

UNIT-3

SUSTAINABLE DEVELOPMENT

- Our technological development has strong impacts on the natural as well as the social components
- Development does not mean an increase in GNP (Gross National Product) of a few different nations
- They have touched the greatest heights of scientific and technological development but at what cost? The air we breathe, the water we drink, and the food we eat have all badly polluted
- Our natural resources are just dwindling due to over exploitation. If this growth continues in the same way we will be facing a doom's day as suggested by the world's famous report "The limits to growth"
- Development has to be visualized in a holistic manner, where it brings benefits to all, not only for the present generation but also for future generation
- According to G.H.Brundtland (Norwegian Prime minister & Director of WHO) **Sustainable development is defined as "meeting the needs of the present without compromising the ability of future generation to meet their own needs"**.

Principles of Sustainable development

- Improving the quality of human life
- Economic growth for all
- Environmental development

Objectives of sustainable development

- To protect our biodiversity
- To increase forest cover
- To prevent pollution
- To reduce waste
- Design ecofriendly technology
- To control population growth

Key aspects for sustainable development:

1) Inter – generational equity:

We should minimize any adverse impacts on resources and environment for future generations

We should handover a safe, healthy, and resourceful environment to our future generations

This is possible only if we stop over exploitation of resources, reduce waste discharge and emissions and maintain ecological balance.

2) Intra – generational equity:

The development process should seek to minimize the wealth gaps within and between nations

The technology should address to the problems of developing countries, producing drought tolerant varieties for uncertain climates, vaccines for infectious diseases, clean fuel for domestic and industrial use.

This will support the economic growth of poor countries, narrowing the wealth gap and lead to sustainability

MEASURE FOR SUSTAINABLE DEVELOPMENT

Using appropriate technology:-

- It is one which is locally adaptable, eco-friendly and resource efficient and culturally suitable.

- This concept of Nature – often taken as model is called “design with Nature”.

- The technology should use less of resources and should produce minimum waste.

Adoption 3 R's (Reduce, Reuse and Recycle):-

- The 3-R approach advocating minimization of resource use, using them again, recycling the materials goes a long way in achieving the goals of sustainability.

- It reduces pressure on our resources as well as reduces waste generation and pollution.

Promoting Environmental Education & Awareness:-

- Making environmental education the center of all learning process will, greatly help in changing the thinking and attitude of people towards our earth and the environment.

Resource Utilization as per carrying capacity:-

- In order to attain sustainability it is very important that consumption should not exceed regeneration and changes should not allow to occur beyond the tolerance capacity of the system.

Urbanization

Urbanization is the movement of human population from rural areas to urban areas for the want of better education, communication, health, employment, etc.

Causes of urbanization

People move from rural areas to urban areas because cities offer more favorable conditions for the resolution of environmental and social problems than rural areas. A few specific reasons for urbanization are summarized below:

- (i) People move into cities to seek jobs and income.
- (ii) With good governance, cities can deliver education, health care and other services more efficiently than rural areas.
- (iii) Cities provide opportunities for women's empowerment and social mobilization.
- (iv) Density of urban life relieves pressure on areas of biodiversity and natural habitats.
- (v) It is through cities that foreign money flows into a country (whether the source is tourism or trade).
- (vi) Restaurants, movie theaters, theme parks and other varieties of entertainment are available in cities.

Drawbacks of Urbanization

Often people who leave rural areas to find better jobs in the city have no choice but to settle in slums, where they lack access to decent housing, drinking water, sanitation, health care and education.

- **Crimes:** Chances of robbery, murder, assault, etc., increases with unplanned urbanization.
- **Poverty:** Poverty is growing faster in urban than in rural areas. One billion people live in urban slums, which are typically overcrowded polluted and dangerous. Urban areas are not self-sustaining. They survive only by importing food, water, energy, etc. However, they also produce large quantities of waste.
- **Urban Heat Island:** As urban and industrial areas are developed, the majority of the sun's energy is absorbed by

urban structures and asphalt. Thus, during warm daylight hours, less evaporative cooling in cities allows surface temperatures to rise higher than in rural areas. Additional city heat is given off by vehicles and factories as well as by domestic and industrial cooling and heating units. This effect causes the city to become 1 to 6°C warmer than surrounding landscapes. Impacts also include intensification of carbon dioxide emissions and reducing soil moisture. The *urban heat island* has become a growing concern and is increasing over the years.

Urbanization is also responsible for pollution (air, water, noise, etc.) and traffic congestion.

Urban Problems Related to Energy

Urban center use enormous quantities of energy. In the past, urban housing required relatively smaller amounts of energy than we use at present. Traditional housing in India required very little temperature adjustments as the material used, such as wood and bricks, handled temperature changes better than the current concrete, glass and steel of ultra-modern building.

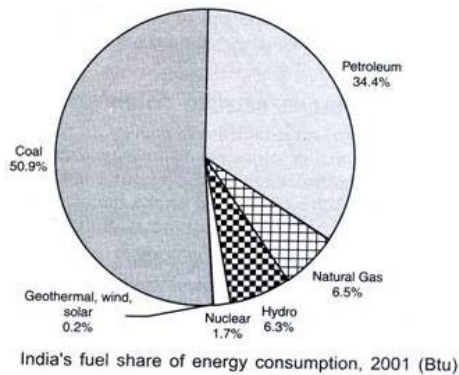
The urban growth is so fast that it is becoming difficult to accommodate all the industrial, commercial and residential facilities within a limited municipal boundary. As a result there is spreading of the cities into the sub-urban or rural areas too, this phenomenon is known as “urban sprawl”.

In developing countries, urban growth is very fast and pollution is uncontrollable and unplanned growth. When compared to rural people, an urban person consumes a lot of energy and materials and generates a lot of waste. This is because urban people have a higher standard of life and their life style demands more energy inputs.

Examples for energy demanding activities

1. Residential and commercial lightings.
2. Transportation means including, motor cycle, car and public transport for moving from residence to work place.
3. Industries using large proportional energy.
4. Modern life-style using a large number of electrical gadgets (fan, fridge, washing machine, A/C, water heater, etc.) in everyday life.
5. Control and prevention of pollution, need more energy dependent technologies.

The two sources of energy are renewable and non-renewable energy sources. Optimal usage shall be the ideal mode for energy conservation. For an integrated management system we should have renewable energy as well as non-renewable energy sources.



At local level, biomass energy tapping, use of solar cooker, solar water heaters and solar photovoltaic cells must be encouraged. This shall be utilised besides the conventional energy from fossil fuels, hydel, thermal and nuclear power resources.

Thus due to high population growth and high energy demanding activities, the urban problems related to energy are much more magnified as compared to the rural population.

WATER CONSERVATION:

Water being one of the most precious and indispensable resources needs to be conserved.

The following strategies can be adopted for conservation for water:

1) Decreasing run off losses: This can be achieved by

- ☐ **Contour cultivation** on small furrows and ridges across the slopes trap rainwater and allow more time for infiltration
- ☐ **Conservation bench terracing** involves construction of a series of benches for catching the runoff water
- ☐ **Water spreading** is done by channeling or lagoon travelling
- ☐ Lagoon travelling means small depressions are dug in the area so that there is temporary storage of water
- ☐ **Chemical wetting agents or conditioners** like Gypsum when applied to soils improves soil permeability and reduce runoff
- ☐ **Surface crop residues** Tillage, mulch, animal residues
- ☐ **Water storage structures** like farm ponds, dug wells

2) Reducing evaporation losses:

- ☐ Horizontal barrier of asphalt placed below the soil surface increases water availability
- ☐ A co-polymer of starch and acrylonitrile called super slurper absorbs water 4000 times its weight

3) Storing water in soil:

- ☐ Soil should be wetted to field capacity
- Leaving the soil fallow for one season water can be made available for the next season for crop growth

4) Reducing irrigation losses:

- ☐ Use of lined canals to reduce seepage
- ☐ Irrigation in early morning or late evening
- ☐ Sprinkling irrigation or drip irrigation

5) Reuse of water:

- ☐ Treated waste water can be used for ferti-irrigation
- ☐ Using grey water from washings, bath tubs for watering gardens washing cars

6) Preventing wastage of water:

- ☐ Closing taps when not in use
- ☐ Repairing any leakage from pipes

7) Increasing block pricing:

- ☐ The consumer has to pay a proportionately higher bill with higher use of water

RAIN WATER HARVESTING:

Objectives

- ☐ To reduce runoff loss
- ☐ To avoid flooding of roads
- ☐ To meet the increasing demands of water
- ☐ To raise the water table by recharging ground water

Rain water harvesting techniques:

Rainwater harvesting means collecting rainwater and storing/conserving it for later use.

Various Methods of Rainwater Harvesting

There are two main methods of rainwater harvesting:

Storage of Rainwater on the Surface for Future Use: In this method, traditional water-harvesting structures like artificial lakes, ponds, etc., are used as such or after proper revival.

Recharge of Ground Water: The structures used for recharge of ground water are as follows:

(a) *Hand Pumps* The water should pass through a filter bed before percolation in existing hand pumps. They are used for recharging aquifers.

(b) *Pits* They are 1–2 m wide and 3 m deep. They are also back filled with gravel and coarse sand to aid filtration before percolation to the ground. They are used for recharging a shallow aquifer.

(c) *Dug Wells* The rain water, after filtration, is put into existing dug wells for storage.

(d) *Roof-Top and Road-Rop Collection of Rainwater* In urban areas, these methods are very useful to recharge aquifers.

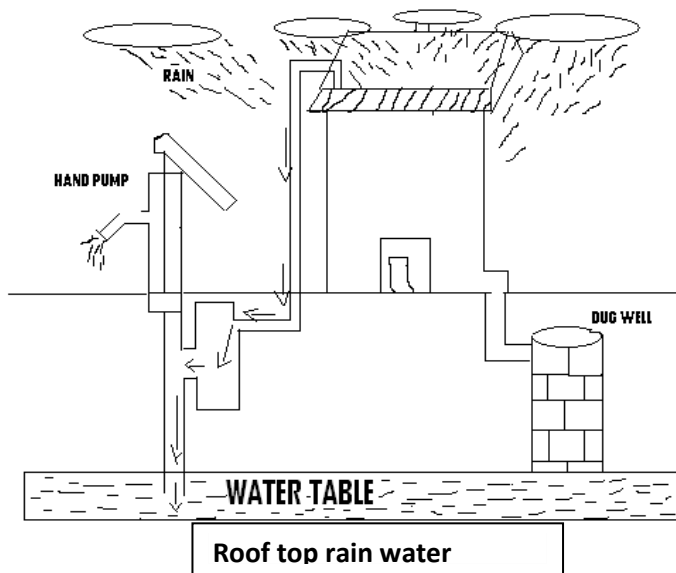
How to Harvest the Rainwater?

Rainwater harvesting systems consists of the following components:

- Catchment- Used to collect and store the captured rainwater.
- Conveyance system – It is used to transport the harvested water from the catchment to the recharge zone.
- Filter – Used for filtering the collected rainwater and removing pollutants.
- Tanks and the recharge structures: Used to store the filtered water which is ready to use.

The process of rainwater harvesting involves the collection and the storage of rainwater with the help of artificially designed systems that run off naturally or man-made catchment areas like- the rooftop, compounds, rock surface, hill slopes, artificially repaired impervious or semi-pervious land surface.

These days, the central ground water board along with the civic authorities is encouraging artificial recharge of ground water through rain water harvesting.



Advantages of Rainwater Harvesting

The benefits of the rainwater harvesting system are listed below.

- Less cost.
- Helps in reducing the water bill.
- Decreases the demand for water.
- Reduces the need for imported water.
- Promotes both water and energy conservation.
- Improves the quality and quantity of groundwater.
- Does not require a filtration system for landscape irrigation.
- This technology is relatively simple, easy to install and operate.
- It reduces soil erosion, storm water runoff, flooding, and pollution of surface water with fertilizers, pesticides, metals and other sediments.
- It is an excellent source of water for landscape irrigation with no chemicals, dissolved salts and free from all minerals.

Disadvantages of Rainwater Harvesting

In addition to the great advantages, the rainwater harvesting system has a few disadvantages like unpredictable rainfall, unavailability of the proper storage system, etc.

Listed below are a few more disadvantages of the rainwater harvesting process.

- Regular maintenance is required.
- Requires some technical skills for installation.
- Limited and no rainfall can limit the supply of rainwater.
- If not installed correctly, it may attract mosquitoes and other waterborne diseases.
- One of the significant drawbacks of the rainwater harvesting system is storage limits.

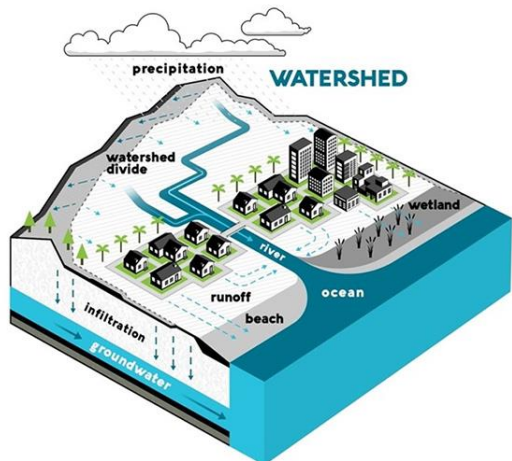
Watershed Management or Drainage basin or catchment basins

Watershed is a geographic area of land that collects, stores, and releases water.

The area collects water from rain, snow, etc. This collected water is stored in lakes and ponds. The stored water is then released through streams, rivers, etc. Thus, a *watershed* means a land from where water drains into a particular stream, lake, river and even the ocean. *Drainage basin* or *catchment basins* are other terms used interchangeably with watershed.

A watershed is a natural system. All lands, humans, wildlife and their activities are part of one or the other watershed. When a watershed is kept in good condition, it provides sustainable benefits to humans, wildlife, etc.

Watershed management refers to the conservation, protection and restoration of a watershed to secure water—both in quantity and quality for drinking, sanitation and agriculture in a sustained manner.



Objectives of Watershed Management:

- Pollution control
- Minimizing over-exploitation of resources
- Water storage, flood control, checking sedimentation
- Wildlife preservation
- Erosion control and prevention of soil
- Recharging groundwater to provide regular water supply

Components of Watershed Management Programmes:

- Soil and water conservation
- Plantation
- Agronomical practices
- Livestock management
- Renewable energy
- Institutional developments

Action Plan for Watershed Management Watershed management can be done through MCD:

- (i) **Mapping** of the watershed area, planting trees and grass for enhancing seeping of water to the ground and for preventing water contamination, torrents and landslides. Thus, plantation helps in the recharging of groundwater.
- (ii) **Constructing** a series of long *trenches* and mounds along hill contours to hold rainwater and allowing it to percolate into the ground.
- (iii) Making **dams** for preventing large amounts of water from rushing down the hillside. This helps in recharging of an underground aquifer. Moreover, streams and rivers flow for the whole year.

Need of Watershed Management: MUD

M: Misuse (i) The *misuse* of Himalayan slopes are increasing. Our water regimes are threatened resulting in the depletion of water resources.

U: Unsustainable (ii) The society is becoming *unsustainable*.

D: Damage (iii) The *damage* to irrigation systems and reservoirs are increasing. Every year, during the 'rainy season', costs for controlling floods is increasing.

Advantages of Watershed Management

The main benefits of watershed management are summarized below:

- (i) Watershed management reduces water shortage during summers by facilitating recharge of groundwater.
- (ii) It provides wildlife and fish, food, habitat, and resting areas, etc., for sustainable survival.
- (iii) It protects stream and river banks from erosion.
- (iv) By retaining water and releasing it during summers, watershed management reduces chances and associated damages of floods.
- (v) It provides good quality water and food for human use.

WASTELAND RECLAMATION

Land is a precious resource because it is used for agriculture, pastures and grazing fields, housing, agroforestry, roads, industrial areas, forestry, etc.

Wasteland is a land which is

- (i) *abandoned,*
- (ii) *degraded* and thus ecologically unstable,
- (iii) *incapable* of producing material or service of value,
- (iv) *eroded,*
- (v) *unfit* for cultivation, unproductive, unfit for grazing as greenery cannot be sustained, and
- (vi) *Saline*, waterlogged, not being utilized to its potentials.

(A) Classification of Wastelands

Wasteland is broadly classified into the following two types:

(i) **Cultivable Wastelands** The lands are cultivable but not cultivated for more than five years due to various reasons such as being declared as notified forest area or state or private occupation.

Examples: Waterlogged marshy lands, saline lands, degraded forests, degraded pastures (or degraded grasslands), shifting cultivation land, gullied land, strip land, etc.

(ii) **Uncultivable or Barren Wastelands**

These wastelands cannot be brought under cultivation or economic use except at a very high cost.

Examples: Barren rocky lands, areas covered by snow or glaciers, steep sloping areas.

(B) Drawbacks of Wastelands Formation Formation of

wastelands result in the deterioration of ecological balance. The various components of the ecosystem directly or indirectly dependent on that particular wasteland are adversely affected.

(C) Wasteland Reclamation

Wasteland reclamation is the process of converting sterile, barren wasteland into something that is fertile and suitable for habitation and cultivation.

(D) Wasteland-Reclamation Practices

Some of the important wasteland-reclamation practices are briefly described below:

a) **Changing Agricultural Practices:** Jhoom or shifting cultivation should be replaced by crop rotation, mixed cropping or developing plantation crops which would improve fertility of land and support a large population.

i) *Mulching:* It means providing protective cover to stop the shifting of sand. A mulch is a protective layer formed by the stubble, i.e., the basal parts of herbaceous plants, especially cereals, attached to the soil after harvest. Dry stems of maize, tobacco, and cotton are used as mulch. For mulching, artificial protective covering can also be used. Mulches act as wind barriers; so soil erosion due to wind is reduced. By addition of organic matter, mulches reduce evaporation and increase soil moisture. Even mulching is useful against water erosion.

ii) *Managing Topography* Water running down the hill erodes soil. The faster it runs, the more soil it carries off the fields. Soil erosion and wasteland formation can be minimized by the following methods:

- *Strip Farming* In alternating strips along the contours, different kinds of crops are planted. When one crop is harvested, the other is still present to protect the soil and keep water from running straight downhill.
- *Contour Ploughing* The ploughing of land is done across the hill, and not in up and down style as in contour ploughing, the ridges created by cultivation make little dams that trap water and allow it to seep into the soil rather than running off.
- *Tied Ridges* This method involves a series of ridges running at right angles to each other, so that water run-off is blocked in every direction and is encouraged to soak into the soil. Tied ridges are very useful in very heavy rainfall

areas.

- **Terracing** means shaping the earth in the form of levelled terraces to hold soil and water. The edges of the terraces are planted with soil-anchoring plant species. This method makes it possible to farm very steep hillsides. However, this method is costly, requires expensive machinery or much hand labour.

b) **Leaching:** By providing adequate drainage to flood-prone and irrigated lands, salinity can be prevented.

By leaching with more water, salt-affected lands can be recovered, especially in the areas where groundwater table is not high.

c) **Afforestation:** It means growing forests over culturable wastelands for the first time. Previously there were no forests there due to lack of seeds or other adverse factors.

Reforestation It means growing the forests over the lands where they were existing earlier; and had destroyed or degraded by forest fires, overgrazing, excessive felling, shifting cultivation, floods, waterlogging, soil erosion, etc.

d) **Protecting the River Banks:** By providing stone, wooden or concrete pitching or by plantation of trees/vegetation along the river banks, it is possible to protect river banks against caving and cutting.

Controlling Formation of Gullies The gullies get widened due to excess run-off water. This can be checked by constructing dams, diversion drains, bounds, etc.

e) **Protecting Soil Erosion by Providing Ground Cover:** After harvesting, the crop residues are left on the ground. They resist wind and water from creating erosion. The ground cover reduces soil temperature and evaporation in the hot season. It thus protects the ground organisms which are helpful in aerating and rebuilding the soil.

f) **Ecological Succession:** This is a natural process of establishment or re-establishment of an ecosystem. In ecological succession, the slow-growing native grasses assist in reclaiming the minerally deficient soils in mining and industrial wastelands.

g) **Drainage:** It is required for waterlogged soil reclamation where excess water is removed by artificial drainage.

In areas where waterlogging happens after heavy rains, surface drainage is facilitated to remove the excess water.

Subsurface drainage is better because chances of evaporation of water leading to accumulation of salt almost become nil in this method.

RESETTLEMENT AND REHABILITATION OF PEOPLE, ITS PROBLEMS AND CONCERNS:

Various development projects often lead to displacement of native or tribal people who are poor and very often not educated. Their rehabilitation is a major socio economic issue.

Problems and concerns:

Displacement problems due to dams:

- The big river valley projects have one of the most serious socio economic impacts due to large scale displacement of local people from their ancestral home and loss of their traditional profession or occupation.
- In India due to big dam construction, more than 20 million people are estimated to have been directly or indirectly affected by these dams
- The Hirakund dam has displaced more than 20,000 people residing about 250 villages.
- The Bhakra Nangal dam was constructed during 1950's and till now it has not been possible to rehabilitate even half of the displaced persons.
- Tehri dam and Sardar sarovar dam also have same issues.

Displacement due to mining:

- Mining is another developmental activity which causes displacement of the native people.
- Several thousands of hectares of land area is covered in mining operation and the native people are displaced.
- Sometimes displacement of local people is due to accidents occurring in mined areas like subsidence of land that often leads to shifting of people.
- Jharia coal fields, Jharkhand have been posing big problems to the residents due to underground fires and they are asked to vacate the area.
- According to latest estimation, about Rs.18,000 crores will be spent for shifting the population while the cost of extinguishing the fire would be around 8,000 crore.

Displacement due to creation of national parks:

- When some forest area is covered under a national park, it is welcome step for conservation of natural resources.
- However it also has a social aspect associated with it.
- A major portion of the forest is declared as core area where the entry of local people is restricted.
- So they start destruction activities

The major issues related to displacement and rehabilitation is

- Tribals are usually most affected amongst the displaced who are already poor
- Break up of families and women are the worst affected.
- The tribals are not familiar with market policies and trends
- Kinship systems, marriages, social and cultural functions, their folk songs, dances and activities vanish with their displacement
- Loss of identity and loss of intimate link between the people

REHABILITATION AND RESETTLEMENT CONCERNS

The objective of the Ministry of Rehabilitation and Resettlement (Government of India) is to transfer the benefits, in lieu of the losses occurred to displaced people due to involuntarily displacement.

This objective may be ensured by implementing the following policies:

- (i) To keep them intact in a *family* or community in which they were settled prior to being displaced.
- (ii) To provide them essential *infrastructure* such as health, schooling and credit in resettlement sites
- (iii) To govern the displacement process by *laws* for avoiding possible problems, to create new rights for them that will enable them to directly share the benefits of the development project and to provide adequate compensation.
- (iv) To relocate them to a *locality* of their preference
- (v) To provide them increasing *incomes* through opportunities of employment and livelihood, to provide them opportunities for the enhancement of capabilities and to improve their standard of living
- (vi) To give them proper *participation* and choice for their resettlement and rehabilitation
- (vii) To provide them social infrastructure and community services

Environmental Ethics: Issues and Possible Solutions

The word '*ethic*' is derived from the Greek word '*ethos*' which means the character of a person as described by his or her actions.

Ethics deals with moral duty and obligations. It gives rise to a set of values, which are used to judge whether one's behavior or conduct is right or wrong.

Trust, honesty, justice, trustworthiness, competence and accountability are the basis of ethics.

Issues In early 1970s, the world started realizing the dangers of human actions on the environment. The main reasons of such concerns were the following issues whose effects were changing the global environment: "ACNE".

- A (i) Reduced purification of *atmosphere* because of increased deforestation.
- C (ii) Increased CO₂ *concentration* and presence of harmful elements in atmosphere due to *enhanced* burning of fossil fuels
- N (iii) Depletion of *natural resources* at a rapid rate due to consumption by increasing population
- E (iv) Deteriorating quality of *environment* because of urbanization, industrialization, deforestation, consumerism, etc.

These issues result in the following serious consequences: Greenhouse effect, global warming, acid rain, ozone layer depletion, etc.

(A) Possible Solutions: Awareness of consequences like global warming, etc., has led the society to adopt environmental ethics. These environmental ethics give equal importance to growth and sustainability.

Environmental ethics can provide us the guidelines for putting our beliefs into action and help us decide what to do when faced with crucial situations. Some important ethical guidelines known as earth ethics (or) Environmental Ethics are as follows:

- You should love and honor the earth since it has blessed you with life.
- You should keep each day sacred to earth and celebrate the changing of its seasons.

- You should not hold yourself above other living things
- You should be grateful to the plants and animals which nourish you by giving you food.
- You should limit your off-springs because too many people will overburden the earth.
- You should not waste your resources
- You should not steal from future generations their right to live in clean and safe planet by polluting it.
- You should consume the materials in moderate amounts. So that all may share the earth is precious treasure of resources.

Climate Change

Climate is the average weather of an area. It is general weather conditions, seasonal variations and extremes of weather in a region. Such conditions which average over a long period- at least 30 yrs is called climate.

Weather is the reflection of atmospheric humidity, temperature and rainfall. Climate is the average weather pattern over longer duration in a place. Climate change is reflected from the following facts:

- Since the late 19th century, the earth has warmed by 0.3 to 0.6°C on an average.
- By the year 2100,
 - (a) Temperatures would rise by 1 to 3.5°C
 - (b) Global mean sea levels would rise by 15 to 95 cm

Causes of climate change on a global scale are linked with changes in the amount of heat that is either let into the earth system or let out of the earth system.

Depending on proximity to oceans and altitude and amounts of sunlight received by different regions of the world, climate differs from place to place.

For example, hot climates are due to greater concentrations of greenhouse gases in the atmosphere which reduce the amount of heat that is let out of the atmosphere.

III effects of climate change are linked to

- (i) cyclones,
- (ii) floods,
- (iii) dry or wet spells of rain fall
- (iv) cold and hot spells of temperature.

A) Impacts of Climate Change

(i) Positive Impacts Reduced deaths from cold and higher agricultural output in northern regions (at least for a while) are few positive impacts of global warming.

(ii) Negative Impacts

- (a) Submergence of low-lying islands (especially in the Pacific), vast saline inundations in countries like Bangladesh, etc., are linked to rise in sea level. (Global warming is responsible for melting of ice caps and glaciers, which lead to rise in sea level.)
- (b) The tourism industry will suffer in parts of southern Europe because of change of climate towards hotter than ever before (prediction by the European Acacia Project).
- (c) Damaging changes in wildlife behaviour like failure of Scottish seabirds to raise young during the 2004 breeding season.
- (d) The poorest of the poor are most likely to be hit by the impacts of climate change.

B) Solutions of Climate-change Problems: Some of the simple solutions are

- (i) Reduce the emission of greenhouse gases
- (ii) Use renewable energy resources
- (iii) Use energy efficient technologies

Example 1 What are the important mitigation technologies and commercially available latest technologies for tackling the climate change as per Fourth Assessment Report of Intergovernmental Panel on Climate Change (IPCC)?

Solutions As per the IPCC Fourth Assessment Report, the important mitigation technologies and practices presently commercially available are described below:

(i) **Industry**

- Recovery of heat and power
- Recycling of material
- Green technology
- Efficient equipment, etc.

(ii) **Buildings**

- Passive and active solar design for cooling and heating
- Efficient electrical appliances
- Improved cooking stoves
- Efficient lighting and day lighting, etc.

(iii) **Transport**

- Use of public transport systems
- Cycling, walking, etc., non motorised transport

- Use of best fuel-efficient vehicles
- Biofuels
- Proper transport planning, etc.

(iv) *Energy supply*

- Renewable energy
- Improved efficiency in supply and distribution, etc.

(v) *Agriculture*

- Improved nitrogen fertilizer application techniques to reduce N_2O emissions,
- Improved rice-cultivation techniques and livestock-and-manure management to reduce CH_4 emissions,
- Dedicated energy corps to replace fossil-fuel use,
- Improved crop and grazing-land management, etc., to increase soil carbon storage,

(vi) *Waste*

- Recycling and waste minimization
- Compositing of organic waste
- Waste incineration with energy recovery
- Waste-water treatment, etc.
- Landfill methane recovery

(vii) *Forests*

- Reduced deforestation
- Forest management
- Afforestation
- Reforestation
- Harvested wood-product management
- Use of forestry products for bio-energy to replace use of fossil fuel, etc.

Case Study

Climate Change, Perspectives from India

Climate change is the biggest development challenge for the planet. There is not much difference between managing a local forest and the global climate—we need a framework which encourages cooperation. Then a country can have both growth and less carbon emissions. To tackle the impact of climate change on food security in India, it has been suggested to practice soil and water conservation. Small-scale industries emit substantial greenhouse gases and have the potential for saving huge amounts of energy.

C) Environment Security and Climate Change

The security of the entire global community is increasingly exposed to risk

by humans through air, water and/or land pollution. Economic activities cause environmental changes that lead to conflict.

It is important for all countries to cooperate in order to reduce the effects of environmental degradation. Everyone should contribute by limiting greenhouse gas emission, conserving natural resources, and developing and sharing energy-efficient technologies.

Global Warming: The Greenhouse Effect

Greenhouse Effect Definition

“Greenhouse effect is the process by which radiations from the sun are absorbed by the greenhouse gases and not reflected back into space. This insulates the surface of the earth and prevents it from freezing.”

What is the Greenhouse Effect?

A greenhouse is a house made of glass that can be used to grow plants. The sun's radiations warm the plants and the air inside the greenhouse. The heat trapped inside can't escape out and warms the greenhouse which is essential for the growth of the plants. Same is the case in the earth's atmosphere.

During the day the sun heats up the earth's atmosphere. At night, when the earth cools down the heat is radiated back into the atmosphere. During this process, the heat is absorbed by the greenhouse gases in the earth's atmosphere. This is what makes the surface of the earth warmer that makes the survival of living beings on earth possible.

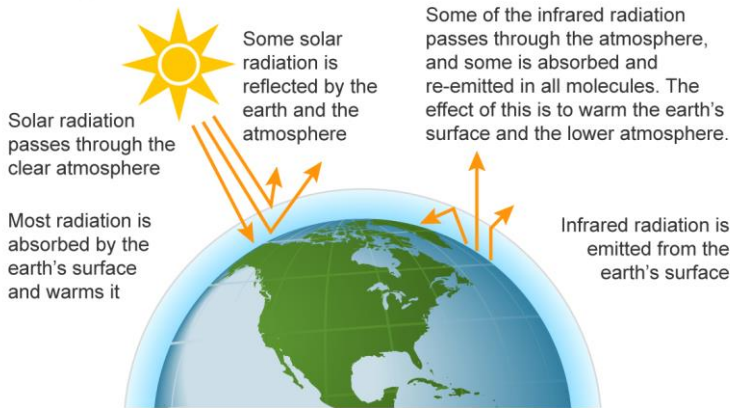
However, due to the increased levels of greenhouse gases, the temperature of the earth has increased considerably. This has led to several drastic effects.

Greenhouse Gases

“Greenhouse gases are the gases that absorb the infrared radiations and create a greenhouse effect. For eg., carbondioxide and chlorofluorocarbons.”

The major contributors to the greenhouse gases are factories, automobiles, deforestation, etc. The increased number of factories and automobiles increases the amount of these gases in the atmosphere. The greenhouse gases never let the radiations escape from the earth and increase the surface temperature of the earth. This then leads to global warming.

The greenhouse effect



Causes of Greenhouse Effect

The major causes of the greenhouse effect are:

Burning of Fossil Fuels

Fossil fuels are an important part of our lives. They are widely used in transportation and to produce electricity. Burning of fossil fuels releases carbon dioxide. With the increase in population, the utilization of fossil fuels has increased. This has led to an increase in the release of greenhouse gases in the atmosphere.

Deforestation

Plants and trees take in carbon dioxide and release oxygen. Due to the cutting of trees, there is a considerable increase in the greenhouse gases which increases the earth's temperature.

Farming

Nitrous oxide used in fertilizers is one of the contributors to the greenhouse effect in the atmosphere.

Industrial Waste and Landfills

The industries and factories produce harmful gases which are released in the atmosphere.

Landfills also release carbon dioxide and methane that adds to the greenhouse gases.

Effects of Greenhouse Effect

The main effects of increased greenhouse gases are:

Global Warming

It is the phenomenon of a gradual increase in the average temperature of the Earth's atmosphere. The main cause for this environmental issue is the increased volumes of greenhouse gases such as carbon dioxide and methane released by the burning of fossil fuels, emissions from the vehicles, industries and other human activities.

Impact of global warming and greenhouse effect

(i)Consequences of Global Warming

- (a) Melting of polar ice caps, and increase of sea/ocean levels
- (b) Flooding of low-lying land
- (c) Less water vapour in the atmosphere leading to more drought
- (d) Causes extremes of weather hurricanes, flooding and droughts, difficulties in growing crops and survival problems

More industrialized countries are responsible for causing high levels of CO₂ in the atmosphere and less industrialized countries are also contributing by destruction of the rainforest.

(ii)Remedial Measures

- (a) Enhance energy efficiency during use by adding insulation to your walls, and by using CFL bulbs, etc.
- (b) Reduce transport sector emissions by less and smart driving.
- (c) Promote renewable energy (like solar energy) usage.
- (d) Remove subsidies on fossil fuels.
- (e) Favor sustainable agriculture.
- (f) Recover methane emissions through waste management.
- (g) Promote afforestation and reforestations—a single tree will absorb approximately one ton of CO₂ during its lifetime.
- (h) Reduce energy consumption by using energy-efficient home appliances.
- (i) Avoid methane production from biomass decay through controlled combustion.
- (j) Enhance energy efficiency during generation, transmission and distribution.
- (k) Reduce waste, prefer reusable products, recycle paper, plastic, metals, etc.
- (l) Eat locally grown fruits and vegetables and not the imported ones. The latter requires the burning of fossil fuels for transport.

Depletion of Ozone Layer

Ozone Layer protects the earth from harmful ultraviolet rays from the sun. It is found in the upper regions of the stratosphere. The depletion of the ozone layer results in the entry of the harmful UV rays to the earth's surface that might lead to skin cancer and can also change the climate drastically.

The major cause of this phenomenon is the accumulation of natural greenhouse gases including chlorofluorocarbons, carbon dioxide, methane, etc.

Ozone-Layer Depletion (Ozone Hole)

(A) **Ozone:** Ozone (O_3) is an allotropic form of oxygen (O_2). It is a pale blue gas. It helps in sustaining life on earth by filtering out the sun's harmful ultraviolet radiation.

(B) **Ozone Layer:** The total amount of ozone in an overhead column of the atmosphere is measured in dobson unit (after the atmospheric ozone pioneer GMB Dobson). One Dobson Unit (DU) indicates that a 0.01 mm thick ozone layer would be formed if ozone is compressed into one layer at 0°C and 1 atm pressure. Across the globe, in the stratosphere, the average thickness of the ozone layer is about 3 mm at 0°C and 1 atm pressure (or about 300 DU). The stratospheric pool of ozone is known as the *ozonosphere*.

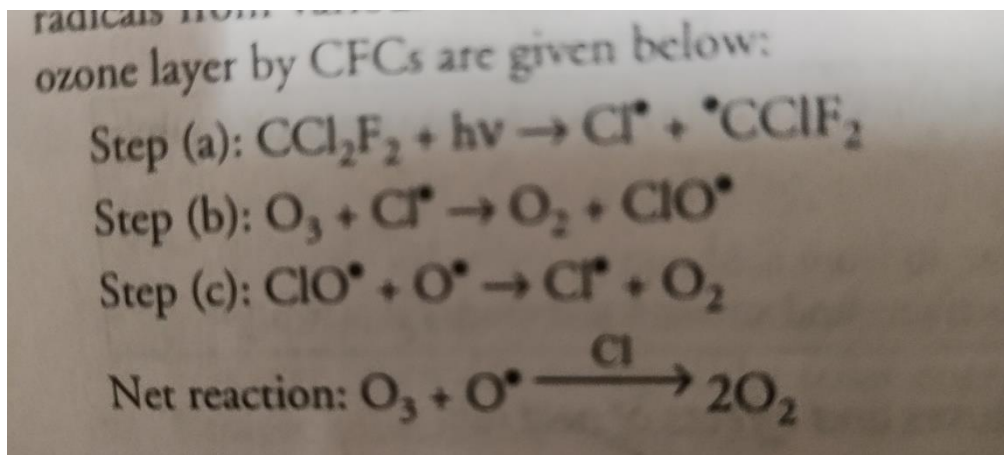
(C) **Ozone Hole:** When the level of ozone in the stratosphere falls below 200 DU, it is considered to represent the beginnings of an ozone hole.

(D) **Causes of Ozone-Hole Formation:** The gradual thinning of the ozone layer and ozone-hole formation occurs by the destruction of ozone due to its reactions with nitric oxide, chlorine, hydroxyl radicals, etc., in the stratosphere.

Flying of supersonic aircrafts, nuclear explosions and various chemical/ photochemical reactions in the atmosphere generate nitric oxide. Burning of biomass generates hydroxyl radicals. Volcanic activity releases chlorine in the atmosphere. Chlorofluorocarbons (CFCs), fluorochloro methane (freons), difluorodichloro methane (CF_2Cl_2) and fluorochloroform (CFCl_3) release chlorine by ultraviolet radiation induced homolytic cleavage in the atmosphere.

It is estimated that about 6.5% of the total ozone-layer depletion is due to chlorine radicals from various CFCs.

The chemical reactions leading to the destruction of ozone layer by CFCs are given below:



As Cl atoms are regenerated in step (c), a long-chain process is followed which keeps on consuming ozone. It is estimated that each atom of chlorine can destroy one lakh ozone molecules when they diffuse to the stratospheric level.

(E) Problems Associated with Ozone-Layer Depletion: The ozone layer absorbs most of the harmful ultraviolet radiations coming from the sun in the region (220–330) nm.

In the absence of an ozone layer, these ultraviolet radiations could cause the following problems:

- (i) Swelling of *skin* and skin cancer; skin aging, burning sensation
- (ii) Death of *phytoplanktons* in marine environment (the sole producers) leading the entire ecosystem to collapse
- (iii) Reduction in the body's ability to fight off disease, as UV suppresses the *immune system*; premature aging.
- (iv) Inhibition and alteration of DNA replication and formation of DNA adduct; leukemia, breast *cancer*
- (v) Visual impairment, dizziness, cataracts of eyes
- (vi) Damage to plants; reduction in crop yields; faster deterioration of *paints, fabrics, plastics*

(F) Remedial Measures to Control the Depletion of Ozone Layer

- (i) Avoid any fire extinguisher that contains bromine-based halons. Preferably use water, carbon dioxide or dry chemical fire extinguishers.
- (ii) Spread awareness about the restricted use of CFCs for the healthy survival of mankind.

- (iii) Avoid purchasing and using refrigerators, air conditioners, etc., which use CFCs, freons, etc., as coolants.
- (iv) Avoid purchasing and using pressurised aerosol cans which use CFCs, freons, etc., as propellants.
- (v) Ban atmospheric nuclear explosions, as they emit NO and deplete the ozone layer.
- (vi) Reduce the air traffic of supersonic aircrafts that fly at the ozonosphere altitude, as they release large amounts of NO and deplete the ozone layer.
- (vii) Facilitate advanced research to plug the ozone holes that have already been formed.

ACID RAIN

Acid rain, also called **acid precipitation** or **acid deposition**, precipitation possessing a pH of about 5.2 or below primarily produced from the emission of sulfur dioxide (SO₂) and nitrogen oxides (NO_x; the combination of NO and NO₂) from human activities, mostly the combustion of fossil fuels. Acid rain contributes to the corrosion of surfaces exposed to air pollution and is responsible for the deterioration of limestone and marble buildings and monuments.

Chemistry of acid deposition

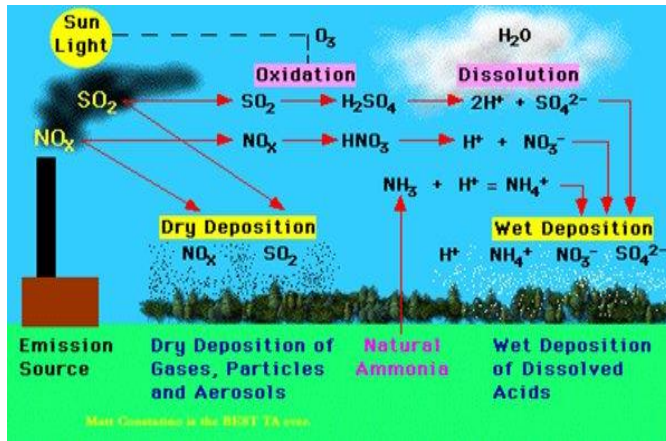
Normal rainwater is weakly acidic because of the absorption of carbon dioxide (CO₂) from the atmosphere—a process that produces carbonic acid—and from organic acids generated from biological activity. In addition, volcanic activity can produce sulfuric acid (H₂SO₄), nitric acid (HNO₃), and hydrochloric acid (HCl) depending on the emissions associated with specific volcanoes. Other natural sources of acidification include the production of nitrogen oxides from the conversion of atmospheric molecular nitrogen (N₂) by lightning and the conversion of organic nitrogen by wildfires. However, the geographic extent of any given natural source of acidification is small, and in most cases it lowers the pH of precipitation to no more than about 5.2.

Anthropogenic activities, particularly the burning of fossil fuels (coal, oil, natural gas) and the smelting of metal ores, are the major causes of acid deposition. In the atmosphere, sulfuric and nitric acids are generated when SO₂ and NO_x, respectively, react with water. The simplest reactions are:





These reactions in the aqueous phase (for example, in cloud water) create wet deposition products.



Causes of Acid Rain

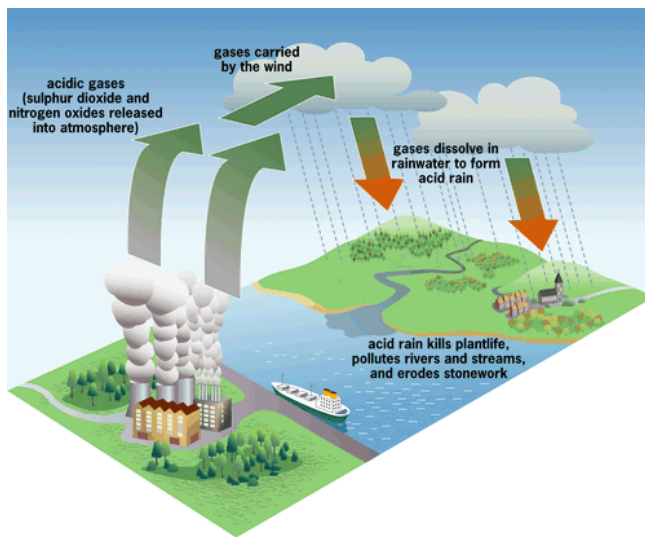
The causes of acid rain are ***Sulphur and Nitrogen particles which get mixed with the wet components of rain.*** Sulphur and Nitrogen particles which get mixed with water are found in two ways either man-made i.e as the emissions that are given out from industries or by natural causes like lightning strike in the atmosphere releasing nitrogen oxides and volcanic eruptions releasing sulphur oxide.

pH 4.2-4.4= Acid rain

pH 5.6= Clean rain

As the pH is $\log [\text{H}^+]$, so each pH unit represents a tenfold change:

- (i) A pH of 5 is ten times more acidic than a pH of 6.
- (ii) A pH of 4 is hundred times more acidic than a pH of 6.



1. Acidic gases (sulphur dioxide and nitrogen oxides) released into atmosphere from industries, vehicle's exhaust etc.
2. Acidic gases carried by the wind.
3. Acidic gases dissolve in rainwater to form acid rain.
4. Acid rain kills plant life, pollutes rivers and streams and erodes stone work.

Effects of Acid Rain

- Acid rain is very harmful to agriculture, plants, and animals. It washes away all nutrients which are required for the growth and survival of plants. Acid rain affects agriculture by the way it alters the composition of the soil.
- It causes respiratory issues in animals and humans.
- When acid rain falls down and flows into the rivers and ponds it affects the aquatic ecosystem. It alters the chemical composition of the water, to a form which is actually harmful to the aquatic ecosystem to survive and causes water pollution.
- Acid rain also causes the corrosion of water pipes, which further results in leaching of heavy metals such as iron, lead and copper into drinking water.
- It damages the buildings and monuments made up of stones and metals.

Acid Rain and Taj Mahal

Tourist traffic is not allowed near the Taj Mahal in an effort to control the deleterious effects of pollution. The degradation of the Taj Mahal's marble facades has still not slowed down.

This is due to acid rain generated from local foundries and an oil refinery. The once brilliant white Taj Mahal has been losing its luster, dulling into a sickly pale shade. Two common air pollutants, SO_2 and NO_x , cause acid rain.

Nuclear Accidents and Holocaust

A) Nuclear Accidents

Nuclear accidents can occur at any stage of the nuclear fuel cycle. They may also result from the failure of nuclear devices.

Types of nuclear accidents are discussed below:

1. **Nuclear test:** Nuclear explosions, carried out in underground, because settling down the radioactive materials on the earth's surface and radioactive particles, radioactive rays into the atmosphere.
2. **Nuclear power plant accidents:** The release of radiation occurs during the accidents. The nuclear power plant located in the seismic vulnerable area may cause nuclear accidents.
3. **Improper disposal of radioactive waste:** It is another source of accident. Drums stored underground can rust and leak radioactive materials into water, land and air.
4. **Accident during transport:** Trucks carrying radioactive wastes or fuels are involved in frequent accidents.
5. **Core melt down:** The major accident at a nuclear power plant is a core melt down.

Effect of Nuclear Radiation

1. Radiations may break chemical bonds such as DNA in cells. This effect may be instantaneous, prolonged or delayed types. It may be even carried to future generations.
2. Exposure at low dose of radiation (100-250 rads), people do not die, but begin to suffer from fatigue, vomiting and loss of hair.
3. Exposure at higher dose of radiation (400-500 rads) affects bone marrow, blood cells, natural resistance and blood to fail clot.
4. Exposure at very high dose of radiation (10,000 rads) kills the organisms by damaging the tissues of heart, brain.

World major nuclear accidents

- (i) **Three Mile Island Accident:** On March 28, 1979, a nuclear accident occurred in US at the Three Mile Island nuclear power plant. One of two reactors lost its coolant, which caused overheating and partial meltdown of its uranium core. This resulted

in release of intense radiation as well as radioisotopes. Fortunately, the plume emitted into the atmosphere was quite low for causing toxic effect.

(ii) **Chernobyl Nuclear Accident:** On April 26, 1986, a nuclear accident occurred in Chernobyl, near Kiev, Ukraine. Explosion and fire in the graphite core of one of four reactors released radioactive material that spread over part of the Soviet Union, eastern Europe, western Europe and Scandinavia. This is one of the world's worst nuclear accidents involving 237 confirmed cases of chronic radiation illness and 37 deaths. Hundreds of thousands of Ukrainians, Russians and Belorussians had to abandon entire cities within a 30 km zone of extreme contamination. About 3 million people, more than 2 million in Belarus alone are still living in contaminated areas. Figures from the Ukraine Radiological Institute suggest that over 2500 deaths were caused by the Chernobyl nuclear disaster.

(iii) **Tokaimura Nuclear Accident:** On September 30, 1999, a nuclear accident occurred in a nuclear plant in Tokaimura, Japan. In a uranium-processing nuclear fuel plant, a chain reaction went uncontrolled, resulting in emission of high levels of radioactive gas into the air. Because of this accident, two workers were seriously injured and one worker got killed.

Populations living in contaminated areas and persons who helped with the clean-up of the accident were found to have thyroid or other cancers. Among Ukrainian young children (up to 15 years of age), the average thyroid cancer rate was 4–6 incidents per million before the accident. After the incident, the cancer rate rose to 45 incidents per million.

People were not told the truth until several years after the accident. The lack of public information available after the accident, the stress and trauma of evacuation and concerns of the people affected and concerns about their children's health resulted in significant increases in psychological health disorders such as depression, anxiety, helplessness, social withdrawal, mental stress and lack of hope for the future.

Nuclear Holocaust

Holocaust means large-scale destruction of human lives by intense heat and fire.

It means destruction of biodiversity by nuclear equipments and nuclear bombs. In a holocaust, a large number of living beings are totally

destroyed. Usually, these kinds of destructions are happened in a nuclear war.

Holocaust: Great Destruction Resulting in the Extensive Loss of Life:

Hiroshima–Nagasaki disaster is a nuclear holocaust. America was involved in the development of an atom bomb while World War II was at its peak. The bomb was made and was test fired on 16 July, 1945 in a desert in Mexico. The 30 m tower on which the bomb was placed completely melted. The blinding light that spread for a few minutes turned the sun into a pale ball. Frightened to the core by the resulting blast, scientists vehemently opposed using it on Japan or anywhere in the world. US President Harry Truman was determined to win the war against Japan. He ordered dropping of the bomb on Japan. The *uranium bomb* named the *Little Boy* was dropped on *Hiroshima* on *August 6, 1945*. Within minutes, one lakh persons were burnt to death like moths near a lamp. Just three days later, a *plutonium bomb* named *Fatman* was dropped over *Nagasaki*. The whole area was burnt and looked like a desert. Devastating shock waves, deadly gamma radiations and enormous amount of heat created conditions where any life cannot survive.

It is estimated that by December 1945, as many as 1,40,000 had died in Hiroshima by the uranium bomb and its associated effects. In Nagasaki, roughly 74,000 people died of the plutonium bomb and its after effects. In both cities, around 2,14,000 people in total, most of them were civilians, were killed. In Nagasaki alone, up to 60,000 people were injured. The radius of total destruction was about 1.6 km, followed by fire across the northern portion of the city to 3.2 km south of the bomb.

Radiation poisoning and necrosis caused illness and death after the bombing in about 1% of Hiroshima residents who survived the initial explosion. In the years between 1950 and 1990, It is estimated that hundreds of deaths are attributable to radiation exposure among atomic-bomb survivors from both Hiroshima and Nagasaki.

Effect of Nuclear Holocaust

1. Nuclear winter

Nuclear bombardment will cause combustion of wood, plastics, petroleum, forest etc. Large quantity of black soot will be carried to the stratosphere. Black soot will absorb all radiations and will not allow the radiation to reach the earth. Therefore, cooling will result. Due to this

cooling effect, water evaporation will also reduce. In stratosphere there won't be significant moisture to rain-out the thick soot. Thus, due to nuclear explosions, a process known as opposite to global warming will occur. This is called nuclear winter.

Effect of nuclear winter

(a) Lowers the global temperature, even in summer the temperature will be at around freezing temperature.

(b) Crop productivity will be reduced causing famines and human sufferings.

2. It ignites all combustible material; destroy all the living beings, material crushing and destruction of homes.

Control measures

1. Suitable precautions are to be taken and training must be given to people for handling these materials to avoid accident.

2. Constant monitoring of the radiation level has to be carried out, limit exposure to the workers.

3. Regular checks and control measures are done by Atomic Energy Regulatory Board under the Department of Atomic Energy.

Consumerism and Waste Products

Consumerism is a process and habit of the chronic purchasing of new goods and services, with less attention to their true need, durability, origin of the product or the environmental impacts during manufacture and disposal.

Model of Paul Ehrlich and John Hodlren (1972) :

Population X Consumerism X Waste generation = Environmental degradation

(No. of persons) x per capita use of resources x waste generated per unit of resource use = Overall environmental degradation

In More Developed Countries (MDCs), population is less and resources are in abundance. Lifestyle is luxurious and per capita consumption of resources is very high. More consumption of resources results in more waste generation and greater environmental degradation.

In Less Developed Countries (LDCs), population is large. Adequate resources are not available for all, so per capita consumption is less. However, overall consumption is high. Thus, environmental impact is same or slightly less in comparison to MDCs.

For example, the population of India is 3.4 times more than that of USA but its overall resource use and waste generation is less than 1/8th that of USA.

A) Creators of Consumerist Culture

(i) **Artificial Beauty:** Millions of people use soaps, detergents, hair dyes, skin-care creams and other cosmetic items to enhance their beauty artificially. Manufacturers have been able to create demands for these cosmetic items and the public is busy spending their money for this temporary beauty enhancement.

Fashion Manufacturers of clothes, textiles, shoes and apparel keep changing fashions to accelerate the speed of consumerism through advertisements.

(ii) **Greed of Industry:** To make more profits, industry and large businesses want to sell more products. Generally, products are made for a one-time use. Through regular advertising a “throwaway society” has been created. This society prefers disposable items discarding notions of inherent value, longevity and the environmental consequences of manufacture and disposal of the product. In the developed world, 200 billion paper cups, bottles, cans and plastic cartons are thrown away each year.

(iii) **More Money, Less Time:** Family ties, friendship, everything becomes mediated through the spending of money on goods and gifts and services. A generation is growing up without knowing what quality goods are. Relations are promoted only as a vehicle of giving and taking gifts.

(iv) **Mega Shows:** Manufacturers of items of consumerism (like automobiles, televisions, radios, refrigerators, air conditioners, dishwashers, cosmetics) sponsor megashows. They kindle passion and unquenchable desire for latest items through prizes and other incentives.

(v) **Advertising:** Advertising is designed to create both a desire to follow fashions, and the resultant personal self-reward system based on acquisition. Thus, a consumerist culture is not based on natural demand, but on a created demand.

(vi) **Politics Consumerism** is encouraged politically so that population remains satisfied by material needs and politicians can do whatever they wish for.

B) Drawbacks of Consumerism

Consumerism

- i. causes more *pollution*, creates more waste products, causes wasteful use of material and energy,
- ii. helps lowest-wage, environ- mentally unregulated *over- seas* manufacturers,
- iii. promotes social *unrest*,
- iv. *promotes riots*, and other criminalities, and
- v. Leads to *societal suicide*.

C) Measures to Prevent Excess Consumerism

Some of the measures to prevent excess consumerism include the following:

- i. **Pigouvian Taxes** For encouraging industrial ecology and waste reduction, manufacturers are taxed for some or all the cost of recycling or waste disposal.
- ii. **Ecolabelling** It involves the marking of products to indicate that they are environmentally friendly. Ecolabelling assesses environmental impact and communicates this to the consumer. It also encourages manufacturers to reduce the impacts of their products. *Ecomark is used in India for ecolabelling.*
- iii. **Green Marketing** It involves communicating green image of the better, environmental friendly products to the consumer. It helps in conserving the environment and achieving better marketing niche. People also happily buy green products like refrigerators that do not leak ozone-layer-depleting chlorofluoro carbons (CFC's) and consumes less electricity.
- iv. **Self-awareness and Self-control**

Having fewer things means enjoying what you have more and actually getting to use it. It also helps in fewer distractions from the essentialssuch as food, family, nature, study, and friends.

ACTS FOR ENVIRONMENTAL PROTECTION

Environment Protection as a Common Goal for All

Paul Bigelow Sears once said, *“How far must suffering and misery go before we see that even in the day of vast cities and powerful machines, the Earth is our mother and that if we destroy her, we destroy ourselves.”*

So, we should act today for a better tomorrow. Adopt a strategy (like outlined below) for environmental protection. Government, industry, public and law must have only one goal, viz. environment protection.

Industry: Replace non-renewable inputs in energy with renewable ones.

Government: Educate and involve all in environmental protection drive. They must act together to fight corruption in government and ruthless exploitation by the industry.

Public: Consume less, share more, control population and reduce pressure on natural resources.

Law: Take help from law, if needed, for protection of our environment.

Role of Government and legal aspects in Environmental Protection

A) Government Increased government intervention is a must for solving environmental problems because of the following reasons:

- (i) The world is facing very serious environmental problems like loss of biodiversity, global warming, water pollution, air pollution, etc.
- (ii) The world is facing increased probabilities of natural disasters due to global warming.
- (iii) The health of millions of people is at risk if companies are left free to sell their products, vehicles, etc., just for profits. This is because we are exposed to thousands of chemicals a year, many of which interact in ways that are not yet fully understood.

B) **Legal Aspects** The Ministry of Environment and Forests (MoEF) in India is the apex administrative body for

- undertaking conservation and survey of fauna, flora, forests and wild life;
- formulating the environmental policy framework in the country;
- planning, promotion, co-ordination and overseeing the implementation of environmental and forestry programmes; and
- Regulating and ensuring environmental protection.

The responsibility for prevention and control of industrial pollution is primarily executed by the *Central Pollution Control Board (CPCB)* at the central level which is a statutory authority, attached to the MoEF. The State Pollution Control Boards and the State Departments of Environment are the designated agencies to perform the function at the state level. The administrative framework in India for protection of the environments is shown in Fig.

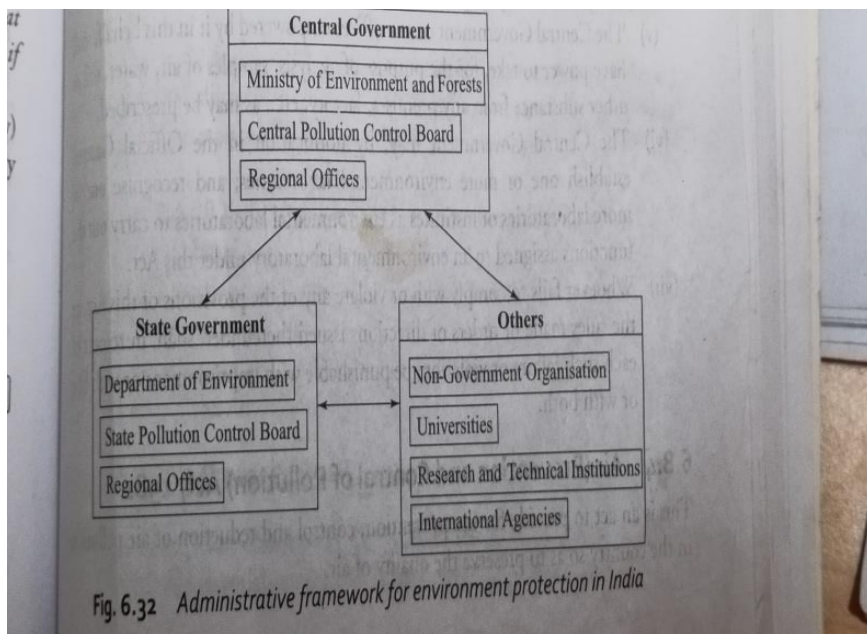


Fig. 6.32 Administrative framework for environment protection in India

Environment (Protection) Act, 1986

It is the umbrella legislation which authorizes the Central Government to

- (i) protect and improve environmental quality,
- (ii) control and reduce pollution from all sources, and
- (iii) restrict or prohibit the selling and/or operation of any industrial facility on environmental grounds.

According to the Act, the term “*environment*” includes water, air and land and the inter-relationship which exists among and between water, air, land, human beings, other living creatures, microorganisms, plants and property.

The main provisions of the Act are given below:

- (i) The Central Government shall have the power to take all such measures as it deems necessary or useful for the purpose of protecting and improving the quality of the environment and preventing, controlling and decreasing environmental pollution.
- (ii) No person carrying on any industry, operation or process shall discharge or emit any environmental pollutants or permit to do so in excess of such standards as may be prescribed.
- (iii) Where the discharge of any environmental pollutant in excess of the prescribed standards occurs or is bound to occur due to any accident or other unexpected act or event, the person responsible for such discharge and the person in charge of the place at which such discharge occurs or is expected to occur, shall be bound to prevent or reduce the environmental pollution caused as a result of such discharge and shall also immediately inform the fact of such occurrence or fear of such occurrence; and be bound, if called upon, to render all assistance to such authorities or agencies as may be advised.
- (iv) No person shall handle or cause to be handled any hazardous substance except in accordance with such procedure and after complying with such safeguards as may be prescribed.
- (v) The Central Government or any officer empowered by it in this behalf, shall have power to take, for the purpose of analysis, samples of air, water, soil or other substance from any premises, factory, etc., as may be prescribed.

- (vi) The Central Government may, by notification in the Official Gazette, establish one or more environmental laboratories; and recognize one or more laboratories or institutes as environmental laboratories to carry out the functions assigned to an environmental laboratory under this Act.
- (vii) Whoever fails to comply with or violate any of the provisions of this Act, or the rules made or orders or directions issued thereunder, shall, in respect of each such failure or violation, be punishable with imprisonment or with fine or with both.

Air (Prevention and Control of Pollution) Act, 1981

This is an act to provide for the prevention, control and reduction of air pollution in the country so as to preserve the quality of air.

The salient features of the Air (Prevention and Control of Pollution) Act 1981 are given below:

- (i) Act is applicable to the whole of India.
- (ii) Under Section 19 of the Act, the State Government in consultation with the State Pollution Control Board (SPCB) has the power to declare Air Pollution Control Area, in which provisions of the Act shall be applicable.
- (iii) As per provisions in Section 21(1) and (2), no person can establish or operate any industrial plant without the previous consent of the State Pollution Control Board.
- (iv) Every application for consent shall be made in Form I and shall be accompanied by a prescribed fee. Within a period of four months after the receipt of application, the Board shall complete the formalities to either refuse or grant consent. During the course of processing consent for the application, the Board may seek any information about the industry after giving notice in Form II.
- (v) Under Section 22, 22(A) operating any industrial plant so as to cause emission of any air pollutant in excess of standard laid down by the State Board is liable for legal action by the Board.
- (vi) Under Section 2(a), the term *air pollutant* is defined as *any solid, liquid or gaseous substance present 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.*

Power of State Government

Under Section 19, the State Government may, after consultation with the State Board, by notification in the official gazette, declare, in such

manner as may be prescribed, any area or areas within the state as air pollution control area or areas for the purposes of this Act.

Under Section 21.3, no person shall without the previous consent of the State Pollution Control Board, establish or operate any industrial plant in an Air Pollution Control Area.

Under Section 22.4, no person operating any industrial plant in any Air Pollution Control Area shall discharge or cause or permit to be discharged, the emission of any air pollutant in excess of the laid-down standards by the State Pollution Control Boards.

Under Section 19.1, the State Government after consultation with the State Pollution Control Board, may

- Prohibit burning of any material causing or likely to cause air pollution in an Air Pollution Control Area
- Prohibit the use of any appliance or fuel causing or likely to cause air pollution in an Air Pollution Control Area

Wildlife Protection Act, 1972

(A) Objectives The objectives of the Wildlife Protection Act are

- (i) to maintain essential ecological processes and life-supporting systems.
- (ii) to preserve biodiversity; and
- (iii) to ensure protection and conservation of wildlife.

(B) Salient Features

- (i) Under Section 3, the appointment of Director, Chief Wildlife Warden and other officers is done by the Central Government.
- (ii) Under Section 6, Wildlife Advisory Board is constituted by the State Government or the Union Territory Administration. Under Section 7, the Wildlife Advisory Board shall meet at least twice a year.
- (iii) The duties of the Wildlife Advisory Board, under Section 8, are to advise the State Government about
 - (a) The selection of areas to be declared as.
 - National parks under Section 35,
 - Sanctuaries under Section 18, etc.
 - (b) The formulation of the policy for protection and conservation of wildlife and specified plants
 - (c) The measures to be taken for harmonizing the protection and conservation of wildlife with the needs of the tribals and other forest dwellers

- (iv) Under Section 44, the Act prohibits dealing in animal articles without license.
- (v) Under Section 38 A, the Central Government shall constitute the Central Zoo Authority which has various roles or functions as described in Section 38 C.

(C) Major Highlights of the Wildlife Protection Act, 1972

- (i) It provides for protection to listed species of flora and fauna and establishes a network of ecologically important protected areas.
- (ii) The act consists of 60 sections and VI schedules divided into eight chapters.
- (iii) It empowers the central and state governments to declare any area a wildlife sanctuary, national park or closed area. Industrial activities are banned in these protected areas.
- (iv) It provides for authorities to
 - (a) administer and implement the Act;
 - (b) regulate the hunting of wild animals;
 - (c) protect specified plants, sanctuaries, national parks, etc., and
 - (d) restrict trade in wild animals or animals articles.
- (v) The Act prohibits hunting of animals except with permission of an authorized officer when an animal has become dangerous to human life or property or as disabled or diseased as to be beyond recovery.

Forest (Conservation) Act, 1980

In 1980, the Forest (Conservation) Act was enacted for providing protection to forests and to regulate diversion of forestlands for non-forestry purposes.

Salient Features

- (i) Prior approval of the Central Government is essential for de-reservation of forest lands and/or diversion of forest lands for non-forestry purposes.
- (ii) It is a regulatory act, not prohibitory.
- (iii) The Forest (Conservation) Act is an interface between conservation and development.
- (iv) It permits sensible and regulated use of forestland for non forestry purposes.

During 1950–80, the rate of diversion of forestland for nonforestry purposes was 1.5 lakh hectares per annum. After enactment of the Forest (Conservation) Act, 1980, the rate came down to about 35 thousand hectares per annum.

At the time of granting approval under the Forest (Conservation) Act, following conditions are insisting upon:

- Compensatory afforestation
- Treatment of catchment area
- Reclamation of mining area in phases
- Provisioning for safety zone area
- Rehabilitation of project affected families
- Plan for wildlife management, etc.

On the directions of the apex court in 2002, a new present value of the forestland being diverted is being charged from the user agencies.

Water (Prevention and Control of Pollution) Act, 1974

“As defined in the Act, 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 uses or to the life and health of animals or plants or of aquatic organism.”

- i. The water (Prevention and Control of Pollution) Act was enacted for prevention and control of water pollution and maintaining or restoring of wholesomeness of water.

The Central and State Pollution Control Boards have been constituted under sections 3 and 4 of the later Act respectively.

- ii. Obligations on the part of industries and local bodies are
 - (a) To obtain prior consent to establish and operate industry for new discharge of domestic sewage or trade effluent under section 25 of the Act
 - (b) Board within four months will either refuse or grant consent
- iii. Power of State Board:
 - To obtain information under Section 20
 - Carry out any related work under Section 30
 - Collect and analyze samples of streams/wells or trade effluent under sections 17(2) and 52.
 - (a) To give direction for closure/prohibition or regulation under Section 33A.

- (b) Enter and inspect any place, examine any plants/records, etc., and seize if necessary under Section 23.

ISSUES INVOLVED IN ENFORCEMENT OF ENVIRONMENTAL LEGISLATION

Regulatory measures in the form of legislation check environmental degradation. They also lead to the enacting of laws at the national or international levels to prevent pollution. To protect the environment, the role of the judiciary lies in formulation and enforcement of effective laws. The judiciary alone cannot improve the environment unless the states and citizens do their duties and obligations.

Some important issues in the enforcement of environmental legislations are given here.

(i) **Public Apathy:** In contrast with conventional crimes such as rape, murder, dacoity, etc., pollution is treated as a white-collared crime. While conventional crimes are always taken seriously, the crime of pollution is generally taken for granted.

(ii) Limitations of Regulating Agencies

Poaching It is a big national problem despite the existence of the Wildlife Act. The Wildlife Department has no provision to punish poachers and unauthorized hunters unless they are caught red handed. In case they are caught, the standard excuse given by armed poachers is that they carried guns for self-defence from dangerous wild animals. Penalties by the Wildlife Department are nominal cash fines. Rich offenders continue poaching by paying such nominal cash fines to the Wildlife Department.

Water Pollution The chairman of the state pollution control board is the key person for the enforcement of the Water Act, 1974. He/she should be professionally qualified and appointed on a full-time basis. However, several State Pollution Control Boards are headed by part-time chairpersons without requisite qualifications and experience. Often, the member secretaries of the Pollution Control Boards are drawn either from the administrative service or even from the forest service. They do not have the required technical background in pollution control.

Thus, it becomes difficult for them to provide proper leadership and guidance to their subordinates. The enforcement action in such situations is obviously weak.

(iii) Legal Loopholes

- (a) The legal provision for penal action against the polluters requires that the State Pollution Control Board has to file a case before the lower court for action against a polluting unit. However, the lower courts are too busy to devote enough time for environment-related litigations. As a consequence, thousands of cases filed by the State Pollution Control Boards are still pending for years together. In some cases where decisions have been taken, the polluters were given the benefit of doubt due to absence of sufficient proof.
- (b) For prevention of pollution, a provision is available for a citizen to approach a court. For this, the citizen is required to give a notice of not less than 60 days to the government, of his/her intention to make a complaint. If the government does not act on the notice, then only the citizen can go to the court. For meaningful result, the court must give directives to the government or the enforcing authority to collect a sample and submit a report.

Thus, this exercise would give the culprit a period of at least 60 days to clean up all traces of its offence and prepare itself for sample collection.

- (c) The Factories Act, 1948, is an important legislation which provides for certain measures with respect to the industrial safety, health of the workers and welfare measures.

However, safety standards and maintenance procedures at various industries are not maintained. India has seen and suffered Bhopal tragedy on the night of December 23, 1984 which is considered the *worst industrial disaster in history*. The Bhopal tragedy was the result of a combination of legal, organisational, technological, and human errors. The accident occurred when toxic Methyl IsoCyanate (MIC) gas was accidentally released into the atmosphere. About 1 lakh people died and more than 2 lakh people were severely disabled. Even after 26 years of the accident, thousands of the poorest members of the population of shanty towns are still suffering.

- (iv) **Lack of Knowledge** While urban citizens cry for stopping pollution and consumerism from one side, they watch television,

see advertisements, purchase new vehicles, gadgets, luxury items and cosmetics whose ecological footprints are large. These urban citizens unknowingly became creators of pollution.

(v) **Lacuna in Implementation** Pollution Control Boards cannot take action against municipal corporations or other civic bodies because they are not empowered to do so. These Pollution Control Boards are empowered to stop industrial water pollution but they cannot fight with rich industrialists. Thus, the public is forced to suffer from use of polluted water.

Despite the various legislations, there is a depletion of forest resources because of commercial exploitation. The present and future generations are bound to suffer from deforestation-linked flood, soil erosion, siltation of water bodies, loss of biological and genetic diversity, etc.

(vi) **Intellectual Indifference** In the Environment Protection Act, all power and authority is reserved in the hands of the Central Government. For the efficient execution of the provisions of the Act, this excessive centralisation is a major burdle.

(vii) **Limitations of Environmental Risk Assessment** Scientific knowledge regarding the potential impacts of Persistent Organic Pollutants (POPs) and endocrine disrupting chemicals on human health and environment is not completely understood because of the complexity of natural ecosystems and limitations in experimental design.

For environmental protection, *The Precautionary Principle* is applied in such circumstances where there are reasonable grounds for concern that an activity is, or could, cause harm but risk is uncertain.

The Precautionary principle directs that action should be taken to correct a problem the moment there is evidence that harm may occur, not after the harm has already occurred. For example, the German Government in 70's ordered to reduce power plant emissions when they realised that forests were suddenly dying because of the acid rain.

Thus, lack of full scientific certainty shall not be used as a reason for postponing cost-effective measures to prevent environmental degradation from substances or activities which cause threats of serious or irreversible damage.

(viii) **Poverty** Affordable food, shelter, clothing, medicine and minimum education for their children are the high-priority

necessities of the poor. They do not have enough money to practice environmental conservation strategies used by the rich. They exploit the environment to generate income. For growing crops, they encroach watershed areas. They live in slums as they cannot afford proper sanitation and waste treatment. They can only purchase cheaper products made in factories where proper pollution control devices are lacking. Thus, survival activities of the poor indirectly contribute to environmental degradation.

According to Polluter-Pays Principle, those who pollute the environment must pay for the damages they have caused. This principle will burden the poor in order to create a better environment for the rich to enjoy. If enforced, this principle will certainly widen the real income gap and can even be interpreted as socially undesirable or morally unjust.

- (a) Suppose forest encroachment is conducted by the poor landless farmers.

According to the Polluter-Pays Principle, they will be liable for causing flooding, soil sedimentation in irrigation and/or hydropower dams.

However, the wealthy people or factory owners will benefit from keeping the forests intact, namely in terms of water supply or hydropower electricity, or as a recreation site. Thus, according to the *Beneficiary-Pays Principle*, the rich should pay for the cost of forest conservation.

- (b) We know that for reducing air pollution, commuters should use public transport instead of personal vehicles. The poor commuters use public buses not for reducing pollution but because they cannot afford personal vehicles.

In order to finance better quality buses which cause minimum air pollution, the Polluter-Pays Principle requires the poor commuters to pay a higher charge as they use public buses.

The alternative Beneficiary-Pays Principle argues that cleaner and less smoky buses should be financed by all city residents and not just by bus commuters. This is because everyone will enjoy the clean air.

What is Environmental Impact Assessments?

EIA full form is Environmental Impact Assessment. The meaning of EIA is that it is a process through which an environmental impact of a proposed development is evaluated. EIA is a tool used to assess the positive and negative environmental, economic, and social impacts of a project. This is used to predict the environmental impacts of a project in the pre-planning stage itself so that decisions can be taken to reduce the adverse impacts.

Impact analysis of the projects

Before starting a major project, it is essential to assess the present environment without the project and the likely impact of the project on environment after its completion. For analysis of the impacts experts from various disciplines should be involved. The EIA should have the following objective:

- Predict environmental impacts of project after its completion
- Find ways and means to reduce the negative impacts
- Shape the project to make it conducive to the local environments
- Present the predictions and viable options to policy makers.

Before any development project is taken up, there should be an analysis of the project by comparing its positive and negative impacts.

Positive impacts of developing new projects are:

1. Increase in the small scale industries
2. Increase in employment to the local people
3. Improved standards of living because of improved infrastructures

Negative impacts of developing new projects are:

1. Deterioration in the quality of local environment (air, water and soil).
2. Deforestation which may subsequently lead to soil erosion.
3. Natural flora and fauna is disturbed which disturbs the ecosystem.
4. May lead to increased level of noise pollution.

For assessment of the large scale projects it is useful to list the environmental parameters which are likely to be affected. Some of the parameters are listed below:

Development Projects	Environment Parameters
Large scale industries (Power plants, manufacturing and processing units, construction work etc.	<div>→ Air quality</div> <div>→ Land quality (land use, soil erosion, seismology, geology</div> <div>→ Water quality(Surface water and ground water quality</div> <div>→ Public health, noise pollution etc.</div> <div>→ Natural flora and fauna (Ecology)</div> <div>→ Socio-economic factors (employment, rehabilitation etc.)</div>

Thus the EIA statement should cover brief description of the positive and negative aspects of any development project, the mitigation and protection measure, consideration of alternatives and its summary with conclusions.