been taking place in the country on a large scale and which had cause ecological imbalance and thus led to environmental deterioration. The President of India promulgated the Forest (Conservation) Ordinance on 25 October, 1980. It simply aims at putting restriction on the de-reservation of forests or use of forest-land for non-forest purposes. The Act is intended to serve a laudable purpose as is evident from the Statement of Objects and Reasons of the Act, which reads deforestation causes

ecological imbalance and leads to environmental deterioration. Deforestation had been taking place On a large scale in the country and it had caused widespread concern.

Restriction on the de-reservation of forests or use of forest land for non-forest purpose.
Section 2 of the Act deals with restriction on the de reservation of forests or use of forest-land for non-forest purposes.
It provides that notwithstanding anything contained in any other law for the time being in force in a State, no State Government or other authority shall make, except with prior approval of the Central Government, any order directing-

(i) that any reserved forest declared under any law for the time being in force in that State or any portion thereof, shall cease to be reserved;
(ii) that any forest land or any portion thereof may be used for any non forest purpose
(iii) that any forest land any portion thereof may be assigned by way of lease or otherwise to any private person or to any authority corporation, agency or any other organization not owned, managed or controlled by Government;
(iv) that any forest land or any portion thereof may be cleared of trees which have grown naturally in that land or portion, for the purpose of using it for re afforestation.

Non Forest Purpose.

"non-forest purpose" means the breaking up of clearing or any forest-land or portion thereof for :-

(a) the cultivation of tea, coffee, spices, rubber, palms, oil-bearing plants, horticulture crops or medicinal plants; or
(b) any purpose other than reforestation, but does not include any work relating or ancillary to conservation, development and management of forests and wild-life, namely, the establishment of check-posts, fire lines, wireless communications and construction of fencing, bridges and culverts, dams, waterholes, trench marks, boundary marks, pipelines or other like purposes.

Constitution of Advisory Committee.
The Central Government may constitute a Committee consisting of such number of persons as it may deem fit to advise that Government

(i) Director- General of Forests, Ministry of Environment and Forests Chairman.
(ii) Additional Director-General of Forests, Ministry of Environment and Forests-Member (He will act as chairperson in the absence of Director General of Forests).
(iii) Additional Commissioner (Soil Conservation), Ministry of Agriculture Member
(iv) Three eminent experts in forestry and allied discipline Environment . Scientists (non-officials) - Member
(v) Inspector - General of Forests (Forests Conservation), Ministry of Environment and Forests-Member-Secretary.

Penalty for contravention of the provisions of the Act

Section 3A of the Act provides that whoever contravenes or abets the contravention of any of the provisions of section 2, shall be punishable with simple imprisonment for a period, which may extend to fifteen days. A perusal of this section shows that the Act contemplates only the punishment of simple imprisonment and it does not contemplate any punishment in terms of fine.

Offences by authorities and Government departments

The Act provides that where any offence under this Act has been committed-

(a) by any department of Government, the head of the department; or

(b) by any authority, every person who, at the time the offence was committed, was directly in charge of, and was responsible to, the authority for the conduct of the business of the authority as well as the authority, shall be deemed to be guilty of the offence and shall be liable to be proceeded against and punished accordingly. However, the Head of the Department or any other person referred to above shall not be liable to any punishment if he Proves that-

- the offence was committed without his knowledge; or
- the exercised all diligence to prevent the commission of such offence.

(c) Where an offence under this Act has been committed by a Department of Government or any authority referred to above and it is proved that the offence has been committed with the consent or connivance of, or is attributable to any neglect on the part of any officer other than the Head of the Department, or in case of an authority any person other than the persons referred to above, then such officer or person shall also be deemed to be guilty of that offence and shall be liable to be proceeded against and punished accordingly.

Power To Make Rules

(i) Section 4 of the Act vests the Central Government with the power to make rules for carrying out the provisions of this Act. Every rule made under this Act shall be laid, as soon as may be after it is made, before each house of the Parliament, while it is in session, for a total period of thirty days which may be comprised in one session or in two or more successive sessions.

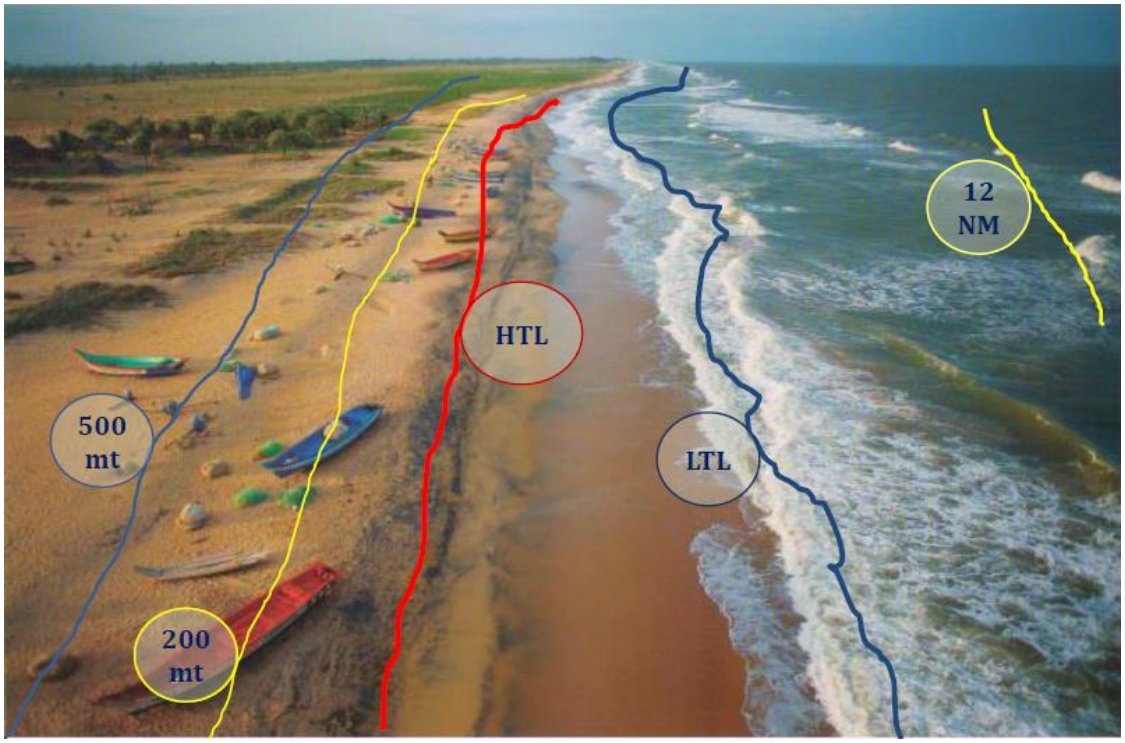
COASTAL REGULATION ZONE

According to Clause(d) of sub-rule (3) of Rule 5 of the Environment (Protection) Rules,1986, the Central Government hereby declares “the coastal stretches of seas, bays, estuaries, creeks, rivers and backwaters which are influenced by tidal action (in the landward side) up to 500 meters from the High Tide Line (HTL) and the land between the Low Tide Line (LTL) and the HTL are referred as Coastal Regulation Zone ” .

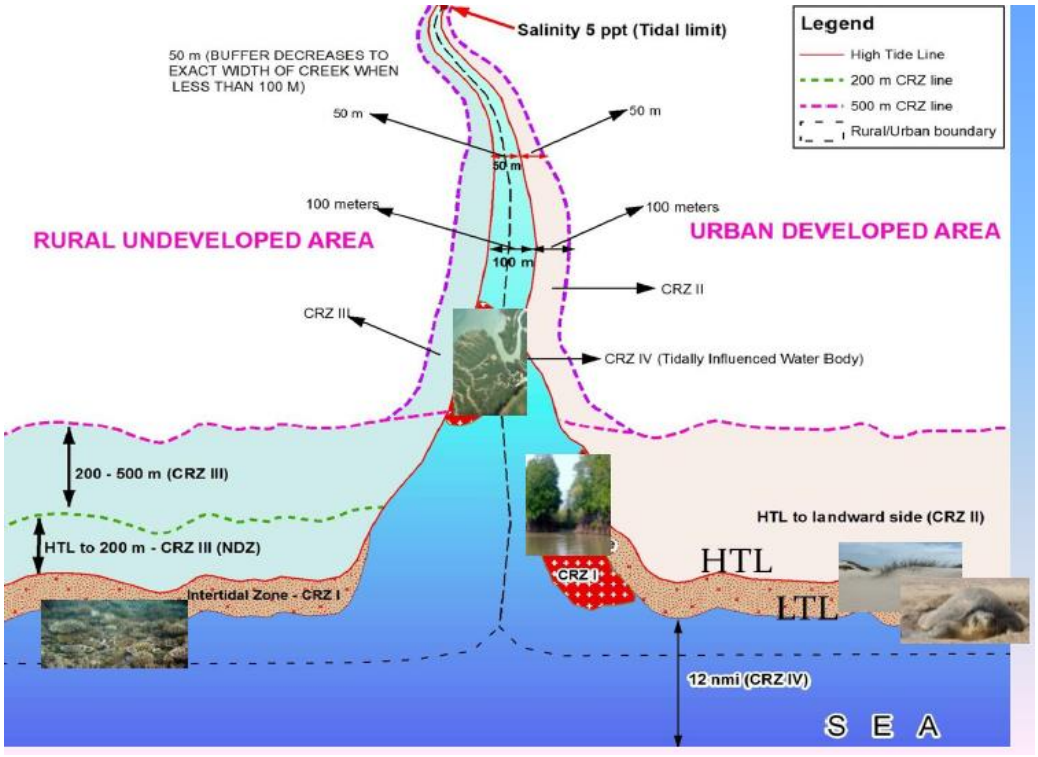
- This has been done after considering the need for protecting the coastal areas and beaches from environmental degradation.
- Prohibition of developmental activities of any kind has caused considerable problems to State Governments as there are existing developed areas within the stretch of 500 M.
- Keeping this in view and ensuring that the use and activities in the coastal areas are consistent with principles and requirements of environment conservation, the Government of India has proposed Coastal Regulations Zone and to impose restrictions on developmental activities.
- These regulations among other things permit developments in the area already developed/partly developed with certain restrictions and subject to land use and other regulations framed under the Town & Country Planning Act prevailing in the State.

Terms

- HIGH TIDE LINE (HTL) : means the line on the land upto which the highest water line reaches during the spring tide.
- LOW TIDE LINE (LTL) : The lowest level of water on the shore.
- SEASHORE: An area of sandy, stone, or rocky land bordering and level with the sea. Area between HTL and LTL.



- CRZ shall apply to the land between the HTL to 100mts or width of the tidal influenced water bodies that are connected to the sea(whichever is lesser).
- The land area falling between the hazard line and 500mts from HTL – landward side in case of seafront.
- The land area falling between the hazard line and 100 mts in case of tidal influenced water body.
- The land area between the HTL and LTL (low tide level) will be termed as intertidal zone.



Classification of Coastal Regulation Zone

For regulation of developmental activities, the coastal stretches within 500m of HTL on the landward side are classified into four categories,

- Category I (CRZ-I)
- Category II (CRZ - II)
- Category III (CRZ-III)
- Category IV (CRZ-IV)

CRZ 1

- The areas that are ecologically sensitive and the geomorphological features which play a role in the maintaining the integrity of the coast,-
- Mangroves, in case mangrove area is more than 1000 sq mts, a buffer of 50meters.
- Corals and coral reefs and associated biodiversity;
- Sand Dunes;
- Mudflats which are biologically active;
- National parks, marine parks, sanctuaries, reserve forests, wildlife habitats and other along the mangroves shall be provided; protected areas under the provisions of Wild Life (Protection) Act, 1972 (53 of 1972), the Forest (Conservation) Act, 1980 (69 of 1980) or Environment (Protection) Act, 1986 (29 of 1986); including Biosphere Reserves.

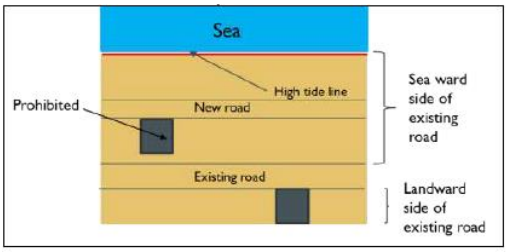
CRZ 1 NORMS FOR REGULATION OF ACTIVITIES

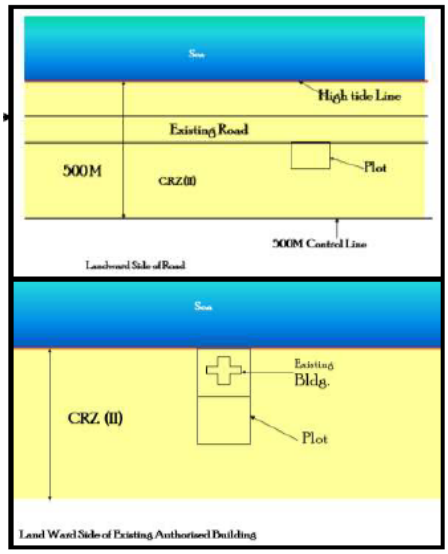
- No new construction shall be permitted in CRZ-I except.
- Projects relating to Department of Atomic Energy.
- Pipelines, conveying systems including transmission lines.
- Facilities that are essential for activities permissible under CRZ-I
- Installation of weather radar for monitoring of cyclones movement and prediction by.
- Construction of trans harbour sea link and without affecting the tidal flow of water.
- Areas between LTL and HTL which are not ecologically sensitive, necessary safety measures will be incorporated while permitting the following, namely:-
- Exploration and extraction of natural gas;
- Construction of dispensaries, schools, public rain shelter, community toilets, bridges, roads, jetties, water supply, drainage, sewerage which are required for traditional inhabitants living within the biosphere reserves after obtaining approval from concerned CZMA.
- Necessary safety measure shall be incorporated while permitting such developmental activities in the area falling in the hazard zone;
- Salt harvesting by solar evaporation of seawater; desalination plants;
- Storage of non-hazardous cargo such as edible oil, fertilizers and food grain within notified ports.
- Construction of trans harbour sea links, roads on stilts or pillars without affecting the tidal flow of water.

CRZ 2

- The areas that have been developed up to or close to the shoreline .
- Developed area: area within the existing municipal limits or in other existing legally designated urban areas which are substantially built -up and has been provided with drainage and approach roads and other infrastructural facilities, such as water supply and sewerage mains.

- Areas that are relatively undisturbed and those do not belong to either CRZ -I or II which include coastal zone in the rural areas (developed and undeveloped) and also areas within municipal limits or in other legally designated urban areas, which are not substantially built up.
- Buildings shall be permitted only on the landward side of the existing road, or on the landward side of existing authorized structures;
- Buildings shall be subject to the existing local town and country planning regulations including the 'existing' norms of Floor Space Index or Floor Area Ratio:
- Provided that no permission for construction of buildings shall be given on landward side of any new roads which are constructed on the seaward side of an existing road.





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NORMS FOR REGULATION OF ACTIVITIES

- Reconstruction of authorized building to be permitted subject with the existing Floor Space Index or Floor Area Ratio Norms and without change in present use
- Facilities for receipt and storage of petroleum products and liquefied natural gas desalination plants and associated facilities;
- Storage of non-hazardous cargo, such as edible oil, fertilizers and food grain in notified ports;
- Facilities for generating power by non-conventional power sources and associated facilities.

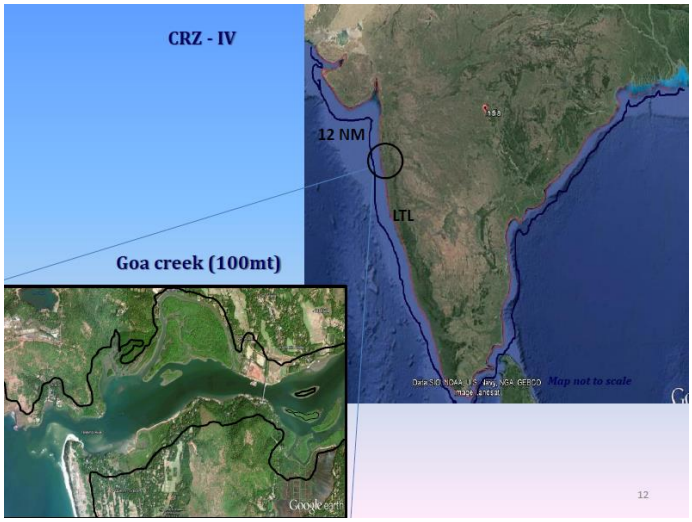
CRZ 3

- Area up to 200mts from HTL on the landward side in case of seafront and 100mts along tidal influenced water bodies or width of the creek whichever is less is to be earmarked as "No Development Zone (NDZ)".

- The NDZ shall not be applicable in such area falling within any notified port limits;
- No construction shall be permitted within NDZ except:
- Repairs or reconstruction of existing authorized structure not exceeding existing Floor Space Index, existing plinth area and existing density and for permissible activities under the notification including facilities essential for activities.
- Dwelling units for traditional coastal communities and fisher folk.
  However, the following activities may be permitted in NDZ –
  • agriculture, horticulture, gardens, pasture, parks, play field, and forestry;
  • projects relating to Department of Atomic Energy;
  • mining of rare minerals;
  • salt manufacture from seawater
- facilities for receipt and storage of petroleum products and liquefied natural gas as specified in Annexure-II;
- facilities for generating power by non conventional energy sources;
- Foreshore facilities for desalination plants and associated facilities;
- weather radars;
- construction of dispensaries, schools, public rain shelter, community toilets, bridges, roads, provision of facilities for water supply, drainage, sewerage, crematoria, cemeteries and electric sub-station which are required for the local inhabitants may be permitted on a case to case basis by CZMA

- construction of units or auxiliary thereto for domestic sewage, treatment and disposal with the prior approval of the concerned Pollution Control Board or Committee;
- Facilities required for local fishing communities such as fish drying yards, auction halls, net mending yards, traditional boat building yards, ice plant, ice crushing units, fish curing facilities and the like

CRZ 4



The water area from the Low Tide Line to twelve nautical miles on the seaward side; shall include the water area of the tidal influenced water body from the mouth of the water body at the sea upto the influence of tide which is measured as five parts per thousand during the driest season of the year. The activities impugning on the sea and tidal influenced water bodies will be regulated except for traditional fishing and related activities undertaken by local communities as follows:-

- No untreated sewage, effluents, ballast water, ship washes, fly ash or solid waste from all activities including from aquaculture operations shall be let off or dumped
- A comprehensive plan for treatment of sewage generating from the coastal towns and cities shall be formulated in consultation with stakeholders including traditional coastal communities, traditional fisher folk and implemented;
- Pollution from oil and gas exploration and drilling, mining, boat house and shipping;
- There shall be no restriction on the traditional fishing and allied activities undertaken by local communities.

CRZ 5

- CRZ area falling within municipal limits of Greater Mumbai;
- The CRZ areas of Kerala including the backwaters and backwater islands;
- CRZ areas of Goa.

CRZ 5 B.

Critically Vulnerable Coastal Areas (CVCA) such as Sunderbans region of West Bengal and other ecologically sensitive areas identified as under Environment (Protection) Act, 1986 and managed with the involvement of coastal communities including fishermen.

Classification of Coastal Regulation Zone -

With the objective of conservation and protection of the coastal environment, Ministry of Environment and Forest and Climate Change notified the Coastal Regulation Zone Notification in 1991, which was subsequently revised in 2011. The notification was amended from time to time based on representations received. A need was felt overtime to undertake a comprehensive revision

of the notification on the basis of number of representations from various Coastal States/UTs, besides other stakeholders particularly related to the management and conservation of marine and coastal eco-systems, development in coastal areas, eco-tourism, livelihood options and sustainable development of coastal communities etc. Therefore, the Ministry of Environment, Forest & Climate Change constituted a Committee in June 2014 to examine the various issues and concerns of Coastal States/UTs and other stakeholders for recommending appropriate changes in the CRZ Notification, 2011.

The Shailesh Nayank Committee submitted its recommendations in 2015. The recommendations were further examined in consultation with Members of Parliament of Coastal States and Union Territories besides other concerned Ministries of Government of India. A draft notification was issued in April, 2018 for inviting comments from public at large.
A number of suggestions and comments were received by the Government and based on overall imperative of sustainable development of Coastal areas and need for conserving the Coastal environment, Government has approved the Coastal Regulation Zone Notification 2018 which is expected to go a long way in meeting the aspirations of Coastal communities besides ensuring welfare of poor and vulnerable populations.

Salient Features for 2018 Notification

Allowing FSI as per current norms in CRZ areas: As per CRZ, 2011 Notification, for CRZ-II (Urban) areas, Floor Space Index (FSI) or the Floor Area Ratio (FAR) had been frozen as per 1991 Development Control Regulation (DCR) levels. In the CRZ, 2018 Notification, it has been decided to de-freeze the same and permit FSI for construction projects, as prevailing on the date of the new Notification. This will enable redevelopment of these areas to meet the emerging needs.
Densely populated rural areas to be afforded greater opportunity for development: For CRZ-III (Rural) areas, two separate categories have now been stipulated as below:
CRZ-III A - These are densely populated rural areas with a population density of 2161 per square kilometre as per 2011 Census. Such areas shall have a No Development Zone (NDZ) of 50 meters from the HTL as against 200 meters from the High Tide Line stipulated in the CRZ Notification, 2011 since such areas have similar characteristics as urban areas.
CRZ-III B - Rural areas with population density of below 2161 per square kilometre as per 2011 Census. Such areas shall continue to have an NDZ of 200 meters from the HTL.
Tourism infrastructure for basic amenities to be promoted: Temporary tourism facilities such as shacks, toilet blocks, change rooms, drinking water facilities etc. have now been permitted in Beaches.
Such temporary tourism facilities are also now permissible in the "No Development Zone" (NDZ) of the CRZ-III areas as per the Notification. However, a minimum distance of 10 m from HTL should be maintained for setting up of such facilities.
CRZ Clearances streamlined: The procedure for CRZ clearances has been streamlined. Only such projects/activities, which are located in the CRZ-I (Ecologically Sensitive Areas) and CRZ IV (area covered between Low Tide Line and 12 Nautical Miles seaward) shall be dealt with for CRZ clearance by the Ministry of Environment, Forest and Climate Change. The powers for clearances with respect to CRZ-II and III have been delegated at the State level with necessary guidance.
A No Development Zone (NDZ) of 20 meters has been stipulated for all Islands: For islands close to the main land coast and for all Backwater Islands in the main land, in wake of space limitations and

unique geography of such regions, bringing uniformity in treatment of such regions, NDZ of 20 m has been stipulated.

All Ecologically Sensitive Areas have been accorded special importance: Specific guidelines related to their conservation and management plans have been drawn up as a part of the CRZ Notification.

Pollution abatement has been accorded special focus:

In order to address pollution in Coastal areas treatment facilities have been made permissible activities in CRZ-I B area subject to necessary safeguards.

Defence and strategic projects have been accorded necessary dispensation.

Benefits

The proposed CRZ Notification, 2018 will lead to enhanced activities in the coastal regions thereby promoting economic growth while also respecting the conservation principles of coastal regions. It will not only result in significant employment generation but also to better life and add value to the economy of India. The new notification is expected to rejuvenate the coastal areas while reducing their vulnerabilities.

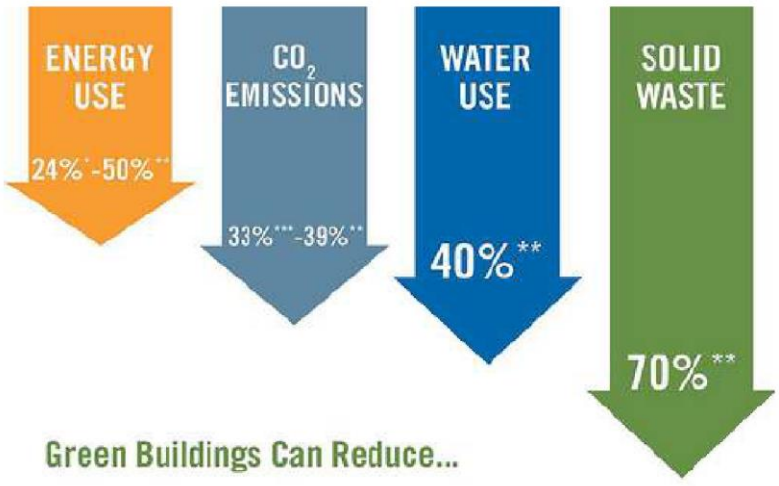
LEED

- LEED (Leadership in Energy and Environmental Design) is a voluntary, market--driven program that provides third-party verification of green buildings.
- From individual buildings and homes, to entire neighborhoods and communities, LEED is transforming the way built environments are designed, constructed, and operated. Comprehensive and flexible, LEED addresses the entire lifecycle of a building.
- It provides building owners and operators with a framework for identifying and implementing practical and measurable green building design, construction, operations and maintenance solutions.

- For commercial buildings and neighborhoods, to earn LEED certification, a project must satisfy all LEED prerequisites and earn a minimum 40 points on a 110-point LEED rating system scale. Homes must earn a minimum of 45 points on a 136-point scale.
- Projects earn points to satisfy green building requirements
- Within each of the LEED credit categories, projects must satisfy prerequisites and earn points.
- The number of points the project earns determines its level of LEED certification.

LEED-certified buildings are designed to:

• Lower operating costs and increase asset value
• Reduce waste sent to landfills
• Conserve energy and water
• Be healthier and safer for occupants
• Reduce harmful greenhouse gas emissions.



MAIN CREDIT CATEGORIES:

• Sustainable sites credits encourage strategies that minimize the impact on ecosystems and water resources.

•Water efficiency credits promote smarter use of water, inside and out, to reduce potable water consumption.

• Energy & atmosphere credits promote better building energy performance through innovative strategies.

• Materials & resources credits encourage using sustainable building materials and reducing waste.

• Indoor environmental quality credits promote better indoor air quality and access to daylight and views.

LEED RATING IN INDIA:

IGBC has licensed the LEED Green Building Standard from the U.S. Green Building Council and currently is responsible for certifying LEED-New Construction and LEED-Core and Shell buildings in India. There are many energy efficient buildings in India, situated in a variety of climatic zones.

Indian Green Building Council, is continuously striving towards wider adoption of eco-friendly / green building concepts in the Indian Industry.

IGBC promotes a whole-building approach to sustainability, based on the principles of 5 elements of nature [earth, water, fire, air & sky] by recognizing performance in the following five key areas:

• Sustainable site development

•Water savings

• Energy efficiency

• Materials selection

• Indoor environmental quality

IGBC Green Homes ratings are awarded according to the following scale:

•Certified 32-39

•Silver 40-47

•Gold 48-59

Platinum 60-80

ADVANTAGES AND DISADVANTAGES OF LEED RATING SYSTEM IN INDIA –

• LEED India certified projects blend enhanced environmental, economic, and occupant-oriented performance.

• They cost less to operate and maintain; are energy- and water-efficient; have higher lease-up rates than conventional buildings in their markets and are healthier and safer for occupants.

• Often when a LEED rating is pursued in India, it increase the cost of initial design and construction.

• One reason for the higher cost is that sustainable construction principles may not be well understood by the design professionals undertaking the project.

• Some of the finer points of LEED certification in India could possibly lead to misunderstandings between the design team, construction team, and client, which could result in delays.

• Also, there may be a lack of abundant availability of manufactured building components which meet LEED standards.

GRIHA (Green Rating for Integrated Habitat Assessment)

- **GRIHA**, or Green Rating for Integrated Habitat Assessment, is the national rating system of India for any completed construction.
- It is an assessment tool to measure and rate a building's environmental performance.
- GRIHA endeavors to calculate facets, for instance, energy consumption, waste generation, renewable energy adoption, among other points, in an attempt to manage, control and reduce the same to the finest achievable degree.

OBJECTIVE OF GRIHA

- Minimize a building's resource consumption, waste generation, and overall ecological impact
- Evaluates the environmental performance of a building holistically over its entire life cycle, thereby providing a definitive standard for what constitutes a 'green building'
- Based on accepted energy and environmental principles, seeks to strike a balance between the established practices and emerging concepts
- Reduced energy consumption without sacrificing the comfort level
- Reduced destruction of natural areas, habitats, and biodiversity, and reduced soil loss from erosion etc.

WHY CHOOSE GRIHA? Two rating systems in India: LEED India and GRIHA

- LEED-India adapted from United States Green Building Council's (USGBC) is primarily based on per capita energy consumption in developed nations like the US which does not work in India since India's per capita energy consumption is very low compared to developed nations.
- GRIHA is more suited to Indian climate. Also unlike LEED, it does not promote usage of certain products like glass and air-conditioning equipment.

FIVE 'R' PHILOSOPHY

Refuse: To blindly adopt international trends, materials, technologies, products, etc. Especially in areas where local substitutes are available.

Reduce: The dependence on high energy products, systems, processes, etc.

Reuse: Materials, products, traditional technologies so as to reduce the costs incurred in designing buildings.

Recycle: All possible wastes generated from the building site, during construction, operation and demolition.

Reinvent: Engineering systems, designs and practices such that India creates global examples that the world can follow rather than India following the international examples.

GRIHA PROCEDURE ELIGIBILITY

Except for industrial complexes, all buildings (offices, institutions, hotels, hospitals, housing complexes, etc.) in the pre-design/design stage are eligible for certification under GRIHA.

ADaRSH (Association for Development and Research of Sustainable Habitats), GRIHA secretariat helps evaluate whether the project is eligible for rating or not.

EVALUATION PROCESS

1. Pre documentation stage: A team from ADaRSH along with the client's Integrated Design Team meet and determine the points being targeted by the project.

2. Post documentation stage: All necessary proof through documents for the points targeted under various criteria is submitted. Evaluation by third party regional evaluators. To determine the final rating that shall be awarded to the project.

GRIHA RATING SYSTEM

VARIANTS OF GRIHA

SVAGRIHA FOR BUILDING AREA- 100-2499 sqm

GRIHA FOR BUILDING AREA-2500-1,50,000 sqm

GRIHA LD FOR BUILDING AREA-> 50 hectare site area

GRIHA VERISON 2015

The latest version of GRIHA, GRIHA version 2015 (GRIHA V2015), was introduced in January 2015. The GRIHA V 2015 rating system consists of 31 criteria categorized under various sections such as Site Planning, Construction Management, Occupant Comfort and Wellbeing, Sustainable Building Materials, Performance Monitoring and Validation, and Innovation & eligibility

All buildings, which are in the design stage and have built up area more than 2,500 m2, are eligible for certification under GRIHA.

Criteria and their weightage

GRIHA is a performance-oriented system where points are earned for meeting the design and performance intent of the criteria. Each criteria has certain points assigned to it. It means that a project demonstrating compliance with a criterion would achieve the associated points. GRIHA is a 100-point system consisting of some core points. Different levels of certification (one star to five stars) are awarded based on the number of points earned. The minimum points required for certification are 25.

GRIHA V 2015 Rating Thresholds	GRIHA Rating
25-40	★
41-55	★★
56-70	★★★
71-85	★★★★
86 or more	★★★★★

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

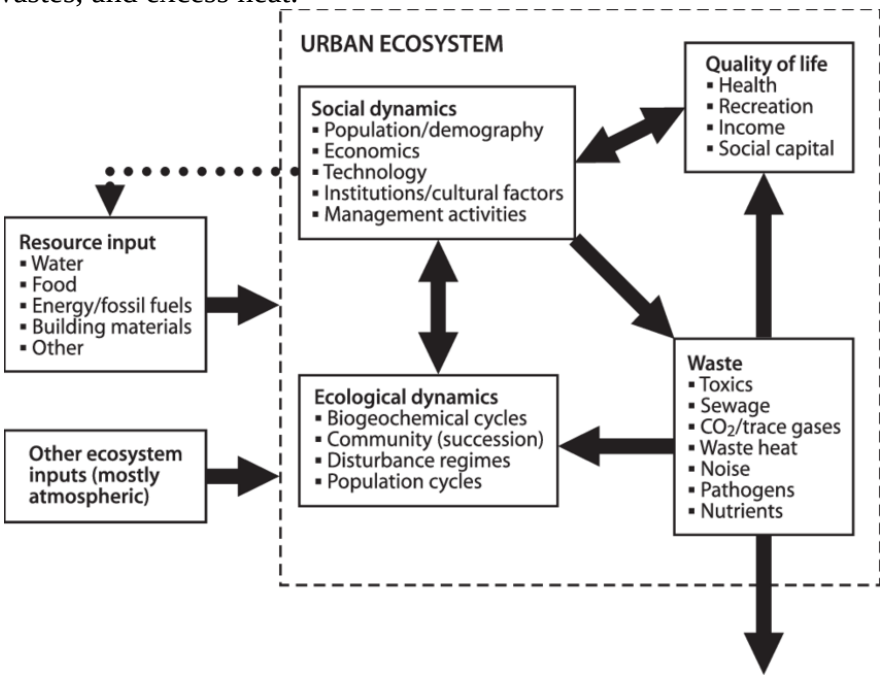
UNIT – III– PLANNING AND EVALUATION TECHNIQUES– SAR1614

III. PLANNING AND EVALUATION TECHNIQUES

INTRODUCTION

Planning Strategies for Urban Areas

Urban ecosystems, like all ecosystems, are composed of biological components (plants, animals, and other forms of life) and physical components (soil, water, air, climate, and topography). However, the biological complex also includes human populations, their demographic characteristics, their institutional structures, and the social and economic tools. The physical complex includes buildings, transportation networks, modified surfaces (e.g., parking lots, roofs, and landscaping), and the environmental alterations resulting from human decision making. Physical complex also include energy use and the import, transformation, and export of materials. Such energy and material transformations involve not only beneficial products (such as transportation and housing) but also pollution, wastes, and excess heat.



Planning Strategies – Urban Planning

Urban planning is the process of developing and designing urban areas. Encompassed in that process is the use of open land, air, water, and the built environment, including buildings, transportation, economic and social functions. Urban planning touches on numerous city-life elements—new and pre-existing land, buildings, roads, communal spaces, transportation, economic development, infrastructure, and the environment.

Strategic Urban Planning

Strategic urban planning focuses on setting high-level goals and determining desired areas of growth for a city or metropolitan area. The result of the planning process is a **strategic plan** also called the development plan, core strategy, or comprehensive plan. The strategic plan's goals may include easing transportation throughout the city, creating more community spaces, improving citizens' quality of life, or encouraging people to visit or move to the city.

Land-Use Planning

Land-use planning largely concerns legislation and policy, adopting planning instruments like governmental statutes, regulations, rules, codes, and policies to influence land use. On a broad level, these planning instruments deal with the type, location, and amount of land needed to carry out

different functions of the city. They also serve to zone or reserve land for certain purposes such as:
Residential, for buildings like apartment homes, single-family residences, and condominiums
Commercial, for buildings like retail shops and office buildings
Industrial, for structures like manufacturing plants and warehouses
Municipal, for structures like police stations and courthouses.

Master Planning
Master planning is typically used for greenfield development projects, or building on undeveloped land—instead of modifying pre-existing structures or spaces, starting from scratch. Urban planners must consider the required zoning such as residential and commercial land, transportation considerations, road locations, etc. They must also plan the location of urban amenities such as community facilities, schools, parks, other recreational zones.

Urban Revitalization
In contrast to master planning, urban revitalization focuses on improving areas that are in a state of decline. The exact definition of a declining area will differ from city to city—for example, areas that have a troubling number of failing businesses or a stagnant or decreasing population growth. The improvement tactics for revitalization will depend on the root cause of decline, and may include things like repairing roads, developing infrastructure, cleaning up pollution, and adding to parks and other public spaces, etc. Community interaction is especially important with Urban Revitalization, may need to change land use from industrial to residential to get the loft apartments need to involve environmental planning to clean up.

Economic Development
Economic development is about identifying areas of growth to faster, greater financial prosperity within the city, specifically by enticing companies to build or move offices there. Subsequently, those companies then hire local talent and drive commuter traffic to the new office. Sometimes an economic development department lives outside of the planning department of a municipality, so it is important to help that group navigate Land Use Plans, Master Plans, and Infrastructure Plans to ensure that any development projects are workable.

Environmental planning
Environmental planning is a type of strategic development that emphasizes sustainability, include air pollution, noise pollution, wetlands, habitats of endangered species, flood zone susceptibility, and coastal zone erosion, along with a host of other environmental factors dealing with the relationship between natural and human systems.

Infrastructure planning
Infrastructure planning deals with the fundamental facilities and systems that serve a city and its people, and how those facilities can support goals laid out in the strategic plan. This type of urban planning covers:
Public works infrastructure such as water supply, sewage, electricity, and telecommunications
Community infrastructure such as schools, hospitals, and parks
Safety and transportation such as roads, police, and fire facilities.

Planning Options Cities – Garden City
Green cities are those where economic growth and development is fostering, that reduce negative environmental impact on natural resources and the pressure on ecosystem services. A clean or effective production and consumption of facilities related to movement of people and goods, waste management and recycling, pollution prevention, treatment, energy, abatement, design, construction,

maintenance, ressource extraction, agriculture, Natural ressource management and other environmental services, are the prime component of a green city.

Key Features of Green city

Effective Land Use:

Green cities promote effective land use and get rid of urban sprawl by encouraging compact mixed-use developments. Higher urban densities are promoted without affecting the quality of life.

Habitat Prevention and Restoration:

These cities aim to prevent damage to the natural landscape, productivity of agricultural land, biodiversity and natural habitat. Such green spaces improve the quality of air and canopy covers reduces noise level.

Efficient Transportation Management:

Green city increases opportunities for non-motorized movement, bicycling, pedestrian friendly network, reduction in the number of automobile trips, promoting public transportation and use of vehicles with alternative fuels.

Effective Use of Resources:

Limits the usage of resources by incorporating efficient systems, like: Water Efficiency: Green city includes "R3" (reduce-recycle-reuse) strategies and can save potable water to an extent of 30-40% including water harvesting.

Energy Efficiency:

On-site power generation using various renewable energy technologies and other clean fuels can significantly reduce the load on grid power supply. There can be energy saving to the tune of 20-30%.

Waste Management:

Waste management in Green Cities are well planned which takes into account waste reduction initiatives by planning and implementation of efficient and effective systems for collection, transportation, treatment, recycling and reuse or disposal of municipal solid waste. Also, Waste-to-energy is a key component of green city.

Other Benefits:

Reduced maintenance costs, resource consumption, waste generation along with higher marketability and speedy environmental clearance approvals.

Planning Options Cities – Compact City

Concept of compact city revolves around high density development without compromising the quality of life of the people. This approach largely solves the problem of externalities such a friction on spaces, travel time delays and losses in economic productivity, air and water pollution, solid waste collection and disposal. The optimum density reduces the capital and operating cost of providing public infrastructure and services and improves overall accessibility.

Key Features of Green city

- Efficient use of land and urban containment.
- Increase in the number of ridership for economically viable MRTS.
- Environment protection by lowering the climate change emission.
- Protection of ecological diversity, countryside and land for agriculture.
- Efficient delivery of utility services in more densely populated areas. Due to the economies of scale in supplying energy, water and treating waste, it is less costly to deliver urban utility services in compact cities than in suburban areas.
- Increased social interaction leading to safety against crime.
- Less travelling distance that saves time money and fuel consumption per capita.
- Improved public health better water and air quality, and by walking and jogging.

TOD- Transit Oriented development

TOD is a compact and integrated transpiration development which should be incorporated in compact cities. It is Defined as any development macro or micro that is focused around a transit node, and facilities and complete ease of access to the transit facility, thereby including people to prefer to walk and use public transportation over personal mode of transport.

Intensive Use of land

The intensive land use offers cities the possibility of (re)development of urban areas for a number of functions that, in combination, can offer residents, workers and visitors high quality services.

Planning Options Cities – Smart City

In view of rapid urbanisation and high congregation of population in large cities, it is imperative to make use of advances in technology, capability to make cities safer and protect cities from cyber-crime and also augment the quality of governance with higher levels of transparency and accountability. Such cities, which take advantage of advanced technology, are called as Smart Cities. A smart city uses information, communication and technology to enhance its liveability, workability and sustainability. A smart city is build-up by key basic functions: Information collection, communicating, and crunching (analysing). The two basic steps towards Smart city are:

DATA – Created by the already implemented information technology. Some of the Indian cities have created a cornucopia of data in past few decades, which can form the basis for the development of a Smart city.

DIGITAL DNA (BUILT ENVIRONMENT DATA) – Data collected by building departments, engineering departments, land department, planning department, tax department and department of postal services. India is still finding its footprints in this regard.

Planning Strategies for Coastal Areas

COASTAL ECOSYSTEM

A coastal ecosystem is an area where land and water come together. Coastal ecosystems provide habitat for a wide variety of marine plants and animals as well as provide resources and homes to humans around the world. As per the CRZ notification, 2011, coastal land up to 500 m from the High Tide Line (HTL) landward side and a stage of 100 m along banks of creeks, estuaries, backwater and rivers subject to tidal fluctuations is called the Coastal Regulation Zone (CRZ). For regulation of developmental activities, the coastal stretches within 500 m of HTL on the landward side are classified into four categories and restrictions have been imposed on construction activities in these zones.

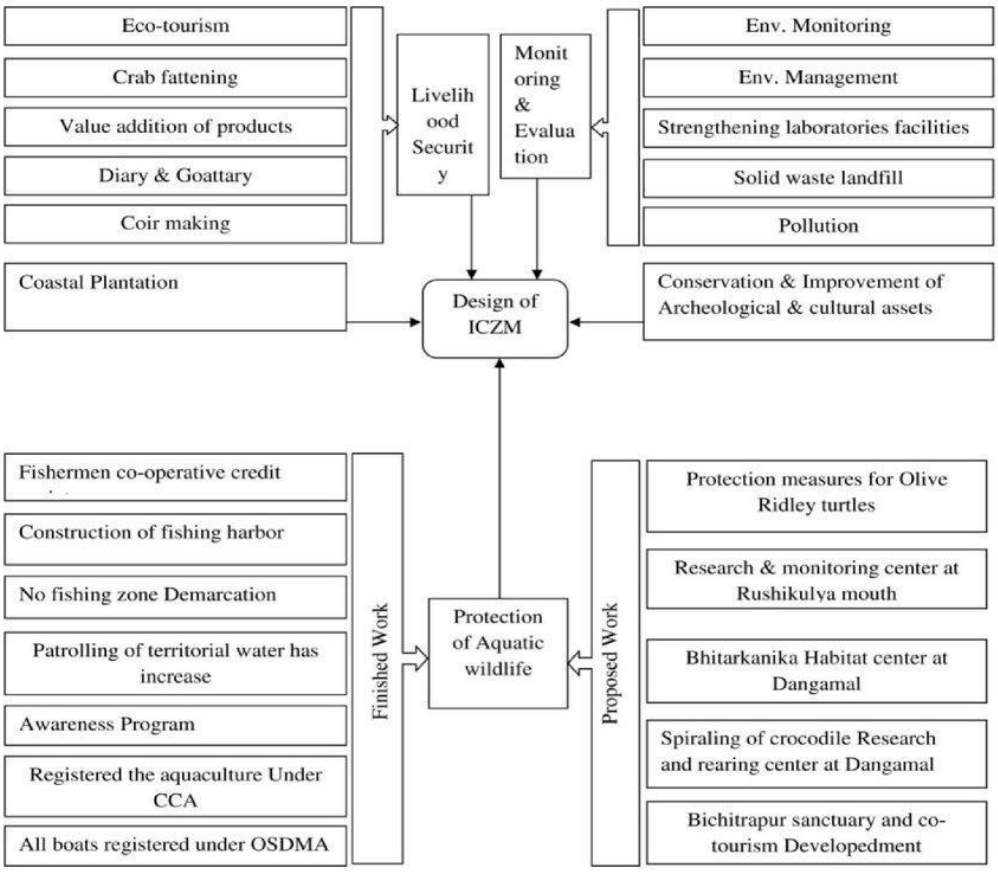
The following activities are prohibited within the CRZ: -

1. Setting up of new industries and expansion of existing industries, except those directly related to waterfront or directly needing foreshore facilities.
2. Manufacture or handling or disposal of hazardous substances.
3. Setting up and expansion of units/mechanism for disposal of waste and effluents into the water course.
4. Discharging of city untreated waters and effluents from industries, cities or towns and other human settlements.
5. Dumping of city or town waste for the purposes of land filling or otherwise, the existing practice, if any, shall be phased out within a reasonable time not exceeding 3 years from the date of notification.

COASTAL ZONE MANAGEMENT STRATEGIES

The Coastal zones are defined by the extent of territorial waters up to the high water mark. They are long, narrow features of mainland, islands and seas, generally forming the outer boundary of the coastal domain. The Coastal Zone Management (CZM) is a process of governance that consists of the legal and institutional framework necessary to ensure that development and management plans

for coastal zones are integrated with environmental and social goals, and are developed with the participation of those affected.



Objective of Coastal Zone Management

The prime objective of CZM is to create balance between development needs and protection of natural resources which means if coastal ecosystems are manage through the guiding principles of sustainability then livelihoods of millions will be protected and their survival guaranteed.

PURPOSE OF COASTAL ZONE MANAGEMENT

- Maximize the benefits provided by the coastal zone
- Minimize conflicts and harmful effects of activities upon each other, resources and the environment
- To dissipate tidal and wave energy & reduce risk from disasters
- To stabilize the adjoining land.
- Promote linkages between sectoral activities
- Guide coastal area development in an ecologically sustainable fashion.

Planning Strategies for Hilly Areas

Hilly areas have one of the most fragile ecosystems, which need to be conserved. Therefore planning and development strategies for hilly areas shall be designed with added sensitivity and stress on integrated development. The development approach shall comprise judicious land use planning and settlement planning. In hill areas, the space standards are affected by the following and therefore these factors should be considered while setting norms in such areas:

- Exposure to sunlight, degree of slopes and accessibility in the form of distance travelled.
- Minimum needs of the people and the conservation principle.
- Flexibility in norms and standards to accommodate conditions guided by difficult hill terrain and its geology.

- Work place and residence relationship.
- Energy needs.
- Alternative mode of transportation
- Communication network.
- Mobile and emergency facilities.

Some of the methods that are practiced for planning and development of hill areas as applicable to various scales can be on lines as follows:-

- Watershed Management – Regional level scale.
- Land suitability Analysis – Regional and Settlement level.
- Carrying Capacity Analysis – Settlement Level.
- Climate Conscious Building Designs- Settlement and Building Level.

Watershed Management

Watershed Management/ Development has been practiced in India from a long time. It is well understood by various Government Departments and the officials involved. It has been prevalent as an ongoing effort of the Ministry of Agriculture. The IWDP (Integrated Watershed Development Programme) was conceived to address issues of soil, water, vegetation conservation. The programme over time has evolved to address issues such as drinking water, animal husbandry, human resource, gender issues etc. Further emphasized the need to address issues such as deforestation, water harvesting, fuel and fodder needs, and also the need to have specific proposals for degraded watersheds.

Land Suitability Analysis

Land Suitability Analysis as a concept has been understood by researchers from past three decades. However, implementation of the same has been recent. This has been possible due to the Geographic Information System (GIS). This is mainly due to the requirement of spatial database and need for overlay analysis. This is one technique which has been used for natural resource conservation. Since this approach can be applied at regional scale and settlement scale, the maps need to be at various scales.

Carrying Capacity Analysis

Carrying Capacity Analysis in the context of Hill Areas has been attempted after 1985, Doon Valley Case, the first Public Interest Litigation to safeguard the fragile Doon Valley Ecosystem. The PIL triggered a carrying capacity analysis for Mussorie Town, based on sustainable water availability and the population size that can be supported by the water resource. Some studies in the area of sustainable tourism in Hills have touched the aspect of availability of buildable land, status of infrastructure as guiding factors to control tourist growth. However, this technique has to be taken much ahead with better data base as this can be best addressed at settlement level.

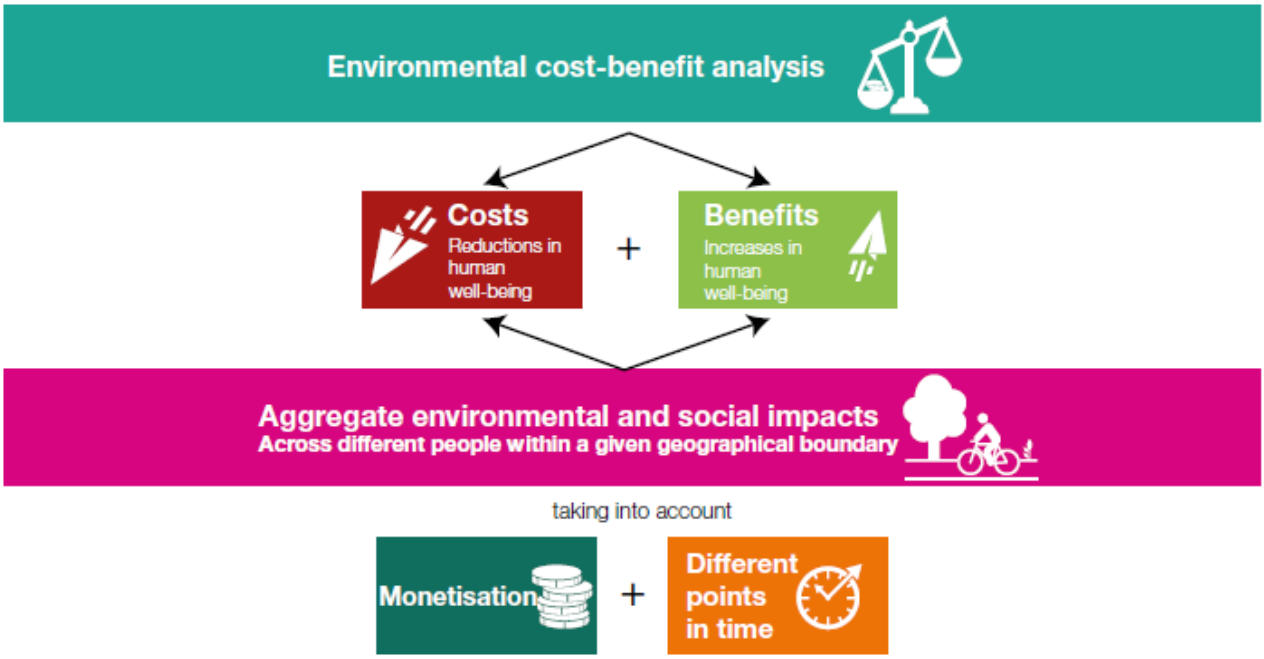
Climate Conscious Building Design

Climate Conscious Building Design is perhaps the oldest technique of sustainable development in hill areas. Vernacular Architecture addresses the climatic issues by incorporating it as a major element in design, and has developed aesthetics as per the climate requirements. Modern building design in hill areas, unfortunately has not taken clues from the tradition, and most buildings on hills ape the plains. However, there are few architects who have set the trend for climate conscious buildings in the hills, which are performing as energy efficient buildings also. These examples need to be propagated at a larger scale. The following chapters outline the characteristics of hill areas, with a view to address the various techniques foe sustainable development of settlements.

Cost Benefit Analysis

Cost-benefit analysis has long been a core tool of public policy. The systematic process of calculating the benefits and costs of policy options and projects is now widely regarded as an essential step in the policy process. It helps decision makers to have a clear picture of how society would fare under a range of policy options for achieving particular goals. This is particularly the case for the development

of environmental policy, where cost-benefit analysis is central to the design and implementation of policies in many countries. Imagine a choice between energy project options which involve investing in a coal-fired power plant or a renewable energy investment, such as in wind turbines. In choosing between these options (or deciding not to invest in either), one analytical tool that decision-makers and practitioners might use is cost-benefit analysis (CBA). This requires understanding what these options provide in terms of benefits (defined as increases in human well-being) and costs (defined as reductions in human well-being). Some way must be found to aggregate environmental and social benefits and costs across different people (within a given geographical boundary) and finding some means of monetising these, accounting for different points in time when the impacts occur. For one of these projects to qualify on cost-benefit grounds, its social benefits must exceed its social costs.



Direct costs of environmental damage

These costs relate to the damage caused by negative agents which affect some environmental function: pollutants or waste products, overexploitation of natural resources or squandering of energy, marginal settlements, noise, etc., with reference to specific environmental functions.

Indirect costs of environmental damage

These costs arise because negative agents can cause other damage to the environment resulting in additional expenditure to prevent greater damage: the pollution of rivers makes them unfit for recreation, overexploitation of forests causes erosion and desertification, lack of urban planning turns cities into eyesores and depresses their inhabitants.

Planning Balance Sheet (PBS)

Lichfield's PBS attempts to indicate the extent of all community impacts of proposals whether in monetary units or not. In the absence of monetary measures, physical units of measurement are employed or costs and benefits are included qualitatively. The method displays the distribution of impacts between the different sectors of the community, such as Wildlife, landscape, etc. classified as producers/operators and consumers. Results are laid out in a balance sheet with the decision-makers left to weigh the relative importance of the costs and the benefits shown.

TABLE 2. Generalized balance sheet of development applied to site selection (Lichfield, 1971).

Sector group and aspect studied	Site 1	Site 2	Site 3	Preferred
Producers				
Group A				
Aspect 1	£	£	£	Site *X*
Aspect 2	NM+	NM−	NM−	Site 1
Group B				
Aspect 2	£	£	£	Site *X*
Aspect 3	U	U	U	U
Consumers				
As above, etc.				
Total	£	£	£	Site X

Note:

£ means "monetary value", NM means "non-monetary value", and U means "intangible" (non quantifiable).

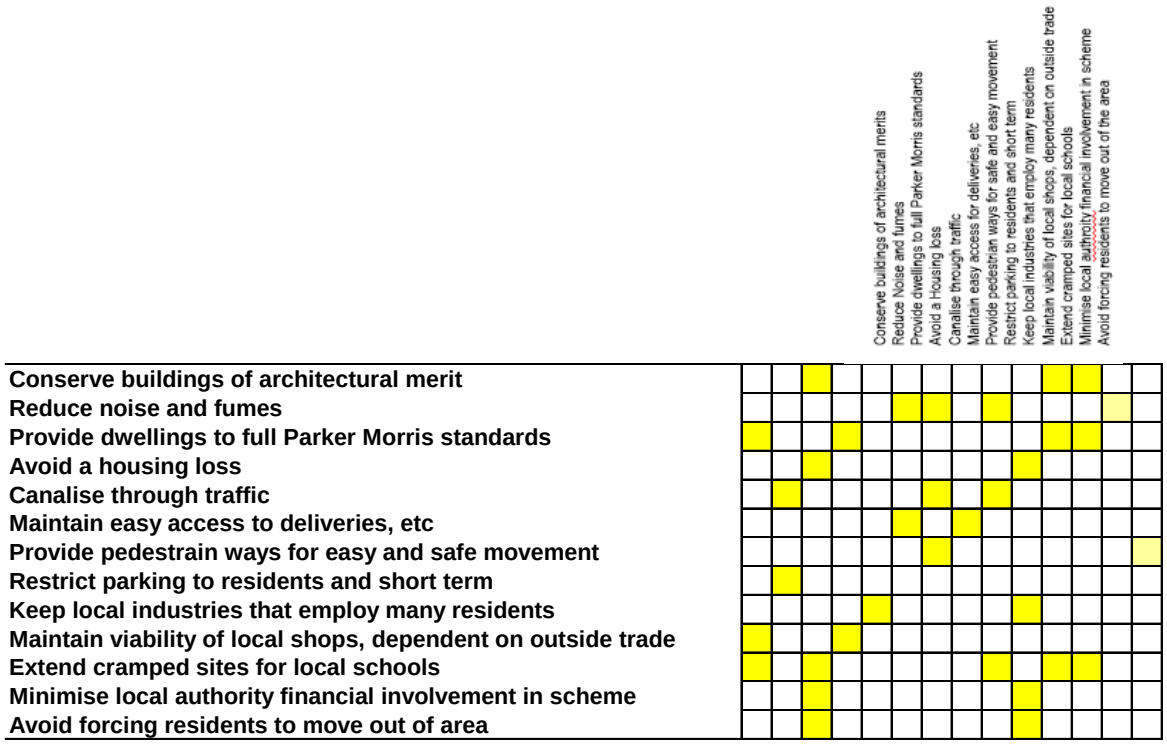
The producers may be a company, an activity, or a place (e.g airport, factory); the consumers are the parties affected by the transaction (e.g nearby residents, other species). In a table the annual benefits and costs to producer and consumer sectors from each plan alternative are quantified, either in monetary terms or in physical units. Where quantification is not possible, the item is foot noted to a verbal description of impact.

	Plan 1		Plan 2		Net Benefit (+) Or Cost (-)	Net Advantage
	Benefit	Cost	Benefit	Cost		
Producer Airplane Traffic	4.0	3.0	4.5	3	+0.5	Plan 2
Consumers						
Air Travelers	.....	4.0	.....	4.5	.....	.....
Nearby Residents	0	1.2	0	1.3	-0.1	Plan 1
Plants and Wildlife	0	....	0	....	....	.....

Goal Achieving Matrix (PBS)

In GAM, developed by Hill, costs and benefits are arranged according to community goals as well as groups affected. The goals-achievement matrix disaggregates parties to the transaction but does not distinguish producers from consumers. Rather it simply examines how each group benefits or loses from each impact. Impact are further categorized or grouped as they contribute toward or detract from some "Community Goal" such as clean air or quiet surroundings. Each community group, and each

affected group is assigned a weight by a panel of experts. Thus the overall performance of each alternative in relation to all the goals can be seen.



Plan 1: Large Airport							
Community Goal:	Airplane Travel			Quiet Neighbourhood			
Goal Weight	3			2			
	Impact: Large Number of Flights			Impact: Increased Noise (Large)			
Affected Groups	Group Weight	Benefits	Costs	Group Weight	Benefits	Costs	Grand Index
Air Travels	3	+2	0	1	0	0	
Nearby Residents	2	0	0	3	0	-2	
Plants and Wild Life	1	0	-2	2	0	-2	
Weighted totals		+18	-6		0	-20	-8

Plan 1: Smaller Airport							
Community Goal:	Airplane Travel			Quiet Neighbourhood			
Goal Weight	3			2			
		Impact: Large Number of Flights		Impact: Increased Noise (Large)			
Affected Groups	Group Weight	Benefits	Costs	Group Weight	Benefits	Costs	Grand Index
Air Travels	3	1	0	1	0	0	
Nearby Residents	2	0	0	3	0	-1	
Plants and Wild Life	1	0	-1	2	0	-1	
Weighted totals		9	-3		0	-10	-4

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SCHOOL OF BUILDING AND ENVIRONMENT

DEPARTMENT OF ARCHITECTURE

UNIT – IV– ENVIRONMENT QUALITY AND DESIGN – SAR1614

IV. ENVIRONMENT QUALITY AND DESIGN

INTRODUCTION

Indoor environmental quality (IEQ)

Indoor environmental quality (IEQ) is a general indicator of the quality of conditions inside a building. It can also include functional aspects of space, for example whether the layout provides access to equipment when needed and whether the building has sufficient space for its occupants. A better indoor environmental quality can enhance the wellbeing of building occupants and help decrease the occurrence of sick building syndrome and building related illness. It can also lead to a decrease in worker complaints and absenteeism which in turn can improve productivity.

FACTORS INFLUENCING INDOOR ENVIRONMENTAL QUALITY

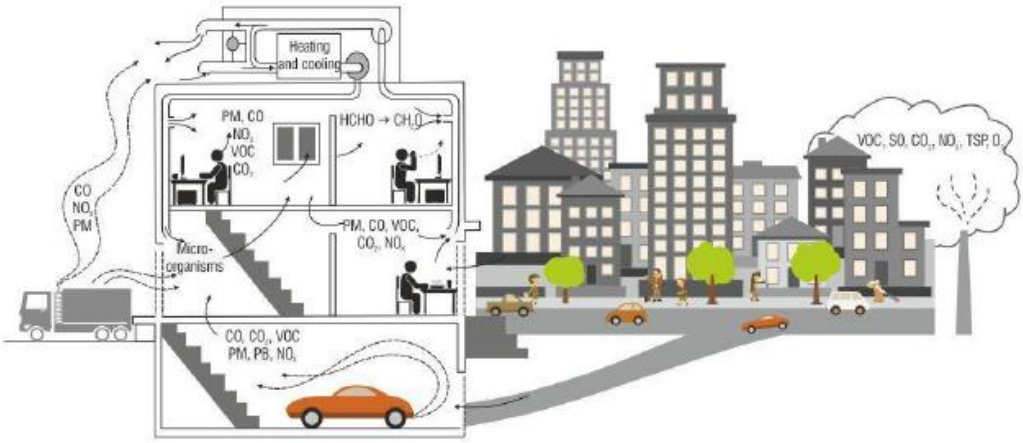
Indoor environmental quality (IEQ) is a general indicator of the quality of conditions inside a building. It can also include functional aspects of space, for example whether the layout provides access to equipment when needed and whether the building has sufficient space for its occupants.

- Indoor air quality.
- Ventilation.
- Thermal comfort.
- Visual Comfort.
- Acoustic conditions.

INDOOR AIR QUALITY

Indoor Air Quality (IAQ) refers to the state of the air within a space. A space with good indoor air quality is one that is low in toxins, contaminants and odors. Indoor air is considered to be healthy when the air does not contain contaminants in harmful concentrations and is acceptable when the majority of people feel satisfied. A human being breathes about 12,000 litres of air every day and is vital for our health. Exposure to hazardous airborne agents present in indoor spaces causes adverse effects such as respiratory and cardiovascular diseases, allergy, and irritation of the respiratory tract and possibly leads to cancer. Main source of indoor air pollutants are from outdoor air, household cooking (especially cooking with biomass or frying), tobacco smoking, polluted ambient air, cleaning agents, resuspension of dust during the cleaning activities, construction materials & paints, copy machines & printers as well as other human activities. Respectively, ambient air pollutant sources are vehicle emissions, thermal power plants, biomass burning, construction work, unattended debris, open sewage pipes, fossil fuel based power generators and various industrial processes. Strategies used to create good IAQ include bringing in 100% outside air, maintaining appropriate exhaust

systems, utilizing high efficiency MERV filters in the heating ventilation and air conditioning (HVAC) system, installing walk-off mats at entryways, prohibiting smoking with the space and near operable windows and air intakes, providing indoor plants, and using only low-emitting / non-toxic materials and green housekeeping products.



CO = carbon monoxide, CO_2 = carbon dioxide, CH_2O = formaldehyde, NO_x = nitrogen oxides, Pb = lead, PM = particulate matter, VOC = volatile organic compounds.

VENTILATION

Ventilation is necessary in buildings to remove 'stale' air and replace it with 'fresh' air, helps in moderate internal temperatures, Reduce the accumulation of moisture, odours and other gases that can build up during occupied periods, Create air movement which improves the comfort of occupants.

Ventilation in buildings can be classified as 'natural' or 'mechanical'.

Mechanical (or 'forced') ventilation tends to be driven by fans.

Natural ventilation is driven by 'natural' pressure differences from one part of the building to another. Natural ventilation can be wind driven.

Mixed-mode ventilation uses both natural and mechanical ventilation, for example, allowing the opening of windows, but also providing a mechanical air distribution system.

The term 'assisted ventilation' typically refers to systems where fresh air enters a building through windows or other openings, but is extracted by continuously running fans

'Trickle ventilation', 'slot ventilators' or 'background' ventilation can be necessary in modern buildings (which tend to be designed to be almost completely sealed from the outside to reduce heat loss or gain), so that problems such as condensation are avoided when openings are closed.

Rates of ventilation in buildings can be expressed in terms of air change rates the number of times that the volume of air in a space is changed per hour or litres per second. The ventilation rate will be determined by the type and size of space and the way it is occupied for example, the number of occupants, sources of heat, moisture, odour, contaminants, and so on.

THERMAL COMFORT

Thermal conditions play a critical role in influencing occupant comfort and well-being. This standard specifies thermal environmental conditions acceptable for healthy adults at

a. Atmospheric pressure equivalent to altitudes up to 3000 m

b. Indoor spaces designed for human occupancy for periods not less than 15 minutes.

This standard specifies set of thermal conditions which are based upon adaptive thermal comfort approach. It also encompasses gradual diminution of the people’s response to repeated environmental

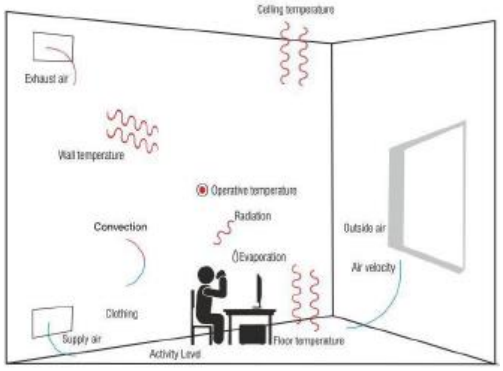
stimulation and subsumes all processes which building occupants undertake in order to improve the comfort of the indoor environment. Thermal comfort is affected by physical and physiological parameters.

Physical parameters

a. Air temperature
b. Vertical air temperature difference
c. Mean radiant temperature
d. Radiant temperature asymmetry
e. Floor surface temperature
f. Relative Humidity
g. Air speed

Physiological factors

a. Metabolic rate
b. Clothing insulation



VISUAL COMFORT – NATURAL LIGHT

Natural light can play an important role in creating a comfortable environment, helping to regulate the body clock, improve concentration and create a calm, tranquil setting.

It can reduce the energy consumption of a building compared to artificial light and can also help prevent mould or mildew from developing in buildings since these spores thrive in darkness.

Typically natural light is transmitted to the interior of a building through glazing such as windows, or through other openings. More complex 'daylight systems' collect natural light and deliver it deep into the heart of buildings. They use collectors in the roof to harvest light, then transport it to diffusers in interior spaces. Exposure to too much natural light can be a problem for workers on a construction site, particularly during the summer, with the risks of sunburn, heatstroke, and glare obstructing vision.

VISUAL COMFORT - LIGHTING

Light has significant impact on many bodily functions, including the nervous system, circadian rhythms, pituitary gland, endocrine system, pineal gland and alertness as these are affected by different wavelengths of light. The term ‘lighting’ refers to equipment, the primary purpose of which, is to produce light. This is typically some form of lamp, but lighting can also refer to the use of natural light to provide illumination. Light is the electromagnetic radiation that exists within a certain portion of the electromagnetic spectrum. In terms of 'visible light', i.e. that which enables the sense of sight, it is the part of the spectrum that can be detected and seen by the eye. The level of light on a surface is described as ‘Illuminance’ and is measured in lux (lx), where one lux is equal to one lumen per square metre (lm/m^2) and a lumen is the SI unit (International System) of luminous flux, describing the quantity of light emitted by a lamp or received at a surface.

VISUAL COMFORT - GLARE

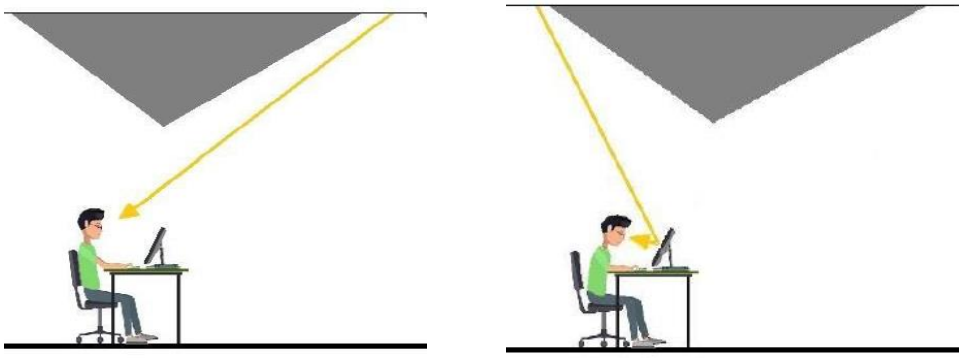
Glare is the result of sudden large changes in brightness of the light source, which leads to lower efficiency of the vision. An occupant under the effect of glare fails to notice subtle changes and details of a scene. It is mainly classified into two types Direct Glare and Reflected Glare.

Direct Glare

Direct Glare is caused when within an occupant's field of vision, the luminaries of a room are without glare control thereby making the task area and surfaces very bright resulting in glare. The effects of it are fatigue, frequent mistakes and loss of concentration.

Reflected Glare

Reflected Glare is caused due to reflections coming from light sources or surfaces of excessive brightness which is the result of incorrect Luminaire arrangement and incorrect workstation position. The effects of it are fatigue, frequent mistakes and loss of concentration.



Direct glare Reflected glare

ACOUSTIC CONDITIONS

Building acoustics is the science of controlling noise in buildings. This includes the minimisation of noise transmission from one space to another and the control of the characteristics of sound within spaces themselves. Building acoustics are an important consideration in the design, operation and construction of most buildings, and can have a significant impact on health and wellbeing, communication and productivity. They can be particularly significant in spaces such as concert halls, recording studios, lecture theatres, and so on, where the quality of sound and its intelligibility are very important.

Building acoustics can be influenced by:

- The geometry and volume of a space.
- The sound absorption, transmission and reflection characteristics of surfaces enclosing the space and within the space.
- The sound absorption, transmission and reflection characteristics of materials separating spaces.

ACOUSTIC CONDITIONS - Characteristics of sound

Sound intensity is measured in Decibels (dB). This is a logarithmic scale in which an increase of 10 dB gives an apparent doubling of loudness. Sound pitch is measured in Hertz (Hz), the standard unit for the measurement for frequency. The audible range of sound for humans is typically from 20 Hz to 20,000 Hz, although, through ageing and exposure to loud sounds the upper limit will generally decrease. As well as intensity and frequency, sound also transmits information. For example, music or speech, transmit information which people may perceive differently from other sounds.

ACOUSTIC CONDITIONS – Reverberation time

Reverberation time describes the length of time taken for a sound to decay 60dB from its original level. The optimal reverberation time for any room depends on both the intended use of the space and the volume of the space, and additionally, reverberation is frequency dependent. The clarity of speech and music at any location within a room is dependent on the size, shape, and surface materials in the space, and as such, the clarity is highly dependent on the reverberation time. Short reverberation times are recommended for speech, whereas longer reverberation times are recommended for music. Not only does the reverberation affect quality of sound, but it also affects the level (dB) of sound within the space from all sources including noise.

ACOUSTIC CONDITIONS – Sound Absorption

Sound absorbers can be divided into three main categories:

- Porous absorbents, such as fibrous materials or open-celled foam.
- Resonance absorbents, which consist of a mechanical or acoustic oscillation system, such as membrane absorbers.

Single absorbers such as tables, chairs or other objects.

AIR POLLUTION

Introduction

Air pollution is the introduction of particulates, biological molecules, or other harmful materials into Earth's atmosphere, causing diseases, death to humans, damage to other living organisms such as animals and food crops, or the natural or built environment. According to The Air (Prevention and Control of Pollution) Act, 1981, "Air pollution is the presence of any solid, liquid, or gaseous substances in the atmosphere in such concentration as may be or tend to be injurious to human beings or other living creatures or plants or property or environment".

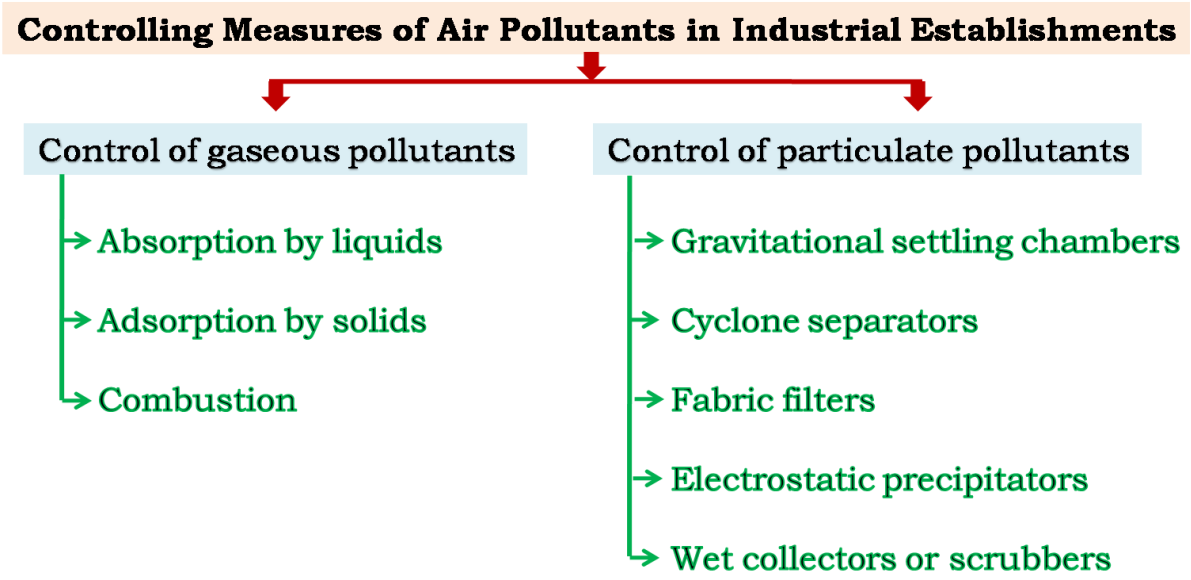
SOURCES OF AIR POLLUTION

Natural sources of pollution are those that are caused due to natural phenomena. Ex: Volcanic eruptions, Forest fires, Biological decay, Pollen grains, Marshes, Radioactive materials. **Anthropogenic (Man-made) sources of pollution** are those which are created by human activities. Ex: Thermal power plants, Industrial emissions, Vehicular emissions, Fossil fuel burning, Agricultural activities etc.

Some measures which can be adopted in this direction are as follows:

1. Use of unleaded petrol.
2. Using fuels with low sulphur and ash content.
3. Promotion of use of public transport.
4. Sensitive locations (hospitals, schools, playgrounds etc.) should not be located along the busy streets.
5. Vegetation cover should be increased along the roadside, busy traffic intersection points, and on the road dividers.
6. Industries and waste disposal sites should preferably be situated in outskirts of the city.

CONTROL MEASURES



WATER POLLUTION

Introduction

Water pollution is the contamination of natural water bodies (e.g. lakes, rivers, sea, ocean, aquifers, ground water etc.). This form of environmental degradation occurs when pollutants are directly or indirectly added into the water bodies without proper treatment to remove harmful compounds.

According to the Water (Prevention and Control of Pollution) Act, 1974, water pollution means such contamination of water or such alteration of the physical, chemical, or biological properties of water or such discharge of any sewage or trade effluent or of any other liquid, gaseous, or solid substance into water (whether directly or indirectly) as may, or is likely to, create a nuisance or render such water harmful or injurious to public health or safety, or to domestic, commercial, industrial, agricultural, or other legitimate uses, or to the life and health of animals or plants or of aquatic organisers.

Sources Of Water Pollution

General sources of water pollution are : Direct and Indirect contaminant sources.

Direct sources of water pollution include effluent outfalls from factories, refineries, industries etc. that emit fluids of varying quality directly into water bodies.

Indirect sources of water pollution include contaminants that enter the water supply from soils/groundwater systems and from the atmosphere via rain water. Soils and ground waters contain the residue of human agricultural practices (fertilizers, pesticides, etc.) and improperly disposed of industrial wastes. Atmospheric contaminants are also derived from human practices (such as gaseous emissions from automobiles, factories and even bakeries).

If pollution comes from a single location, such as a discharge pipe attached to a factory, it is known as point-source pollution. If pollution comes from one single source but from many different scattered sources. This is called nonpoint-source pollution.

Controlling Measures Of Water Pollution

Water pollution in natural water bodies can be identified and quantified on the basis of various parameters, such as, dissolved oxygen (DO), biochemical oxygen demand (BOD), coliform organisms, pH etc. As per the water quality criteria, the DO levels in drinking water should be ≥ 6 mg/L and BOD levels should be < 2 mg/L. Moreover coliforms level should not exceed 50 MPN/100 mL in water which is safe for drinking purpose. If the water quality of any source is not complying

with these criteria, the water can not be used for drinking purpose without undergoing complete treatment. Water pollution can be controlled by diluting the water pollutants in a reservoir.
The various methods for the control of water pollution can be summarized as follows:
1. The sewage pollutants are required to be treated in sewage treatment plants before their discharge in natural water bodies.
2. Water pollution due to organic insecticides and pesticides can be reduced by the use of very specific and less stable chemicals in the manufacture of insecticides/pesticides. Moreover, use of bio-fertilizers needs to be promoted.
3. Oxidation ponds can be useful in removing low level of radioactive wastes.
4. Hot water should not be disposed directly into the river, as it adversely affects the life of aquatic organisms. Thermal pollution can be reduced by employing techniques such as cooling, cooling ponds, evaporative or wet cooling towers and dry cooling towers.
5. Domestic and industrial waste waters should be treated properly in waste water treatment plants, before discharge in the natural aquatic systems.
6. Strict implementation of legislations for water treatment should be done.
7. No solid waste should be dumped into water bodies.
8. Dead bodies of animals/human should not be floated in water sources.
9. Bathing, washing of clothes, and idol immersion should be strictly restricted in natural water bodies.

NOISE POLLUTION

Introduction

Noise is, typically, defined as unwanted sound. Sound which pleases the listeners is music and that which causes pain and annoyance is noise. At times, what is music for some can be noise for others. Most of the machines that have been developed for industrial purposes, for high-speed transportation, or to make life more enjoyable, by furnishing additional comfort, reducing the drudgery of everyday living, and speeding up our daily routines to provide additional leisure hours, are accompanied by noise. Noise prevention and control is important as noise affects us in hearing, ability to communicate and behaviour. Undoubtedly, lesser noise can make the environment more friendly and life becomes pleasant.

Sources Of Noise Pollution

Noise can be broadly classified under 4 categories
1.TransportNoise
2. Occupational /Industrial Noise
3. Neighbourhood noise
4. Recreational Noise
1. Transport Noise: Transport noise mainly consists of traffic noise from road, rail, and aircraft. The number of automobiles on roads like motors, scooters, cars, motor cycles, buses, trucks and diesel engine vehicles has increased enormously, leading to noise pollution. This can be subdivided into
• Road traffic noise
• Air craft noise
• Rail traffic noise
Noise levels in most residential areas in metropolitan cities are hovering around the border line due to increased vehicular noise pollution. In general, on urban roads there are distinct traffic peaks in the morning and evening as people travel to and from work.

Occupational /Industrial Noise: It is the sound having high intensity, mainly caused by industrial machines. Sources of such noise pollution are various factories' machines, industries, and mills. Noise from mechanical saws and pneumatic drills is unbearable and a nuisance to the public. It also includes noise from domestic gadgets e.g. washing
Industrial machines ,vacuum cleaner, etc. workers who are exposed to noise for 8 hours per day and 6 days per week suffer from occupational noise pollution.
Neighbourhood noise: This implies variety of sources of noise which disturb and annoy the general public by interfering with their comfort and welfare. This type of noise includes disturbance from household gadgets and community. Common sources include musical instruments, TV, VCR, radios, transistors, telephones, music in public functions, and loudspeakers etc.
Recreational Noise: Harmful noise exposure is not only limited to the workplace. Some recreational activities are also dangerously loud and cause permanent damage to hearing. Additionally, many recreational activities create loud noises which interfere with the peace and quiet of the community. These activities may include sound at music concerts, firecrackers, sound at aerobic studios, personal stereo systems, children's toys, hunting, target shooting, motor boating, waterskiing, snowmobiling, woodworking, listening music, motorcycle riding etc. Movie theatres, home entertainment centres, car stereo systems, health clubs, dance clubs, bars, and amusement centres also pose serious risk to hearing

CONTROLLING MEASURES OF NOISE POLLUTION

Some measures which can be adopted in this direction are as follows:
1. Prescribing noise limits for vehicular traffic
2. Ban on honking (usage of horns) in certain areas
3. Creation of silence zones near schools and hospitals
4. Redesigning buildings to make them noise proof
5. Reduction of traffic density in residential areas
6. Giving preference to mass public transport system.
7. Minimum use of loudspeakers and amplifiers especially near silence zones.
8. Banning pressure horns in automobiles.
9. Framing a separate Noise Pollution Act

LAND POLLUTION

Introduction

Land pollution refers to the deterioration of the earth's land surfaces, at and below ground level. The cause is the accumulation of solid and liquid waste materials that contaminate groundwater and soil. These waste materials are often referred to as municipal solid waste (MSW), which includes both hazardous and non-hazardous waste.
When waste is deposited onto an area of land, the permeability of the soil formations below the waste can increase or reduce the risk of land pollution. The higher the permeability of the soil, the more likely that land pollution will occur.

Causes of Land Pollution

There are various causes which contribute to this pollution. The various substances that spill on the land cause land pollution. Similarly, these substances have different sources of origin. The most common ones are:

Garbage, Factories, Farming and Mining.

1. Clean up

Environmental remediation consists of removing pollution from the soil, groundwater or surface water. Bioremediation (microbes) and phytoremediation (plants) can be used to convert the pollutants into harmless products. These are natural solutions that need to be supported by in-depth actions.

2. Green agriculture

Sustainable agriculture is essential as it is meant to control the impact on the cultivated environment, by minimizing the external contributions (phytosanitary products), by diversifying the cultures and by using biological treatments.

3. Sustainable forest management

Conservation of the forests is key. Without the protection of the trees, the land becomes dry and starts to erode. Therefore, sustainable forestry or logging is crucial to saving the soil from pollution.